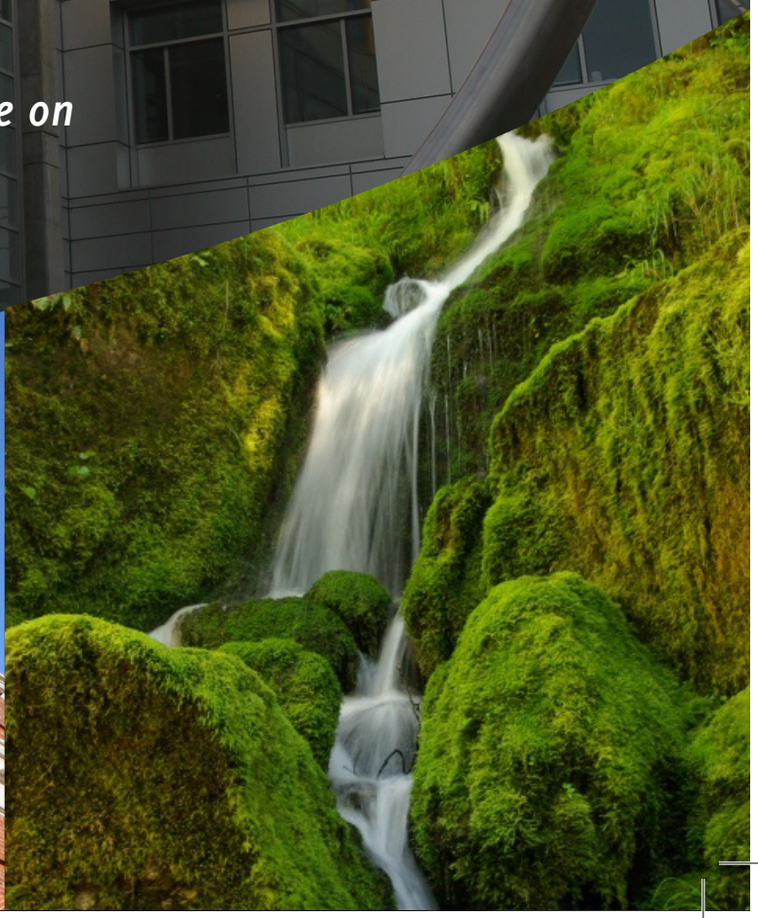
2011 MSEC/NAMRC/ICM&P CONFERENCE

Exploring the Role of Manufacturing Engineering in Innovation and Economic Development

June 13-17, 2011
Oregon State University
Corvallis, Oregon

- *2011 ASME International Manufacturing Science and Engineering Conference (MSEC)*
- *39th Annual SME North American Manufacturing Research Conference (NAMRC)*
- *2011 JSME/ASME International Conference on Materials Processing (ICM&P)*



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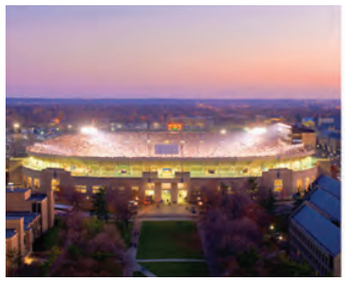


The University of Notre Dame is pleased to invite you to attend the **2012 joint manufacturing conference**, combining:

1. The annual ***International Manufacturing Science and Engineering Conference*** (MSEC 2012). MSEC is the foremost annual forum sponsored by the Manufacturing Engineering Division (MED) of the American Society of Mechanical Engineers, intended to disseminate the most recent manufacturing research and development through both technical and panel sessions.
2. 40th Annual SME ***North American Manufacturing Research Conference*** (NAMRC XL). NAMRC is the premier international forum for applied research and industrial applications in manufacturing and design. Sponsored by the North American Manufacturing Research Institution of SME, global academic and industrial leaders in manufacturing attend this conference to interact with each other and advance the field.
3. 5th ***International Conference on Tribology in Manufacturing Processes*** (ICTMP5). Sponsored by the International Tribology in Manufacturing Research Group, the ICTMP is the bi-annual international meeting bringing together leading research in friction, lubrication and wear applied to manufacturing.

The 2012 location for these conferences is the University of Notre Dame, just outside South Bend, Indiana. Notre Dame is world renown for its storied athletic history, and ranks among the Nation's Top 25 Institutions of Higher Learning. With 1250 acres containing two lakes and 137 buildings, Notre Dame is well-known for the quality and beauty of its campus.

South Bend is centrally located in the Chicago-Detroit corridor. The home of the Studebaker brand of automobiles, a large number of automotive suppliers remain in South Bend and the surrounding area. Nearby Warsaw, Indiana is the Orthopedics Capital of the World, where three of the top five orthopedics companies maintain their headquarters. In addition, the recreational vehicle industry is centered in Elkhart, Indiana.

Visit *www.nd.edu/~namrcxl* for more details and updated information.

ASME SETTING THE STANDARD

NAMRI SME® North American Manufacturing Research Institution of SME

ITMPRG International Tribology in Manufacturing Research Group

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SETTING THE STANDARD

NAMRI SME
North American Manufacturing
Research Institution of SME

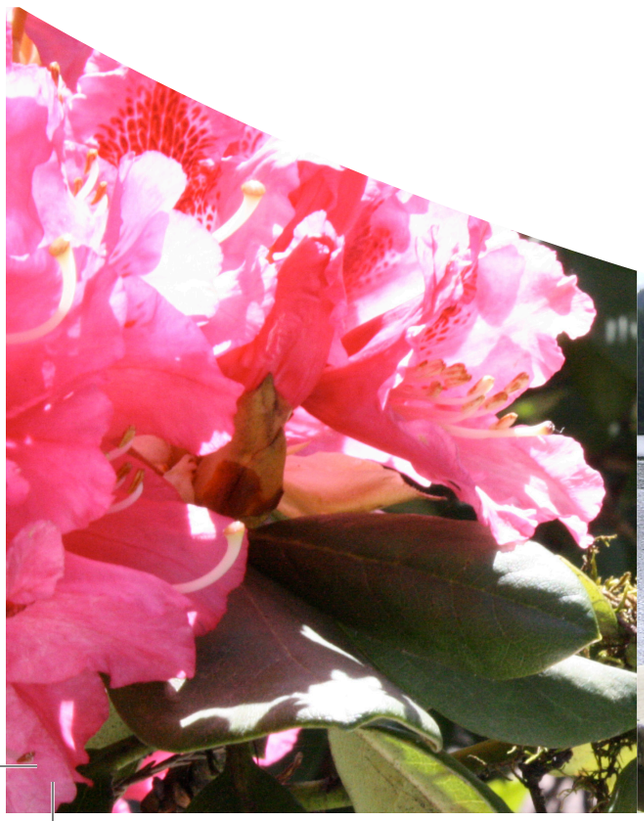
JSME

Oregon State UNIVERSITY OSU

Oregon State University has always been a place with a purpose — making a positive difference in quality of life, natural resources and economic prosperity in Oregon and beyond. Through discovery, innovation and application, we are meeting challenges, solving problems and turning ideas into reality.

Oregon State welcomes a diverse student body of nearly 24,000 students from across Oregon, all 50 states and more than 100 countries.

Oregon State also ranks high in sustainability, fourth among universities nationwide for using renewable energy and first in the Pac-10 Conference. And our students literally help power the university: 22 exercise machines at Dixon Recreation Center are connected to the grid.



GREETINGS FROM THE CONFERENCE COORDINATING COMMITTEE CHAIR

A conference having this kind of involvement from three professional societies does not happen overnight. I first would like to thank the leadership teams of each society for being visionary, open-minded, patient and collaborative. Next, I would like to thank the members of the Conference Coordinating Committee for their dedications of their wisdom and effort to the strategic planning of this conference and its future ones. These members are Drs. John Agapiou, Matt Bement, Kevin Chou, Steven Hayashi, Brad Kinsey, Shreyes Melkote, John Roth, Z. Cedric Xia, and Lawrence Yao. In addition, special thanks go to Dr. Robert Ivester for his smooth work on the MOU, to Dr. Hitomi Yamaguchi Greenslet for being an excellent ambassador for both sides of the Pacific Ocean, and to Dr. Brian Paul and his team for unconditionally taking over this new challenge.

Finally, on behalf of our CC members, I would like to welcome you to the collocated conferences in beautiful Corvallis. A special welcome goes to our Japanese colleagues for overcoming the difficulties after Mother Nature demonstrated her indisputable power. We hope you will take advantage of this international conference setting to meet old friends, make new acquaintances, find talents for your firms, and establish new collaborations. Enjoy the conference!

With my best wishes,

Jian Cao, Ph.D., FASME, FSME

Northwestern University

WELCOME FROM THE HOSTS

On behalf of the MSEC/NAMRC/ICM&P Organizing Committee and Oregon State University (OSU), we would like to welcome you to the mid-Willamette Valley for the 2011 ASME International Manufacturing Science and Engineering Conference (MSEC), the 39th Annual SME North American Manufacturing Research Conference (NAMRC), and the 2011 JSME/ASME International Conference on Materials and Processing (ICM&P). The theme of this first ever collocated set of conferences is to explore the role of manufacturing engineering in innovation and economic development.

While Oregon is noted for its beauty, manufacturing technology has helped it transform from a resource-based, tourism economy to a high-tech manufacturing economy. The Portland high technology corridor, known as the Silicon Forest, is home to over 1,000 high technology companies and corporate manufacturing leaders. OSU has played a big role in this transformation. Since its founding in 1889, the College of Engineering at OSU has graduated over 29,000 engineers. Currently, the college houses thirteen undergraduate degree programs enrolling about 3,100 undergraduate students and awarding about 595 baccalaureate degrees annually, ranking it 25th nationally. One-third of our graduates participate in cooperative learning experiences involving two 6-month internships in industry. Our education of graduate engineering students in micro and nanomanufacturing is enhanced through commercialization efforts ongoing in OSU facilities like the Microproducts Breakthrough Institute.

This year's conference has been designed with the help of industry for industry. We are dedicating a significant portion of the program to industry keynotes and panels to increase industrial participation. Multiple student events and competitions are being used to reach out to the next generation. Further, through the many nights of hard work from our three Program Chairs and the diligent efforts of the three conference scientific committees, we have assembled an excellent technical program of research papers, presentations and posters.

Special thanks are due to Ms. Donna Williams and Ms. Maya Perez of OSU Conference Services and Professors Toni Doolen and Belinda Batten for their creativity and hard work that have helped make this event a reality. Thanks also go to the collocation coordinating committee and the many volunteers, organizers and panelists that have made this a truly unique event.

Our sincere appreciation also goes to our sponsors including the Oregon Nanoscience and Microtechnologies Institute, the OSU College of Engineering, Los Alamos National Laboratory, Pacific Northwest National Laboratory, GE Global Research, Boeing, Aerotech, and NIST without which the conference could not have been possible. Finally, we would like to thank all of you for showing your support by attending the conference. We sincerely wish all of you an enjoyable stay in Corvallis and hope you find inspiration for your work in advancing manufacturing engineering education and technology.

Brian Paul, Professor
Oregon State University
Host Committee Chair

Karl Haapala, Assistant Professor
Oregon State University
Host Committee Co-Chair

WELCOME FROM THE LEADERSHIP OF ASME/MED, NAMRI/SME AND JSME/MPD

On behalf of our three organizations, we would like to welcome you to the first collocated MSEC/NAMRC/ICM&P Manufacturing Research Conference. This collocated event has been several years in the making, with many details hammered out by the Coordinating Committee chaired by Professor Jian Cao. The goal of collocation is better service to the manufacturing engineering research community. We believe that collocating will increase the visibility of this community; expand the participation in academia, industry and national laboratories; facilitate broader coverage of manufacturing topics; and promote efficiency of intellectual exchange. Many participants are members of multiple societies and a single large conference can be cost effective.

At the core of the collaboration is an annual event between ASME/MED and NAMRI/SME. This year JSME/MPD also joins, enabling a truly grand event. Future conferences bring the possibility of periodic partnerships with global sister organizations and synergies with complementary organizations.

While collocation has created a common framework for the three conferences, we still retain our individual characters. Each society retains ownership of topics, solicitation, paper review and quality standards, publication, presentation scheduling, honors, awards and key events. We try to preserve the best of our individual natures and open ourselves to collaboration and sharing.

Of course, any change will have some inevitable negatives, but we endeavor to minimize these. We welcome and appreciate your comments and suggestions for future changes in any aspect of the conference. And for things that are good, positive comments will help us to reinforce the best features.

Many thanks to our host, Oregon State University, and the dedicated organizing committee led by Professors Brian Paul and Karl Haapala with committee members Professors Toni Doolen, Belinda Batten and John Parmigiani. Thanks also to the hardworking student volunteers, support staff, symposium organizers, reviewers, panelists, scientific committees, and session chairs.

Y. Lawrence Yao
Chair, ASME/MED

Steven R. Hayashi
President, NAMRI/SME

Naoto Ohtake
Chair, JSME/MPD

FOREWORD FROM THE MSEC/ICM&P PROGRAM CHAIRS

On behalf of the Technical Program Committees, we are pleased to present this Conference CD that symbolizes the continued collaboration between the ASME Manufacturing Engineering Division (MED) and the JSME Materials & Processing Division (MPD) in research exchanges and disseminations in the Manufacturing, Materials and Processing fields. The CD consists of the technical papers (total 260) and research posters (total 18) presented at the Sixth ASME International Manufacturing Science and Engineering Conference (MSEC) and the Fourth JSME/ASME International Conference on Materials and Processing (ICM&P), collocated at and hosted by Oregon State University in Corvallis, Oregon, USA, from June 13-17, 2011. This is the second joint event between the two conferences that offer the flagship forum in such fields at an international level, embodying authors from over 20 countries around the world. We are indeed encouraged by the fact that well over 300 presentations will be made at this joint conference. The details of the presentations are: 165 ASME technical presentations, 95 JSME technical presentations, 11 MSEC and 10 ICM&P poster presentations. In addition, there will be a number of Keynote Lectures, more than 25 Plenary/Technical Panel presentations with timely topics, several Invited Speakers, an Early Research Career Forum, and three Workshops, jointly developed by the host institute. Moreover, there will be 9 exciting entries of the ASME Student Manufacturing Design Competition.

MSEC and ICM&P each have their individual focused activities and unique research fields. MSEC is involved in such manufacturing areas as machining, process simulation and monitoring, green energy manufacturing, nontraditional manufacturing, manufacturing systems, and laser processing, just to name a few. On the other hand, ICM&P has abundant expertise in dealing with different conventional and emerging engineering materials such as, from an exhaustive list, polymers, metals, ceramics, various types of composites, and multi-functional as well as smart materials, etc. Further, both conferences concurrently have research activities overlapped to some extent in metal forming, mechanical characterizations, material behaviors, and micro/nano technologies, etc. By bringing the two conferences together, it has shown certain contents of strong coherence, and yet other subjects being unique on its own. Hence, this conjunction will unquestionably cultivate a dynamic and stimulating environment to all the participants. Equally inspiring, the MSEC-ICM&P this year coincides with the first-ever annual collocated meetings between MSEC and another core international manufacturing conference, the North American Manufacturing Research Conference (NAMRC) sponsored by the North American Manufacturing Research Institution of the Society of Manufacturing Engineers (NAMRI/SME), which will take the joint event to a new high of research dialogues.

The papers and posters included in the CD were contributed from 4 technical tracks and 35 symposia. Every single paper submitted to the conference was put through a rigorous peer review conducted by the respective track and symposium organizers. We are in debt to all the organizers for their dedicated management of the symposia as well as for guarding the quality of the papers and posters to be presented, which have contributed a great deal to the success of the conference technical program. Thanks are also due to all reviewers for their critical assessment of a very large number of submissions.

We would like to acknowledge a few groups for their leadership and guidance to the program, including the ASME MED Executive Committee, JSME MPD Executive Committee, the Host Organizing Committee and the Conference Coordinating Committee. We would also like to extend our appreciations to all conference sponsors for providing the financial support. Additionally, MSEC would like to thank the National Science Foundation, Manufacturing and Construction Machines and Equipment Program, for providing US student participants, for the third year, with generous travel funding. Last, but not the least, ASME conference web-tool staff has done an outstanding job ensuring seamless manuscript processing and the high-quality paper publication.

We hope that you all find this Conference CD beneficial as well as the joint conference enjoyable, and we sincerely wish your long-lasting affiliation and contributions to the future MSEC and ICM&P.

Kevin Chou
The University of Alabama, USA
2011 MSEC Technical Program Chair

Hiroshi Asanuma
Chiba University, Japan
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University of Florida
2011 MSEC Technical Program Vice-Chair

Satoshi Kishimoto
National Institute for Materials Science, Japan
2011 ICM&P Technical Program Vice-Chair

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2011 MSEC/NAMRC/ICMP Schedule

June 13-17, 2011

Corvallis, Oregon

Monday, June 13, 2011		
Time	Activity	Location
8:30-19:30	Registration	CH2M Hill Alumni Center Foyer
8:30-15:30	NAMRI/SME Board Meeting	TBD
9:00-13:00	Workshop 1- Sustainable Nano Manufacturing Workshop Greg Herman	TBD
9:00-13:00	Workshop 2- NW Collaboratory Sustainable Manufacturing (NWCSM) Research Agenda, Norm Eder, Manufacturing 21	TBD
9:00-13:00	Workshop 3- JSME Organized Workshop Smart Materials and Related Technologies JSME- Hiroshi Asanuma	TBD
15:45-18:00	OSU Tours	Hinsdale Wave Lab, SAE Racing Headquarters
17:30-19:30	Reception	
Tuesday, June 14, 2011		
Time	Activity	Location
7:30-18:00	Registration	CH2M HILL Alumni Center Foyer
7:30-8:00	Continental Breakfast	CH2M HILL Alumni Center Foyer
8:00-8:15	Welcome	CH2M HILL Alumni Center Ballroom
8:15-9:00	Keynote Keynote: Chandra Brown, The Role of Casting Foundries in Advancing Clean Energy Organized by OSU	CH2M HILL Alumni Center Ballroom
9:00-10:15	Panel – Sustainable Manufacturing Matt Carter, Betsy Lenger, Boeing Organized by Boeing/OSU	CH2M HILL Alumni Center Ballroom
10:15-10:30	Break	
10:30-12:00	ASME/MED EC Meeting	TBD
10:30-12:00	9 Concurrent Technical Sessions (1-36)	Alumni Center/LaSells Stewart Center
12:00-13:00	Lunch – ASME	CH2M HILL Alumni Center Ballroom
13:00-14:15	Panel-Manufacturing Research Toward Sustainable Transportation	CH2M HILL Alumni Center Ballroom

2011 MSEC/NAMRC/ICMP Schedule

June 13-17, 2011
Corvallis, Oregon

13:00-14:30	9 Concurrent Technical Sessions (37-72)	Alumni Center/LaSells Stewart Center
14:30-14:45	Break	
14:45-16:15	9 Concurrent Technical Sessions (73-108)	Alumni Center/LaSells Stewart Center
16:15-17:00	NAMRI/SME Membership Meeting	TBD
17:00-17:45	ASME Membership Meeting	TBD
16:15-18:15	Early Career Forum Organized by Yong Huang, Clemson (ASME)	TBD
18:00	TYEE Winery Dinner: Shuttles will begin leaving at 6:00pm	Tyee Wine Cellars
22:00	Shuttles back to Hotels by 22:00 (10:00pm)	
Wednesday, June 15, 2011		
Time	Activity	Location
7:30-17:00	Registration	CH2M HILL Alumni Center Ballroom
7:30-8:00	Continental Breakfast	CH2M HILL Alumni Center Ballroom
8:00-8:45	Keynote Bryan Dods, General Electric Organized by OSU	CH2M HILL Alumni Center Ballroom
8:45-10:15	Panel – 21st Century Manufacturing Paradigms Organized by Barry Rahimian	CH2M HILL Alumni Center Ballroom
10:15-10:30	Break	
10:30-12:00	9 Concurrent Technical Sessions (109-144)	Alumni Center/LaSells Stewart Center
12:00-13:15	Lunch – NAMRI/SME Founders Lecture Organized by SME	CH2M HILL Alumni Center Ballroom
13:15-14:30	Panel-SME Manufacturing Education	CH2M HILL Alumni Center Ballroom
13:15-14:45	9 Concurrent Technical Sessions (145-180)	Alumni Center/LaSells Stewart Center
14:45-15:00	Break	
15:00-16:30	9 Concurrent Technical Sessions (181-216)	Alumni Center/LaSells Stewart Center
16:30-18:30	MBI Tours and Reception, and Awards Banquet Shuttles begin leaving at 18:30	Microproducts Breakthrough Institute
Thursday, June 16, 2011		

2011 MSEC/NAMRC/ICMP Schedule

June 13-17, 2011

Corvallis, Oregon

Time	Activity	Location
7:30-17:00	Registration	CH2M HILL Alumni Center Ballroom
7:30-8:00	Continental Breakfast	CH2M HILL Alumni Center Ballroom
8:00-8:45	JSME Keynote Organized by JSME	CH2M HILL Alumni Center Ballroom
9:00-10:15	Panel – Lean Manufacturing Organized by OSU/NWPEC	CH2M HILL Alumni Center Ballroom
9:00-10:15	Panel – Manufacturing Engineering Education Panel Organized by SME (Ajay Malshe)	CH2M HILL Alumni Center Ballroom
10:15-10:30	Break	
10:30-12:00	9 Concurrent Technical Sessions (217-252)	Alumni Center/LaSells Stewart Center
12:00-13:15	Lunch – JSME Lunch Organized by JSME	CH2M HILL Alumni Center Ballroom
13:15-14:45	9 Concurrent Technical Sessions (253-288)	Alumni Center/LaSells Stewart Center
14:45-15:00	Break	
15:00-16:30	9 Concurrent Technical Sessions (289-324)	Alumni Center/LaSells Stewart Center
16:30-18:00	OSU Tours	
Friday, June 17, 2011		
Time	Activity	Location
7:30-14:00	Registration	CH2M HILL Alumni Center Ballroom
7:30-8:00	Continental Breakfast	CH2M HILL Alumni Center Ballroom
8:00-9:30	9 Concurrent Technical Sessions (325-360)	Alumni Center/LaSells Stewart Center
9:30-9:45	Break	
9:45-11:15	9 Concurrent Technical Sessions (361-396)	Alumni Center/LaSells Stewart Center
11:15-12:15	Closing Lunch	CH2M HILL Alumni Center Ballroom
12:30-15:00	HP Tours	Hewlett Packard Campus

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ACKNOWLEDGEMENTS

A special thank you for all the hard work from the following individuals without whose support the conference would not have been successful.

MSEC/ICM&P Symposium Organizers:

Sontipee Aimmanee
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LIST OF MSEC/ICM&P TRACKS AND SYMPOSIA

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Symposium 1-2 Metal and Metal Matrix Composites
Symposium 1-3 Ceramics and Ceramic Matrix Composites
Symposium 1-4 Adhesion and Interface
Symposium 1-5 Functional/Multi-Functional Materials
Symposium 1-6 Smart Materials and Structures
Symposium 1-7 Recycling of Composites

Track 2 Processing

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Symposium 2-2 Advanced Casting and Semisolid Forming Techniques
Symposium 2-3 Advanced Powder Processing Technique
Symposium 2-4 Advanced Welding and Bonding Technology
Symposium 2-5 Thermal and Cold Spray Coatings
Symposium 2-6 Green Energy Manufacturing
Symposium 2-7 Advances in Nontraditional/Hybrid Manufacturing
Symposium 2-8 Manufacturing with Soft Materials
Symposium 2-9 Advances in Biomanufacturing
Symposium 2-10 Advances in Modeling, Analysis, and Simulation of Manufacturing Processes

Track 3 Properties, Applications and Systems

Symposium 3-1 Mechanical Characterization and Measurement Techniques
Symposium 3-2 Contact Surface Mechanics, Fracture and Reliability
Symposium 3-3 Surface Modification Technology, Wear and Tribology
Symposium 3-4 Dynamic Behavior of Materials and Structures
Symposium 3-5 Monitoring, Sensing, and Control for Intelligent Machining and Inspection
Symposium 3-6 Manufacturing Research Toward Sustainable Transportation
Symposium 3-7 Advances in Quality and Process Control in Manufacturing Systems
Symposium 3-8 CAD Based Information Integration in Product and Production Development
Symposium 3-9 Advances in Pervasive Sensing and Computing for Manufacturing Systems
Symposium 3-10 Nondestructive Testing
Symposium 3-11 Manufacturing System Operations

Track 4 Micro and Nano Technologies

Symposium 4-1 MEMS, NEMS and Biologic Application
Symposium 4-2 Nanomaterials, Nanofabrication and Their Applications
Symposium 4-3 Sustainable Nanomanufacturing
Symposium 4-4 Advances in Traditional Nano/Micro/Meso Manufacturing Processes
Symposium 4-5 Micro-Nano Assembly Systems and Applications
Symposium 4-6 Laser Based Meso/Micro/Nano Manufacturing
Symposium 4-7 Ultra-Precision and Micro/Nano Forming of Materials

STUDENT MANUFACTURING DESIGN COMPETITION

We would like to congratulate all of our student manufacturing design competition finalists and welcome them to the MSEC Conference. We would also like to invite all conference participants to attend the presentations by these outstanding future engineers.

List of teams participating in MSEC 2011 student design competition:

Lead Participant	Other Team Members	University	Project Title	Faculty Advisor
Mathew A. Kuttolamadom	Joshua J. Jones	Clemson ICAR	Lightweight Engineering Focused Redesign, Manufacture, and Validation of an Unsprung Vehicle Component for Total Life-Cycle Cost Savings	Laine Mears
Ethan Thibaudeau	Parris Ballentine Alex Lippincott Jordan Kusch	University of New Hampshire	Electromagnetic Metal Forming Machine	Brad Kinsey
Weichao Wu		Northwestern University	Micro Electrode Tube Non-Circular Flaring Process and Desktop Micro Flaring System	Jian Cao
Alex Weisser	16 other team members	RPI	M1A1 Abram's Tank Model	Sam Chiappone, Larry Ruff
Anthony Morin	Lauren Heimann	University of New Hampshire	Smart Tool Torque Calibration Test Stand	Barry Fussell
Axel Fehrenbacher		University of Wisconsin	Wireless Real-Time Data Acquisition System for Process Instrumentation and Closed-Loop Control of Friction Stir Welding	Frank Pfefferkorn
Matthew Standley	Kyle Shaughnessy Russell Wilcox	University of New Hampshire	Automation of Non-Destructive Ultrasonic Transmission Scanning of Piping and Tubing	Brad Kinsey
Michael Church	Peter Nguyen Derek Rampersaud	Oregon State University	Paintbrush Rework SOP	Kenneth Funk II
Austin Jolley	15 other team members	RPI	G.I.A.N.T. – Wind Turbine Model	Sam Chiappone, Larry Ruff

KEYNOTE SPEAKERS

Chandra Brown, Vice President
Oregon Iron Works, Inc.

Tuesday, June 14, 0815, Ballroom, Alumni Center

Topic: The Role of Casting Foundries in Advancing Clean Energy

Ms. Brown has worked for Oregon Iron Works, Inc. (OIW) for over 15 years and has held a variety of positions during her tenure with the company. She is currently President of a newly created subsidiary of OIW called United Streetcar, dedicated to offering American built streetcars throughout the United States.

As OIW's Vice President, she is responsible for overall business development and marketing activities. She is also the primary point of contact for all Government Relations activities on behalf of OIW in the Pacific Northwest and Washington, D.C. She has assisted in raising OIW's profile to be one of the 10 Overall Most Admired Companies in Oregon as published in the Portland Business Journal.

In addition to her work at OIW/United Streetcar, Ms. Brown serves on many non-profit boards and does community volunteer work. In August 2010 she was appointed to serve on the U.S. Manufacturing Council by Secretary of Commerce Gary Locke. In February 2010 she was nominated and appointed to the Oregon Business Development Commission by Oregon Governor Kulongoski. She was also appointed by the Governor to serve on the Oregon Innovation Council.

She is on the board of directors and chair's the Pacific Northwest Defense Coalition, which is a non-profit for the advancement of defense work in the region. She is a founding member and on the board of the Oregon Wave Energy Trust, a non-profit with the goal of promoting the emerging wave energy industry to create jobs and economic development opportunities in the U.S. She also serves on an arts advocacy board, the Creative Advocacy Network, the Oregon Women's MBA board, and is a member of the Oregon Museum of Science & Industry's gala committee. Other volunteer work includes participating in SOLV's beach clean up and, in the past, she has volunteered with the Multnomah County District Attorney's Office as a rape victim advocate.

In 2005, Ms. Brown was selected as one of Oregon Business Magazine's Top 50 Business Leaders in the state. In 2006, Ms Brown was selected to be a member of the Leadership Portland Class through the Portland Business Alliance and in 2007 she was named one of the Portland Business Journal's Forty under 40 leaders in the state. Most recently she was named one of the Top 20 People to Watch in 2008.

Ms. Brown received a Bachelor's Degree in Marketing and an M.B.A. in International Marketing from Miami University. She successfully completed both degrees in four years and was a distinguished academic member of the Honors College.

Currently she lives in a historic 90+ year old house in Southeast Portland and enjoys international travel as well as scuba diving, snowboarding, camping, Sudoku, and wine.

Professional Affiliations:

U.S. Manufacturing Council – Member
Oregon Business Development Commission – Board Member
Pacific Northwest Defense Coalition – Chair/Board of Directors
Oregon Wave Energy Trust – Founder & Board Member
Oregon Innovation Council – Member & Chair of Communications Committee (appointed by Oregon Governor Ted Kulongoski)
Creative Advocacy Network – Board Member
Ocean Renewable Energy Coalition – Board Member
Oregon Museum of Science & Industry – Gala Board Member
Oregon Women's MBA – Board Member
Act for Art Regional Steering Committee – Member
Portland Business Alliance – Member – Leadership Class of 2007
Community Streetcar Coalition – Member
Manufacturing 21 – Member

Jake Nichol, President/CEO
Leatherman Tool Group

Tuesday, June 14, 1200, Ballroom, Alumni Center

Topic: Manufacturing: The Sweet Smell of Cutting Oil

Personal:

Married – Darnell – 37 Years (Small Town Utah Girl)
Children – 5 Cydney/Tanner/Paige/Logan/Parker
Grandchildren 9 – Avery/Peyton/Brooklyn/Reese/Beck/Calla/Saylor/Ashyton/Ford
Born – Salt Lake City, Utah – 1952 (You do the math)
Lived – Utah, California, Georgia, Singapore, Connecticut, Maryland, Oregon
Traveled – +/- 100 Countries
Interests – Family, Church, Youth, Outdoors, Sports – Skiing, Fishing, Hunting, Hiking, Tennis, Soccer

Career Highlights:

The Stanley Works (Stanley Tools) – 24 Years
1974-84 – Sales/Sales Leadership – (California)
1984-88 – Sales/Marketing Leadership – (Georgia)
1989-93 – President Stanley Proto Industrial Tools (Georgia)
Brands – Stanley Tools, Proto, Husky, Blackhawk
1993-96 – President Stanley Works Asia-Pacific (Singapore)
1996-97 – President Stanley Mechanics Tools (Connecticut)

Danaher Corporation – 8 Years
1997-2005 – President Danaher Tool Group PTD. (Maryland)
Brands – Craftsman Tools, Armstrong, Allen, Jacobs, K-D

Leatherman Tool Group Inc – Present
2005 – Present President/Chief Executive Officer – (Oregon)
Brands – Leatherman, LED Lenser

Community/Professional :

Boy Scouts of America – Cascade Pacific Council – Board Chair
Big Brothers Big Sisters Columbia Northwest– Immediate Ex -Board Chair
Industrial Distribution Association – Board of Directors (Past)
ISA Manufacturing Association – Board of Directors (Past)
Leupold Stevens Corp – Board of Directors (Current)

Education:

University of Utah 1970-74 – Marketing

Jake's Business Tenets:

Integrity in Everything We Do
People, Plan and Processes – In a Culture of Discipline
Imagination and Innovation – Define Our Future
Safety, Quality, Delivery, Cost – 'And' NEVER 'Or' – Genius of And/Tyranny of Or
VOC (Voice of Customer) We Listen and This Drives Our Strategy
Continuous Improvement – It's Our Way of Life
Confront the Brutal Facts – Make It Ugly
Muda (Japanese for "Waste") – Search and Destroy Everyday/Everywhere
Breakthroughs Change the Game –Identify/Allocate/Measure/Manage

Bryan Dods
Executive Manufacturing Technology Leader, GE Energy

Wednesday, June 15, 0800, Ballroom, Alumni Center

Topic: Energy Innovation Enabled by Manufacturing

Bryan Dods serves as the Executive, Manufacturing Technology Leader for GE Energy. The Manufacturing Technology organization has responsibility for new product and technology introduction across GE Energy's global factory and supplier network. Before joining GE Energy in 2008, he spent 21 years in the aerospace industry. Bryan has 23 years of manufacturing experience in various quality assurance, production management, and technology development roles. He has been active in re-establishing manufacturing as a competitive advantage through participation with industry consortiums, government agencies, research institutes and universities.

He was selected to the National Academy of Engineering Frontiers of Engineering program in 2004, served on the Centre of Excellence for Customised Assembly board for the United Kingdom's Advanced Manufacturing Research Center and served as the Industry Advisory Board chairman for the National Science Foundation's Industry/University Collaborative Research Center for Intelligent Maintenance Systems. Bryan is currently building GE Energy's newly created Manufacturing Technology organization using a distributed manufacturing technology center model to utilize the best of GE's internal resources and leverage partnerships with global external resources. Bryan holds a Bachelor of Science degree in Metallurgy, Mechanics, & Materials Science from Michigan State University, a Masters of Science degree in Materials Engineering from Washington University in St. Louis, and a Masters of Business Administration degree from Washington University in St. Louis.

Ranga Komanduri, Ph.D., D. Eng.

Wednesday, June 15, 1200, Ballroom, Alumni Center

NAMRI/SME Founders Lecturer

Topic: How to Conduct Research—The Rumford Way

Dr. Ranga Komanduri earned his bachelor's and master's degrees from the Regional Engineering College, Warangal, affiliated to Osmania University, India. He earned his Ph.D. (1972) and D.Eng. (1992) from Monash University, Australia. He began his career as a research engineer and assistant professor in the mechanical engineering department at Carnegie Mellon University from 1972-77. He then moved to General Electric Corporate Research (Schenectady, New York) as a member of the scientific staff from 1977-89. He was also an adjunct full professor at Rensselaer Polytechnic Institute from 1977-86. From 1986-89, Dr. Komanduri was with the National Science Foundation as a program director for several programs, including material engineering and processing, tribology, and manufacturing processes. He was also a deputy division director and an acting division director. Dr. Komanduri joined Oklahoma State University in 1989 as a professor and MOST Chair in Intelligent Manufacturing in the School of Mechanical and Aerospace Engineering. His current position is Regents Professor and A. H. Nelson, Jr. Endowed Chair in Engineering.

Dr. Komanduri's research interests are machining, grinding, high-speed machining, and ultraprecision machining. His work includes advanced ceramics for ball and roller-bearing applications; hard, wear-resistant coatings on cutting tools, including low-pressure diamond coatings and nanocoatings; molecular dynamics simulation of nanometric cutting and tribology; thermal aspects of manufacturing processes; and laser-assisted material processing. He has written and edited numerous technical papers, book chapters, and proceedings and holds 21 patents.

Dr. Komanduri is distinguished as a Fellow of the Society of Manufacturing Engineers (1989), a Fellow of the American Society of Mechanical Engineers (1986), and a Fellow of the International Academy for Production Engineering (CIRP) (1988). In service to SME, Dr. Komanduri was a member of the Scientific Committee of the North American Manufacturing Research Institution of SME (NAMRI/SME) for many years and served as NAMRI/SME President in 1992. In 1993, he

co-organized the 21st North American Manufacturing Research Conference (NAMRC) at Oklahoma State. For ASME, Dr. Komanduri was chairman of the ASME Production Engineering Division (now Manufacturing Division) and vice-president of the Manufacturing Group (1989-93) and was instrumental in establishing the M. Eugene Merchant Medal of ASME/SME.

Highlights of Dr. Komanduri's honors include: F.W. Taylor Medal of CIRP (1977); Blackall Machine Tool & Gage Award, ASME (1981); Pi Tau Sigma-Charles Russ Richards Memorial Award of ASME (1990); ASME William T. Ennor Manufacturing Technology award (2002); and SME Albert M. Sargent Progress Award (2004).

Skip Rung
President and Executive Director
Oregon Nanoscience and Microtechnologies Institute

Wednesday, June 15, MBI Reception

Mr. Rung is a senior high technology R&D executive with over 25 years of R&D management experience in CMOS process technology, application-specific integrated circuit (ASIC) design and electronic design automation (EDA), IC packaging, MEMS, microfluidics, and inkjet printing.

Mr. Rung was asked in December 2003 to serve as the initial Executive Director of the Oregon Nanoscience and Microtechnologies Institute (ONAMI), Oregon's first "Signature Research Center" and an unprecedented collaboration among Oregon's research universities and the Pacific Northwest National Laboratory. ONAMI's dual mission is to grow "small tech" research in Oregon and commercialize technology in order to extend the success of Oregon's world-leading "Silicon Forest" technology cluster, which includes the most advanced R&D and manufacturing operations for leading companies such as Intel Corporation, Hewlett-Packard Company, FEI Company, LSI Logic Corporation, Pixelworks, Electro Scientific Industries, Xerox Office Products, Tektronix, Molecular Probes, and many dynamic smaller firms. ONAMI has so far received $28M in state investment and approximately doubled Oregon's annual federal and private research awards in the fields of nanoscience, green nanotechnology, nanoscale metrology, and microtechnology-based energy and chemical systems (MECS).

Following his retirement from Hewlett-Packard in 2001, Mr. Rung consulted in the areas of innovation management, technology business development, and intellectual property. He is a co-author of the 2004 Oregon Research Competencies study commissioned by the Oregon Economic and Community Development Department and the author of the initial business plan for the Oregon Nanoscience and Microtechnologies Institute, successfully recommended for funding as Oregon's first Signature Research Center by the Oregon Council on Knowledge and Economic Development. OCKED's determination was aided and influenced by Mr. Rung's 2002 consulting study of Oregon's most commercially promising and industrially relevant research.
Mr. Rung was a member of the Oregon Engineering and Technology Industry Council from 1999 to 2003 and a co-founder of the New Economy Coalition. He is currently a technical advisor to Northwest Technology Ventures, an Oregon seed-stage venture capital firm, a director of the Oregon Entrepreneurs Forum, Vice-Chair of the Corvallis-Benton County Economic Development Partnership, and active in several other community development efforts.

From 1987 to 2001, Mr. Rung was the director of Research and Development at Hewlett-Packard's Corvallis, Oregon facility, responsible for the development of future generations of HP's world-leading thermal inkjet technology, and for developing future business opportunities enabled by HP's microelectronics, MEMS, and microfluidics competencies. During Mr. Rung's 14 years as R&D director, inkjet printing became HP's largest and most profitable business, maintaining worldwide technical leadership through several major new generations of technology and holding market share nearly twice that of the next largest competitor. Prior to his work on inkjet, Mr. Rung was the R&D Manager for HP's Northwest Integrated Circuits Division in Corvallis, which achieved worldwide ASIC technology leadership in 1986 with a 1-micron process comparable to those used for DRAM. Mr. Rung's organization also developed novel and performance-leading in-house IC design automation systems and custom IC packaging technologies (hybrids, flat packs, TAB) to enable calculators and other HP products.

Mr. Rung began his industrial career in 1977 at Hewlett-Packard Laboratories in Palo Alto, CA, performing advanced research in the areas of CMOS process device isolation, latch-up, and comparison with alternative silicon and compound semiconductor technologies. In 1981 and 1982, Mr. Rung was selected by HP to be a technology exchange engineer with Toshiba Corp. in Kawasaki, Japan, where he continued his research inside the world's leading semiconductor memory engineering group. He is the holder of 2 US Patents, author or co-author of over 14 refereed journal or conference papers on IC technology, 4 invited papers (2 at leading international meetings), and 4 invited presentations on inkjet printing technology.

Mr. Rung received his BSEE and MSEE co-terminally in 1976 from Stanford University, where he was elected to both Phi Beta Kappa and Tau Beta Pi in his junior year. His master's thesis concerned the experimental determination of semiconductor doping profiles, and was part of the Stanford research on process simulation that was seminal for the rapid growth of computer simulation for solid state electronic processes and devices.

Dr. Yasushi Fukuzawa
Professor, Mechanical Engineering, Nagaoka University of Technology, Japan

Thursday, June 16, 0800, Ballroom, Alumni Center

Topic: Electrical Discharge Researches and New Technologies in Japan

From 2009, he serves as the President of Japan Society of Electrical Machining Engineers (JSEME)

From 1985 to 1987, he was in Germany to study ceramics material and joining at Stuttgart, Max-Planck Institute. Under Prof. Dr G.Petzow and Dr. G.Elssner, he researched the ceramics-metal joining.

Prof. Fukuzawa received a Bachelor of engineering degree in Metallurgy from Yokohama National University, a Master of engineering degree in Materials Science from Tokyo Institute of Technology, and Doctor of engineering degree in Materials Science from Tokyo Institute of Technology.

His research fields are Acoustic Emission, joining of dissimilar materials and electrical discharge machining. He succeeded to machine the insulating ceramics materials by electrical discharge machine for 3 dimensional complex shapes. The method was named as the assisting electrode method. This research was carried out with Prof. Dr. Naotake Mohori, The University of Tokyo.

Dr. Yasubumi Furuya
Professor, Department of Intelligent Machines and System Engineering Hirosaki University, Japan

Thursday, June 16, 1200, Ballroom, Alumni Center

Topic: Recent Work on Smart Materials Technology for Magnetostrictive Torque Sensor in Automobile Application

Academic History:

Undergraduate School of Tohoku University (at Sendai, Japan) in 1974 (Metal Processing)
Doctor Degree in Graduate School of Tohoku University in 1979 (Materials Processing)
Research Associate and Associate Professor, Faculty of Engineering, Tohoku University from 1979 to 1998
Full Professor of Department of Intelligent Machines and System Engineering, Faculty of Science and Technology, Hirosaki University, Aomori Prefecture, Japan
Visiting Professor of Institute for Materials Research of Tohoku University (Sendai)
Visiting Professor of Research Center of University of Maryland (USA)

Research Fields:
New functional materials based on noble processing design
Smart materials and their applications for smarter devices and composites.
1) High performance Sensor/Actuator materials
2) Shape Memory Alloys ,Iron-based magnetostrictive alloys,
3) Multi-ferric materials and devices
4) Multi-functional Surface acoustic wave (SAW) sensor devices
Amorphous/nano-crystal Bulk Metallic Glasses (BMGs)
Rapid-rotation Centrifugal Casting Method
Soft magnetic materials and devices based on BMG and Nano-crystals morphology control

Activities and Prizes, etc.:.
ASME Best Paper Awards in Aerospace Division (2000, USA) on ferromagnetic FePd alloy development
Best world 500 Scientists in 2006 Award (2006, USA)
JIM Academic Contribution Awards,(2008, Japan)
JSME Best Technical Development Award (M&P Division of JSME, 2009)

Prof.Furuya has been continuously the Lead-organizer of MRS Smart Materials and Devices Symposium held at MRS Meetings (2004, 2006, 2008 and 2011)

INVITED SPEAKER

Dr. Charalabos C. Doumanidis
Nanomanufacturing Program Director, National Science Foundation

Monday, June 13, 1300, 1-Willamette Room, Alumni Center
Tuesday, June 14, 1030, 4-Austin Auditorium, LSC

Prof. Charalabos (Haris) Doumanidis holds his Diploma in Mechanical Engineering from the Aristotelian Univ. of Thessaloniki (1983), his M.S. from Northwestern University (1985), and his Ph.D. from MIT (1988). He has been a Postdoctoral Associate with the MIT Laboratory for Manufacturing and Productivity (1989), a Squadron Sergeant for the Hellenic Air Force (1990), and a Lecturer at the Aristotelian Univ. (1991). He has been a Professor of Mechanical Engineering and Director of the Hephaistos Thermal Manufacturing Laboratory at Tufts University in Medford, MA (1991-2000); Chief Scientist with Axcelis Technologies (Thermal Processing Systems) in Beverly, MA (2000-01); Visiting Professor of Mechanical Engineering at MIT (2003-06); Professor (2003-present) and Marie Curie Chair (2004-2007), Founding Head of the Mechanical and Manufacturing Engineering Dept (2004-06) and Founding Director of the Hephaistos Nanotechnology Research Center at the University of Cyprus (2006-2009); the founding Director of the Nanomanufacturing Program at the National Science Foundation (NSF) in Arlington, Virginia (2001-03, 2006-07 and Oct. 2010-); and consultant for the automation, optoelectronics, biomedical and automotive industry.

His research and teaching interests include nanoscale manufacturing and mechanics, thermal processing of materials, deposition and joining processes, rapid prototyping, rapid thermal processing and laser annealing of semiconductors, distributed parameter system modeling and control, robotics and mechatronics, and biomedical instrumentation. He is Guest/Associate Editor of international scientific journals for Elsevier and IASTED; research reviewer for 15 technical journals and research funding institutions; organizer and chair of over 20 symposia for ASME, IEEE, NSET, NSF etc; speaker of over 20 keynote/plenary lectures and over 100 invited seminars; the author of over 200 refereed papers, distinguished by 3 best paper awards (ASME, ACC and ISNM), eight patents and two book chapters. He is a recipient of the Marie Curie Chair of Excellence (2004) by the European Commission, the ASME Blackall Award (2002), the Presidential Faculty Fellow Award by the White House (1996), the NSF Young Investigator (1994) and the Research Initiation Award (1992), as well as several grants from NSF, SME, DoE, NIST, Honda R&D Americas etc, totalling over $10 million as a PI. He teaches courses in design and manufacturing, controls and robotics, and has set up ten research/teaching laboratories at Tufts and UCY. He mentors the research planning of many junior investigators at UCY and the USA, postdocs, 40 graduate students, and his three children.

EARLY CAREER FORUM (TUESDAY, JUNE 14, 1615-1815)

The forum will discuss various challenges associated with a research career and how to be successful professionally in the various settings. The target audience for the forum is recent advanced degree graduates as well as current Master's and Ph.D. students. Contents to be covered(20 min presentation + 10 min Q/A):

- Research life and how to be successful professionally
- Sharing of personal stories on career development
- Some words to future manufacturing professionals

Dr. Yong Huang, Organizer

Associate Professor
Clemson University, Clemson, SC
yongh@clemson.edu

Prof. Irem Y. Tumer, Panelist

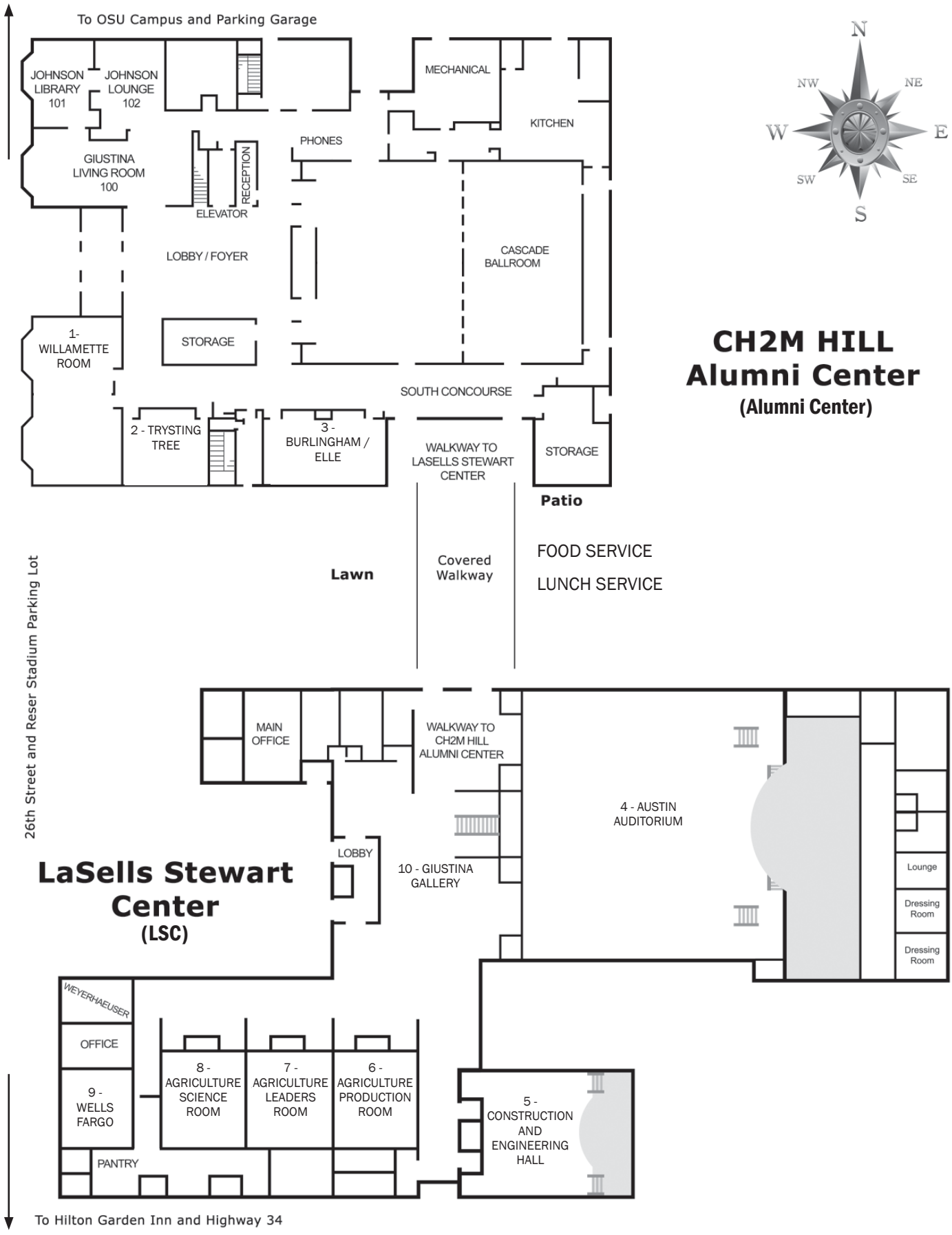
Associate Professor
Director, Complex Engineered Systems Design Lab
Mechanical, Industrial, and Manufacturing Engineering
Oregon State University
irem.tumer@oregonstate.edu

Dr. Cedric Xia, Panelist

Technical Leader, Global Materials & Manufacturing CAE Research; and
Group Leader, Sheet Metal Research
Research & Advanced Engineering
Ford Motor Company
zxia@ford.com

Dr. George A. Hazelrigg, Panelist

Deputy Division Director
Civil, Mechanical and Manufacturing Innovation (CMMI) Division
National Science Foundation
Email: ghazelri@nsf.gov


To OSU Campus and Parking Garage
JOHNSON LIBRARY 101
JOHNSON LOUNGE 102
GIUSTINA LIVING ROOM 100
RECEPTION
ELEVATOR
PHONES
MECHANICAL
KITCHEN
LOBBY / FOYER
CASCADE BALLROOM
1- WILLAMETTE ROOM
STORAGE
SOUTH CONCOURSE
2 - TRYSTING TREE
3 - BURLINGHAM / ELLE
WALKWAY TO LASELLS STEWART CENTER
STORAGE
Patio
Lawn
Covered Walkway
FOOD SERVICE
LUNCH SERVICE
N
NW
NE
W
E
SW
SE
S
CH2M HILL Alumni Center
(Alumni Center)
26th Street and Reser Stadium Parking Lot
LaSells Stewart Center
(LSC)
MAIN OFFICE
WALKWAY TO CH2M HILL ALUMNI CENTER
LOBBY
10 - GIUSTINA GALLERY
4 - AUSTIN AUDITORIUM
Lounge
Dressing Room
Dressing Room
WEYERHAEUSER
OFFICE
9 - WELLS FARGO
8 - AGRICULTURE SCIENCE ROOM
7 - AGRICULTURE LEADERS ROOM
6 - AGRICULTURE PRODUCTION ROOM
PANTRY
5 - CONSTRUCTION AND ENGINEERING HALL
To Hilton Garden Inn and Highway 34

PROGRAM AT A GLANCE

Monday, June 13, 2011		
Time	Activity	Location
0800-1930	**Workshop and Conference Registration**	CH2M HILL Alumni Center Foyer
0800-1530	**NAMRI/SME Board Meeting**	CH2M HILL Alumni Center Boardroom
1300-1630	**Workshop 1- Sustainable Nano Manufacturing Workshop** - *Greg Herman, Oregon State University* - *Chih-hung Chang, Oregon State University* **Invited Speaker** - *Charalabos C. Doumandis, National Science Foundation, Artlington, VA, USA* **Topic**: The development of nanomanufacturing practices that minimize risk to environmental ecosystems and human health while also promoting economic growth are at the forefront of the next generation of international manufacturing technologies. This workshop provides an overview of nanomanufacturing technologies and the integration of sustainable processes with the initial focus on nanomaterials synthesis and their incorporation in renewable energy	1 - Willamette Room, CH2M HILL Alumni Center
0900-1600	**Workshop 2- Smart Materials and Related Technologies - JSME Organized Workshop** - *Hiroshi Asanuma, Chiba University* - *Yasubumi Furuya, Hirosaki University* - *Satoshi Kishimoto, National Institute for Materials Science (NIMS)* - *Wataru Nakao, Yokohama National University* **Topic**: Discussion and exploration on Smart/ Intelligent Materials and Structural Systems including some new directions such as development of Smart Mechanical Material Systems, applications to Manufacturing and Processing fields, and so on. The organizers hope that you will understand what smart materials are, will be able to imagine your own smart materials, and might be changed by attending this workshop!	5 - Construction & Engineering Hall, LaSells Stewart Center
1600-1800	**OSU Tours**	Shuttles will leave from the CH2M HILL Alumni Center at 1600 **Tour Sites**: Hinsdale Wave Lab, SAE Racing Headquarters
1730-1930	**Welcome Reception**	CH2M HILL Alumni Center

Tuesday, June 14, 2011		
Time	Activity	Location
0730-1800	**Conference Registration**	Foyer , CH2M HILL Alumni Center
0730-0800	**Continental Breakfast**	Foyer , CH2M HILL Alumni Center
0730-1600	**Speaker Preparation Room**	Lounge, CH2M HILL Alumni Center
0800-0815	**Welcome** *- Brian Paul, Mechanical, Industrial & Manufacturing Engineering, Oregon State University* *- Sabah Randhawa, Provost and Executive Vice President, Oregon State University*	Ballroom, CH2M HILL Alumni Center
0815-0900	**Keynote Speaker** *- Chandra Brown, Vice President, Oregon Iron Works; President, United Streetcar LLC* **Topic:** The Role of Casting Foundries in Advancing Clean Energy	Ballroom, CH2M HILL Alumni Center
0900-1015	**Panel 1 – Sustainable Manufacturing** *- Matt Carter, Senior Principal Engineer, BR&T (Boeing Research and Technology)* *- Betsy Lenger, Senior Engineer, BR&T (Boeing Research and Technology)* **Presenters** *- Paul J. Wright, Enterprise Engineering Design for Environment Leader, Boeing* *- Sandra Carter, Environmental Engineering Manager, Daimler Trucks North America* *- Ryan Pennington, Environmental Technician and Green Team Facilitator, Freightliner Custom Chassis Corporation* *- Guodong Shao is a computer scientist in the Manufacturing System Integration Division at The National Institute of Standards and Technology (NIST)*	Ballroom, CH2M HILL Alumni Center

1015-1030	**Break**	
1030-1200	**ASME/MED EC Meeting**	Austin Parrish Boardroom, Alumni Center
1030-1200	**Concurrent Technical Sessions (1-38)**	Alumni Center/LaSells Stewart Center (See Technical Program)
1200-1300	**Lunch –** **Keynote Speaker** *- Jake Nichol, President/CEO Leatherman Tool Group* **Topic: Manufacturing: The Sweet Smell of Cutting Oil**	Ballroom, CH2M HILL Alumni Center
1300-1430	**Panel 2 -Manufacturing Research Toward Sustainable Transportation** *- Umesh Gandi, Toyota Research North America* *- Wayne Cai, Global R&D, GM* *- Jeonghan Ko, University of Nebraska, Lincoln* **Presenters** *- Dr. Jeff Abell, Group Manager of Advanced Propulsion Manufacturing Process Research Group, GM R&D* *- Dr. David A. Glasscock, Global Automotive Technology Director, DuPont* *- Dr. S. Jack Hu, Professor of Mechanical Engineering and Industrial and Operations Engineering, The University of Michigan, Ann Arbor* *- Dr. Wei Zhang, Oakridge National Laboratory*	Ballroom, CH2M HILL Alumni Center
1300-1430	**Concurrent Technical Sessions (39-71)**	Alumni Center/LaSells Stewart Center (See Technical Program)
1430-1445	**Break**	
1445-1615	**Concurrent Technical Sessions (72-102)**	Alumni Center/LaSells Stewart Center (See Technical Program)
1615-1700	**ASME/MED Membership Meeting**	5 - Construction & Engineering Hall, LSC

1700-1745	**NAMRI/SME Membership Meeting**	5 - Construction & Engineering Hall, LSC
1615-1815	**Early Career Forum** **Organizer** *- Yong Huang, Clemson (ASME)* **Panelists** *- Irem Y. Tumer, Professor, Mechanical, Industrial, and Manufacturing Engineering, Oregon State University* *- Cedric Xia, Technical Leader, Global Materials & Manufacturing CAE Research; and Group Leader, Sheet Metal Research Research & Advanced Engineering, Ford Motor Company* *- George A. Hazelrigg, Deputy Division Director, Civil, Mechanical and Manufacturing (CMMI) Division, National Science Foundation*	1 - Willamette Room, Alumni Center
1800 2200	**TYEE Wine Cellars Dinner**	Shuttles will leave the Alumni Center at 1800, 1815, and 1830 Shuttles will leave Tyee at 2115, 2130, 2145 and drop you off at your hotel

Wednesday, June 15, 2011		
Time	Activity	Location
0730-1700	**Conference Registration**	Foyer, CH2M HILL Alumni Center
0730-0800	**Continental Breakfast**	Foyer, CH2M HILL Alumni Center
0800-0845	**Keynote Speaker** *- Bryan Dods, Executive, Manufacturing Technology Leader, GE Energy* **Topic:** Energy Innovation Enabled by Manufacturing	Ballroom, CH2M HILL Alumni Center
0845-1015	**Panel 3 – 21st Century Manufacturing Paradigms** *- Barry Rahimian, Business Consultant* **Presenters** *- Don Carkner, Principal Technologist Industrial and Advanced Technology, CH2M HILL* *- Bikash Chatterjee, President and Chief Technology Officer, Pharmatech Associates, Inc.* *- David Kirk, Director of Technology, Industrial and Advanced Technology Group, CH2M HILL*	Ballroom, CH2M HILL Alumni Center
1015-1030	**Break**	
1030-1200	**Concurrent Technical Sessions (104-137)**	Alumni Center/LaSells Stewart Center (See Technical Program)
1200-1315	**Lunch – NAMRI/SME Founders Lecture,** *- Dr. Ranga Komanduri, Ph.D., D. Eng.* **Topic:** How to Conduct Research—The Rumford Way	Ballroom, CH2M HILL Alumni Center
1315-1445	**Concurrent Technical Sessions (138-169)**	Alumni Center/LaSells Stewart Center (See Technical Program)

1400-1600	**Poster Session**	Giustina Gallery , LaSells Stewart Center
1445-1500	**Break**	
1500-1630	**Concurrent Technical Sessions (170-201)**	Alumni Center/LaSells Stewart Center (See Technical Program)
1630-1900	**Microproducts Breakthrough Institute Tours and Reception**	Shuttles will leave Alumni Center at 1630, 1645, and 1700
1900-2200	**Awards Banquet following the Reception at the Microproducts Breakthrough Institute**	Shuttles will leave Microproducts Breakthrough Institute at the conclusion of the Banquet

Thursday, June 16, 2011		
Time	Activity	Location
0730-1700	**Registration**	Foyer , CH2M HILL Alumni Center
0730-0800	**Continental Breakfast**	Foyer , CH2M HILL Alumni Center
0800-0845	**Keynote Speaker** *- Dr. Yasushi Fukuzawa, Professor, Mechanical Engineering, Nagaoka University of Technology, Japan* **Topic:** Electrical Discharge Researches and New Technologies in Japan	Ballroom, CH2M HILL Alumni Center
0850-1015	**Panel 4 – "Quo Vadimus": Manufacturing Education for US Competitiveness in the 21st Century** **Organizer** *-Ajay Malshe, University of Arkansas* **Presenters** *- Bin Wei, GE Global Research* *- Yoram Koren, University of Michigan* *- Kamalkar Rajurkar, University of Nebraska-Lincoln* *- Ralph Resnick, National Center for Defense Manufacturing & Machining*	8 - Agriculture Science, LSC
0850-1015	**Panel 5 – Case Studies in Lean Manufacturing** **Organizers** *-John Parmigiani, Research Assistant Professor in the School of Mechanical, Industrial, and Manufacturing Engineering at Oregon State University* *-Toni Doolen, Associate Professor, School of Mechanical, Industrial, and Manufacturing Engineering and an Associate Dean of the University Honors College, Oregon State University* **Presenters** *- Kyle Stavig, Myers Container* *- Scott Simmons, Climax Portable Machine Tools*	3 - Burlingham/Elle, Alumni Center

0900-1015	**Concurrent Technical Sessions (202-216)**	Alumni Center/LaSells Stewart Center (See Technical Program)
1015-1030	**Break**	
1030-1200	**Concurrent Technical Sessions (217-252)**	Alumni Center/LaSells Stewart Center (See Technical Program)
1200-1315	**Lunch –** **Keynote Speaker** *- Dr. Yasubumi Furuya, Professor Department of Intelligent Machines and System Engineering Hirosaki University, Japan* **Topic:** Recent Work on Smart Materials Technology for Magnetostrictive Torque Sensor in Automobile Application	Ballroom, CH2M HILL Alumni Center
1315-1445	**Concurrent Technical Sessions (253-282)**	Alumni Center/LaSells Stewart Center (See Technical Program)
1445-1500	**Break**	
1500-1630	**Concurrent Technical Sessions (283-316)**	Alumni Center/LaSells Stewart Center (See Technical Program)
1630-1830	**OSU Tours**	Shuttles will leave from the CH2M HILL Alumni Center at 1630 **Tour Sites:** Hinsdale Wave Lab, SAE Racing Headquarters
1800-1930	**COMEC Meeting: Educating Manufacturing Engineers for 2020**	1 - Willamette Room, Alumni Center

Friday, June 17, 2011

Time	Activity	Location
0730-1400	**Conference Registration**	Foyer, CH2M HILL Alumni Center
0730-0800	**Continental Breakfast**	Foyer, CH2M HILL Alumni Center
0800-0930	**Concurrent Technical Sessions (317-335)**	Alumni Center/LaSells Stewart Center (See Technical Program)
0930-0945	**Break**	
0945-1115	**Concurrent Technical Sessions (336-349)**	Alumni Center/LaSells Stewart Center (See Technical Program)
1130-1245	**Closing Lunch**	Ballroom, CH2M HILL Alumni Center
1300-1530	**Hewlett Packard Tours** **(*Pre-registration required, space limited*)**	Shuttle will depart the Alumni Center at 1300 Hewlett Packard Campus

TECHNICAL PROGRAM OVERVIEW

Tuesday, June 14, 2011

1030 to 1200

2-2-1	**Advanced Casting and Semisolid Forming Techniques**	1-Willamette Room, Alumni Center
1-1	**Forming 1**	2-Trysting Tree, Alumni Center
1-3	**Micro/Bio Fabrication**	3-Burlingham/Elle, Alumni Center
4-3-1	**Sustainable Nanomanufacturing 1**	4-Austin Auditorium, LSC
3-1-1	**Mechanical Characterization and Measurement Techniques 1**	5-Construction & Engineering Hall, LSC
3-4-1	**Dynamic Behavior of Materials and Structures 1**	6-Agriculture Production Room, LSC
2-10-1	**Metal Forming**	7-Agriculture Leaders Room, LSC
1-4-1	**Adhesion and Interface**	8-Agriculture Science Room, LSC
1-1-1	**Mechanical Properties-1**	9-Wells Fargo Room, LSC

1300 to 1430

2-3-1	**Advanced Powder Processing Technique 1**	1-Willamette Room, Alumni Center
1-4	**Manufacturing Systems 1**	2-Trysting Tree, Alumni Center
1-16	**Machining and Grinding Tribology**	3-Burlingham/Elle, Alumni Center
3-6-1	**Manufacturing Research towards Sustainable Transportation (Panel Session)**	4-Austin Auditorium, LSC
3-1-2	**Mechanical Characterization and Measurement Techniques 2**	5-Construction & Engineering Hall, LSC
4-7-1	**Ultra-Precision and Micro/Nano Forming of Materials**	6-Agriculture Production Room, LSC
2-10-2	**Machining Processes 1**	7-Agriculture Leaders Room, LSC
2-1-1	**Microforming**	8-Agriculture Science Room, LSC
1-1-2	**Mechanical Properties-2**	9-Wells Fargo Room, LSC

1445 to 1615

4-2-1	**Nanomaterials, Nanofabrication and Their Applications 1**	1-Willamette Room, Alumni Center
1-2	**Forming 2**	2-Trysting Tree, Alumni Center
1-5	**Manufacturing Systems 2**	3-Burlingham/Elle, Alumni Center
3-3-1	**Surface Modification Technology, Wear and Tribology 1**	4-Austin Auditorium, LSC
3-7-1	**Advances in Quality and Process Control in Manufacturing Systems**	5-Construction & Engineering Hall, LSC
2-3-2	**Advanced Powder Processing Technique 2**	6-Agriculture Production Room, LSC
2-10-3	**Design, Materials, and Nontraditional Processes 1**	7-Agriculture Leaders Room, LSC
2-1-2	**Incremental forming**	8-Agriculture Science Room, LSC
1-1-3	**Natural Composites and Recycling**	9-Wells Fargo Room, LSC

1615 to 1815

5-1-2	**Early Research Career Forum (Panel Session)**	1-Willamette Room, Alumni Center

Wednesday, June 15, 2011

1030 to 1200

2-9-1	**Bio-Fabrication Processes**	1-Willamette Room, Alumni Center
1-17	**Metrology 1**	2-Trysting Tree, Alumni Center
1-7	**Sustainable Manufacturing 1**	3-Burlingham/Elle, Alumni Center
2-10-4	**Machining Processes 2**	4-Austin Auditorium, LSC
1-3-1	**Ceramics and Ceramic Matrix Composites 1**	5-Construction & Engineering Hall, LSC
2-7-1	**Advances in Nontraditional/Hybrid Manufacturing 1**	6-Agriculture Production Room, LSC
4-2-2	**Nanomaterials, Nanofabrication and Their Applications 2**	7-Agriculture Leaders Room, LSC
2-5-1	**Thermal and Cold Spray Coatings, and Surface Treatment**	8-Agriculture Science Room, LSC
1-6-1	**Smart Actuators and Sensors**	9-Wells Fargo Room, LSC

1315 to 1445

1-10	**Machining 1**	1-Willamette Room, Alumni Center
1-6	**Additive and Polymer Manufacturing**	2-Trysting Tree, Alumni Center
1-8	**Sustainable Manufacturing 2**	3-Burlingham/Elle, Alumni Center
2-1-3	**Tube Hydroforming**	4-Austin Auditorium, LSC
1-3-2	**Ceramics and Ceramic Matrix Composites 2**	5-Construction & Engineering Hall, LSC
2-7-2	**Advances in Nontraditional/Hybrid Manufacturing 2**	6-Agriculture Production Room, LSC
5-1-3	**Student Manufacturing Design Competition 1**	7-Agriculture Leaders Room, LSC
3-11-1	**Manufacturing System Operations 1**	8-Agriculture Science Room, LSC
1-5-1	**Multi-Functional Materials (Metal and Ceremics Base)**	9-Wells Fargo Room, LSC

1400 to 1600

5-1-1	**Poster Session**	Giustina Gallery, LSC

1500 to 1630

1-9	**Machining 2**	1-Willamette Room, Alumni Center
1-18	**Metrology 2**	2-Trysting Tree, Alumni Center
1-15	**Nontraditional Machining**	3-Burlingham/Elle, Alumni Center
2-10-5	**Machining Processes 3**	4-Austin Auditorium, LSC
4-4-1	**Nano/Micro/Meso Manufacturing 1**	5-Construction & Engineering Hall, LSC
3-2-1	**Fretting and Fretting Fatigue**	6-Agriculture Production Room, LSC
5-1-4	**Student Manufacturing Design Competition 2**	7-Agriculture Leaders Room, LSC
3-5-1	**Monitoring, Sensing, and Control for Manufacturing 1**	8-Agriculture Science Room, LSC
1-6-2	**Advanced Smart Materials 1**	9-Wells Fargo Room, LSC

Thursday, June 16, 2011

0900 to 1015

3-3-2	**Surface Modification Technology, Wear and Tribology 2**	1-Willamette Room, Alumni Center
2-1-4	**Material Characterization 1**	4-Austin Auditorium, LSC
2-7-3	**Advances in Nontraditional/Hybrid Manufacturing 3**	6-Agriculture Production Room, LSC
2-10-6	**Design, Materials, and Nontraditional Processes 2**	7-Agriculture Leaders Room, LSC
1-6-3	**Advanced Smart Materials 2**	9-Wells Fargo Room, LSC

1030 to 1200

1-2-1	**Microstructure, Simulation and Modeling**	1-Willamette Room, Alumni Center
4-4-2	**Nano/Micro/Meso Manufacturing 2**	2-Trysting Tree, Alumni Center
1-22	**Laser Processing**	3-Burlingham/Elle, Alumni Center
2-1-5	**Electrical and Thermal Assisted Forming**	4-Austin Auditorium, LSC
3-4-1	**Dynamic Behavior of Materials and Structures 2**	5-Construction & Engineering Hall, LSC
2-4-1	**Advanced Welding and Bonding Technology 1**	6-Agriculture Production Room, LSC
2-10-7	**Machining Processes 4**	7-Agriculture Leaders Room, LSC
2-6-1	**Energy Manufacturing 1**	8-Agriculture Science Room, LSC
1-11	**Machining 3**	9-Wells Fargo Room, LSC

1315 to 1445

4-5-1	**Micro-Nano Assembly**	1-Willamette Room, Alumni Center
1-23	**Residual Stress in Manufacturing**	2-Trysting Tree, Alumni Center
1-19	**Manufacturing Uncertainty**	3-Burlingham/Elle, Alumni Center
2-1-6	**Springback and Bending**	4-Austin Auditorium, LSC
3-1-3	**Mechanical Property Testing**	5-Construction & Engineering Hall, LSC

2-4-2	**Advanced Welding and Bonding Technology 2**	6-Agriculture Production Room, LSC
4-6-1	**Micro/Nano-Scale Surface 3D Structuring**	7-Agriculture Leaders Room, LSC
3-5-2	**Monitoring, Sensing, and Control for Manufacturing 2**	8-Agriculture Science Room, LSC
1-13	**Micro/Nano Machining 1**	9-Wells Fargo Room, LSC

1500 to 1630

1-2-2	**Mechanical and Other Properties**	1-Willamette Room, Alumni Center
1-12	**Machining 4**	2-Trysting Tree, Alumni Center
1-20	**Joining 1**	3-Burlingham/Elle, Alumni Center
2-1-7	**New Processes**	4-Austin Auditorium, LSC
3-11-2	**Manufacturing System Operations 2**	5-Construction & Engineering Hall, LSC
2-7-4	**Advances in Nontraditional/Hybrid Manufacturing 4**	6-Agriculture Production Room, LSC
4-2-3	**Nanomaterials, Nanofabrication and Their Applications 3**	7-Agriculture Leaders Room, LSC
3-5-3	**Monitoring, Sensing, and Control for Manufacturing 3**	8-Agriculture Science Room, LSC
1-14	**Micro/Nano Machining 2**	9-Wells Fargo Room, LSC

Friday, June 17, 2011

0800 to 0930

2-9-2	**Biomaterials Processing**	1-Willamette Room, Alumni Center
1-24	**Design for Manufacturing**	2-Trysting Tree, Alumni Center
2-1-8	**Material Characterization 2**	4-Austin Auditorium, LSC
3-11-3	**Manufacturing System Operations 3**	5-Construction & Engineering Hall, LSC
4-4-3	**Nano/Micro/Meso Manufacturing 3**	6-Agriculture Production Room, LSC
1-21	**Joining 2**	8-Agriculture Science Room, LSC

0945 to 1115

4-3-2	**Sustainable Nanomanufacturing 2**	4-Austin Auditorium, LSC
2-7-5	**Advances in Nontraditional/Hybrid Manufacturing 5**	6-Agriculture Production Room, LSC
4-6-2	**Thermal Based Micro/Nano-Scale Laser Processing**	7-Agriculture Leaders Room, LSC
2-6-2	**Energy Manufacturing 2**	8-Agriculture Science Room, LSC

Room Locations:

CH2M HILL Alumni Center, Alumni Center: 1-Willamette Room, 2-Trysting Tree, and 3-Burlingham/Elle

LaSells Stewart Center, LSC: 4-Austin Auditorium, 5-Construction & Engineering Hall, 6-Agriculture Production Room, 7-Agriculture Leaders Room, 8-Agriculture Science Room, 9-Wells Fargo Room and Giustina Gallery

TECHNICAL PROGRAM - TUESDAY, JUNE 14, 2011

Concurrent Technical Sessions, Papers 1-38 1030 – 1200 on Tuesday, June 14, 2011		
1-Willamette Room (Alumni Center)	2-2-1 Advance Casting and Semisolid Forming Techniques	
Tues 1030-1200	Session Chair: Session Co-Chair:	Toshio Haga, *Osaka Institute of Technology, Osaka, Japan* Satoshi Kishimoto, *National Institute for Materials Science, Tsukuba, Ibaraki, Japan*
1-1	MSEC2011-50130	Modeling of Semi-Solid Powder Processing for a Closed Die Compaction Yufeng Wu, *Iowa State University, Ames, IA, USA* Gan-Yong Kim, *Iowa State University, Ames, IA, USA*
1-2	MSEC-2011-50173	Monotonic and Cyclic Characterization of Five Different Casting Processes on a Common Magnesium Alloy J. Brian Jordon, *The University of Alabama, Tuscaloosa, AL, USA* Liang Wang, *Center for Advanced Vehicular Systems, Mississippi State University, Starkville, MS, USA*
1-3	ICMP2011-51032	Vertical Type Twin Roll Caster with Scrapers for Casting Clad Strips Hiroshi Tsuge, *Graduate School of Osaka Institute of Technology, Osaka, Japan* Toshio Haga, *Osaka Institute of Technology, Osaka, Japan* Takuya Ishihara, *Osaka Institute of Technology, Osaka, Japan* Shinji Kumai, *Tokyo Institute of Technology, Yokohama, Tokyo, Japan* Hisaki Watari, *Gunma University, Kiryu, Gunma, Japan*
1-4	ICMP2011-51038	Casting of Aluminum Alloy Clad Strip by a Single Roll Caster Kazuya Akitsu, *Osaka Institute of Technology, Osaka, Japan* Keisuke Kamakura, *Osaka Institute of Technology, Osaka, Japan* Toshio Haga, *Osaka Institute of Technology, Osaka, Japan* Shinji Kumai, *Tokyo Institute of Technology, Yokohama, Tokyo, Japan* Hisaki Watari, *Gunma University, Kiryu, Gunma, Japan*
1-5	ICMP2011-51057	Casting of Aluminum Alloy Clad Strip Using a Roll Caster Ryoji Nakamura, *Osaka Institute of Technology, Osaka, Japan* Takanori Yamabayashi, *Osaka Institute of Technology, Osaka, Japan* Toshio Haga, *Osaka Institute of Technology, Osaka, Japan* Shinji Kumai, *Tokyo Institute of Technology, Yokohama, Tokyo, Japan* Hisaki Watari, *Gunma University, Kiryu, Gunma, japan*

2-Trysting Tree (Alumni Center)	1-1 Forming 1	
Tues 1030-1200	Session Chair Session Co-Chair:	Dr. Steven Schmid, *University of Notre Dame, Notre Dame, IN, USA* Dr. Gracious Ngaile, *North Carolina State University, Raleigh, NC, USA*
2-6	NAMRC39-4716	Theoretical and Experimental Investigation of the Springback Characteristics of Metal Foam Dr. Steven Schmid, *University of Notre Dame, Notre Dame, IN, USA* Paul Nebosky, *Sites Medical, Columbia City, IN, USA* Miguel Selles, *Polytechnic University of Valencia, Campus of Alcoy, Alcoy, Spain*

2-7	NAMRC39-4771	Prediction and Analysis of Fracture in Single Point Incremental Forming Using a Damage Based Material Model Rajiv Malhotra, *Northwestern University, Evanston, IL, USA* Liang Xue, *Northwestern University, Evanston, IL, USA* Dr. Jian Cao, *Northwestern University, Evanston, IL, USA* Ted Belytschko, *Northwestern University, Evanston, IL, USA* Dr. K. Scott Smith, *University of North Carolina Charlotte, Charlotte, IL, USA* John Ziegert, *University of North Carolina Charlotte, Charlotte, IL, USA*
2-8	NAMRC39-4775	Experimental Investigation of Key Assumptions in Analytical Failure Criteria for Sheet Metal Forming Tugce Kasikci, *University of New Hampshire, Durham, NH, USA* Joseph Wilson, *University of New Hampshire, Durham, NH, USA* Dr. Brad Kinsey, *University of New Hampshire, Durham, NH, USA*

3-Burlingham/Elle (Alumni Center)	1-3 Micro/Bio Fabrication	
Tues 1030-1200	Session Chair: Session Co-Chair:	Dr. Kamlakar Rajurkar, *University of Nebraska-Lincoln, Lincoln, NE, USA* Dr. Xiaochun Li, *University of Wisconsin-Madison, Madison, WI, USA*
3-9	NAMRC39-4795	Automated Micro-Transfer Printing with Cantilevered Stamps Numair Ahmed, *University of Illinois at Urbana Champaign, Urbana, IL, USA* Dr. Placid Ferreira, *University of Illinois at Urbana Champaign, Urbana, IL, USA* Andrew Carlson, *Department of Materials Science and Engineering, Urbana, IL, USA* Dr. John A. Rogers, *University of Illinois at Urbana Champaign, Urbana, IL, USA*
3-10	NAMRC39-4802	A High-Resolution Electrohdrodynamic Jet Printing System Philip G. Graf, *University of Illinois at Urbana Champaign, Urbana, IL, USA* Erick Sutanto, *University of Illinois at Urbana Champaign, Urbana, IL, USA* Kira L. Barton, *University of Illinois at Urbana Champaign, Urbana, IL, USA* Andrew G. Alleyne, *University of Illinois at Urbana Champaign, Urbana, IL, USA* Dr. John A. Rogers, *University of Illinois at Urbana Champaign, Urbana, IL, USA* Placid M. Ferreira, *University of Illinois at Urbana Champaign, Urbana, IL, USA*
3-11	NAMRC39-4799	Alginate Microsphere Fabrication Using Bipolar Wave-Based Drop-On-Demand Jetting C.Leigh Herran, *Clemson University, Clemson, SC, USA* Dr. Yong Huang, *Clemson University, Clemson, SC, USA*

4-Austin Auditorium (LSC)	4-3-1 Sustainable Nanomanufacturing 1	
Tues 1030-1200	Session Chair: Session Co-Chair:	Devi Kalla, *Wichita State University, Wichita, KS, USA* Sundar Atre, *Oregon State University, Corvallis, OR USA*
4-12	MSEC2011-50305 Invited Speaker	The Nano-World as a Manufacturing Playground: The Vision of Nanomanufacturing at NSF Charalabos C. Doumanidis, *National Science Foundation, Arlington, VA, USA*
4-13	MSEC2011-50304 Invited Speaker	Development of Scalable Nanomanufacturing for Photovoltaics using Microreactor-Assisted Nanomaterial Deposition TM Processes Chih-Hung Chang, *Oregon State University, Corvallis, OR, USA*

4-14	MSEC2011-50276	CDS Nanoparticle Synthesis Using Oscillatory Flowing Mixing Barath Palanisamy, *Oregon State University, Corvallis, OR, USA* Yu-Wei Su, *Oregon State University, Corvallis, OR, USA* Anna Garrison, *Oregon State University, Corvallis, OR, USA* Brian K. Paul, *Oregon State University, Corvallis, OR, USA* Chih-Hung Chang, *Oregon State University, Corvallis, OR, USA*
4-15	MSEC2011-50057	Environmental and Cost Assessment of Several Injection Molded Powder Electronics Packaging Materials Misha Sahakian, *Oregon State University, Corvallis, OR, USA* Malcom Brown, *Oregon State University, Corvallis, OR, USA* Sundar Atre, *Oregon State University, Corvallis, OR, USA* Karl R. Haapala, *Oregon State University, Corvallis, OR, USA*

5-Construction & Engineering Hall (LSC)	3-1-1 Mechanical Characterization and Measurement Techniques 1	
Tues 1030-1200	Session Chair: Session Co-Chair:	Ikuo Ihara, *Nagaoka University of Technology, Nagaoka, Niigata, Japan* Kenji Kaneko, *Tokyo University of Science, Tokyo, Japan*
5-16	ICMP2011-51027	Depth Controlled Nanoindentation Tester Precisely Detecting Initial Indentation Depth with a Load Sensor at 0.1 Micro-Newton Resolution Moriyasu Kanari, *Ibaraki National College of Technology, Hitachinaka-shi, Ibaraki-ken, Japan*
5-17	ICMP2011-51071	Adhesive Strength Evaluation of Thermal Sprayed Coating by Torsion Pin-test Method Kenji Kaneko, *Tokyo University of Science, Tokyo, Japan* Keitarou Higaki, *Tokyo University of Science, Tokyo, Japan*
5-18	ICMP2011-51098	PVDF Resonating Diaphragm Actuator for Fatigue Test of Microspecimens Nastaran Tamjidi Hoseine, *Tokyo Institute of Technology, Yokohama, Kanagawa, Japan* Ryo Suzaki, *Tokyo Institute of Technology, Yokohama, Kanagawa, Japan* Junpei Sakurai, *Tokyo Institute of Technology, Yokohama, Kanagawa, Japan* Seiichi Hata, *Tokyo Institute of Technology, Yokohama, Kanagawa, Japan*
5-19	ICMP2011-51103	Development of Acoustic Emission Clustering Method to Detect Degradation of Lithium Ion Batteries Takuma Matsuo, *Aoyama Gakuin University, Kanagawa, Japan* Masaya Uchida, *Aoyama Gakuin University, Kanagawa, Japan* Hideo Cho, *Aoyama Gakuin University, Fuchinobe Chuo-ku, Kanagawa, Japan*
5-20	ICMP2011-51089	Aluminum Alloy Wheel Production and Fatigue Evaluations Murathan Soner, *Olguncelik, Manisa, Turkey*

6-Agriculture Production Room (LSC)	3-4-1 Dynamic Behavior of Materials and Structures 1	
Tues 1030-1200	Session Chair: Session Co-Chair:	Masaaki Itabashi, *Tokyo University of Science, Suwa, Chino, Nagano, Japan* Chiaki Sato, *Tokyo Institute of Technology, Yokohama, Japan*
6-25	ICMP2011-51151	Influences of Loading Rates on Stress-Strain Relations of Cured Bulks of Brittle and Ductile Adhesives Toru Sugaya, *Graduate School, Tokyo Institute of Technology, Yokohama, Japan* Tatsuya Obuchi, *Graduate School, Tokyo Institute of Technology, Yokohama, Japan* Chiaki Sato, *Tokyo Institute of Technology, Yokohama, Japan*

6-22	ICMP2011-51069	Strain Rate Dependency on the Strength of E-Glass Fibers Yoshihiko Arao, *Waseda University, Tokyo Japan* Norihiko Taniguchi, *Asics, Hyogo, Japan* Tsuyoshi Nishiwaki, *Asics, Hyogo, Japan* Norio Hirayama, *Nittobo, Fukushima, Japan* Hiroyuki Kawada
6-23	ICMP2011-51092	Effect of Lading Rate in Three Point Bending Tests for rock on Its Fracture Behavior and Accompanying Electromagnetic Phenomenon Hidetoshi Kobayashi, *Osaka University, Toyonaka, Osaka, Japan* Kinya Ogawa, *Institute of Space Dynamics, Kyoto, Japan* Keiko Watanabe, *Osaka University, Toyonaka, Osaka, Japan* Keitaro Horikawa, *Osaka University, Toyonaka, Osaka, Japan*
6-24	ICMP2011-51094	Improvement of Output Bar Support with a Polytetrafluoroethylene Collar on High Velocity Tensile Test for Steel Plate Masaaki Itabashi, *Tokyo University of Science, Suwa, Chino, Nagano, Japan*
6-21	ICMP2011-51040	High Strain-Rate Compressive Behavior of Bulk Structural Adhesives: Epoxy DP-460 and Methacrylate MA560-1 Takashi Yokoyama, *Okayama University of Science, Okayama, Japan* Kenji Nakai, *Okayama University of Science, Okayama, Japan* Norfazrina Hayati Mohd Yatim, *Okayama University of Science, Okayama, Japan*

7-Agriculture Leaders Room (LSC)	2-10-1 Metal Forming	
Tues 1030-1200	Session Chair: Session Co-Chair:	Ihab Ragai, *Hitachi Construction Truck Manufacturing Ltd., Guelph, ON, Canada* J. Brian Jordon, *The University of Alabama, Tuscaloosa, AL, USA*
7-26	MSEC2011-50148	Finite Element Analysis of Central Bursting Defects Occurring in Cold Forward Extrusion MinCheol Kim, *Gyeongsang National University, Jinju, Gyeongnam, Korea* DukJae Yoon, *Korea Institute of Industrial Technology, Incheon, Korea* HoJoon Choi, *Korea Institute of Industrial Technology, Inchecon, Korea* YoHun Son, *Yongsin Metal Industrial Company Limited, Pyongtack, Kyunggi-Do, Korea* ManSoo Joun, *Gyeongsang National University, Jinju, Gyeongnam, Korea*
7-27	MSEC2011-50156	Finite Element Predictions for a Cold Sheet Metal Forming Process Using Tetrahedral Mini-Elements MinCheol Lee, *Gyeonsang National University, Jinju, Gyeongnam, Korea* SangHyun Sim, *Gyeonsang National University, Jinju, Gyeongnam, Korea* JaeGun Eom, *TIC of Gyeonsang National University, Sacheon, Gyeongnam, Korea* WanJin Chung, *Seoul National University of Technology, Seoul, Korea* ManSoo Joun, *Gyeonsang National University, Jinju, Gyeongnam, Korea*
7-28	MSEC2011-50238	Prediction on Die Structure Performance During Advanced High-Strength Steel Sheet Metal Stamping with Non-Rigid Tooling Definition Dong-Kai Xu, *Shanghai Jiao Tong University, Shanghai, China* Jun Chen, *Shanghai Jiao Tong University, Shanghai, China* Xi-feng Li, *Shanghai Jiao Tong University, Shanghai, China* Yu-cheng Tang, *Shanghai Jiao Tong University, Shanghai, China* Gui-bao Zhang, *Shanghai Jiao Tong University, Shanghai, China*

7-29	MSEC2011-50280	Process Mechanics in Deep Rolling of Magnesium-Calcium (MGCA) Biomaterial M. Salahshoor, *The University of Alabama, Tuscaloosa, AL, USA* Y.B. Guo, *University of Alabama, Tuscaloosa, AL, USA*

8-Agriculture Science Room (LSC)	1-4-1 Adhesion and Interface	
Tues 1030-1200	Session Chair: Session Co-Chair:	Chiaki Sato, *Tokyo Institute of Technology, Yokohama, Japan* Yukio Miyashita, *Nagaoka University of Technology, Nagaoka, Niigata, Japan*
8-30	MSEC2011-50119	Studying Effects of Arc Discharge Surface Texturing on Stress Distribution in Adhesively Bonded Joints By Using Finite Element Modeling Mehdi Asgharifar, *Southern Methodist University, Dallas, TX, USA* Fanron Kong, *Southern Methodist University, Dallas, TX, USA* Radovan Kovacevic, *Southern Methodist University, Dallas, TX, USA* Blair Carlson, *GM, Warren, MI, USA*
8-31	ICMP2011-51102	Evaluation of Fiber/Matrix Interfacial Properties of C/C Using Model Material Masashi Koyama, *Tokyo University of Science, Noda, Japan* Kazuki Yamamoto, *Tokyo University of Science, Noda, Japan* Hiroki Kurita, *Tohoku University, Sendai, Miyagi, Japan* Hiroshi Hatta, *Japan Aerospace Exploration Agency, Kanagawa, Japan* Hiroshi Fukuda, *Tokyo University of Science, Noda, Chiba, Japan*
8-32	ICMP2011-51115	Friction Stir Spot Welding Between A5052 and PET Yukio Miyashita, *Nagaoka University of Technology, Nagaoka, Niigata, Japan* Farazira Yusof, *Nagaoka University of Technology, Nagaoka, Niigata, Japan* Ryusuke Ozaki, *Nagaoka University of Technology, Nagaoka, Niigata, Japan* Nobushiro Seo, *Nippon Light Metals Co. Ltd., Shizuoka, Shizuoka, Japan* Yuichi Otsuka, *Department of System Safety, Nagaoka University of Technology, Nagaoka, Niigata, Japan* Yoshiharu Mutoh, *Department of System Safety, Nagaoka University of Technology, Nagaoka, Niigata, Japan*
8-33	ICMP2011-51133	Effects of Electron Beam Irradiation (EBI) on Adhesive Strength Between Different Polymers for Biomedical Application Hidenori Kawadu, *TOKAI University, Hiratuka, Kanagawa, Japan* Hiroaki Takei, *TOKAI University, Hiratsuka, Kanagawa, Japan* Hironori Satoh, *TOKAI University, Hiratsuka, Kanagawa, Japan* Keisuke Iwata, *TOKAI University, Hiratsuka, Kanagawa, Japan* Akira Tonegawa, *TOKAI University, Hiratsuka, Kanagawa, Japan* Yoshitake Nishi, *TOKAI University, Hiratsuka, Kanagawa, Japan*
8-34	ICMP2011-51150	Influence of Temperature Fluctuation of Creep Crack Growth Rates of Adhesively Bonded Joints Ayako Kasuga, *Graduate School, Tokyo Institute of Technology, Yokohama, Japan* Satoshi Okazaki, *Tokyo Institute of Technology, Yokohama, Japan* Chiaki Sato, *Tokyo Institute of Technology, Yokohama, Japan*

9-Wells Fargo Room (LSC)	1-1-1 Mechanical Properties 1	
Tues 1030-1200	Session Chair: Session Co-Chair:	Yoshinobu Shimamura, *Shizuoka University, Hamamatsu, Shizuoka, Japan* Kohji Suzuki, *Chiba Institute of Technology, Chiba, Japan*
9-35	ICMP2011-51036	Advanced Accelerated Testing Methodology for Life Prediction of CFRP Laminates for Marine Use Masayuki Nakada, *Kanazawa Institute of Technology, Hakusan, Japan* Yasushi Miyano, *Kanazawa Institute of Technology, Hakusan, Japan*
9-36	ICMP2011-51060	Effects of Temperature of Fatigue Crack Growth Behavior of Epoxy Resin Reinforced by Silica Particles Yuta Miyazawa, *Department of Mechanical Engineering, Nagaoka University of Technology, Nagaoka, Niigata, Japan* Yuichi Otsuka, *Department of System Safety, Nagaoka University of Technology, Nagaoka, Niigata, Japan* Yoshiharu Mutoh, *Department of System Safety, Nagaoka University of Technology, Nagaoka, Niigata, Japan* Kohsuoku Nagata, *Department of System Safety, Nagaoka University of Technology, Nagaoka, Niigata, Japan*
9-37	ICMP2011-51063	Delayed Fracture of GFRP Laminates Under Constant Tensile Load in Hydrochloric Acid Solution Nasahiro Kotani, *Waseda University, Shinjuku-ku, Tokyo, Japan* Yohei Yamamoto, *Graduate School of Waseda University, Shinjuku, Tokyo, Japan* Hiroyuki Kawada
9-38	ICMP2011-51128	Crack Growth Behavior of Sealing Rubber Under Static Strain in High-Pressure Hydrogen Gas Junichiro Yamabe, *Kyushu University, Fukuoka, Japan* Shin Nishimura, *Kyushu University, Fukuoka, Japan*

Concurrent Technical Sessions (10-18), Papers (39-71) 1300 – 1430 on Tuesday, June 14, 2011		
1-Willamette Room (Alumni Center)	2-3-1 Advanced Powder Processing Technique 1	
Tues 1300-1430	Session Chair: Session Co-Chair:	Matt Bement, *Los Alamos national Laboratory, Los Alamos, NM, USA* Jianwen Hu, *Silgan Containers LLC, Oconomowoc, WI, USA*
1-39	MSEC2011-50129	Micro Feature Enhanced Sinter Bonding of Metal Injection Molded (MIM) Parts to Solid Substrate Thomas Martens, *Clemson University International Center for Automotive Research, Greenville, SC, USA* Laine Mears, Ph.D, P.E., *Clemson University, Greenville, SC, USA*
1-40	MSEC2011-50199	Fabrication of Supports for Solid Oxide Fuel Cells by Powder Injection Molding Ali Keshavarz Panahi, *Iran University of Science and Technology, Tehran, Iran* Hadi Miyanaji, *Iran University of Science and Technology, Tehran, Iran* Moein Taheri, *Iran University of Science and Technology, Tehran, Iran* Milad Janbakhsh, *Iran University of Science and Technology, Tehran, Iran*

1-41	MSEC2011-50249	The Effect of Nanoparticles on Processing and Properties of Aluminum Nitride by Powder Injection Molding Valmikanathan Onbattuvelli, *ONAMI, Corvallis, OR, USA* Sachin Laddha, *Pacific Northwest National Laboratory, Richland, WA, USA* Timothy McCabe, *Kinetics, Wilsonville, OR, USA* Sundar Atre, *ONAMI, Corvallis, OR, USA*

2-Trysting Tree (Alumni Center)	1-4 Manufacturing Systems 1	
Tues 1300-1430	Session Chair: Session Co-Chair:	Dr. Dragan Djurdjanovic, *The University of Texas at Austin, Austin, TX, USA* Dr. Lin Li, *University of Illinois at Chicago, Chicago, IL, USA*
2-42	NAMRC39-4719	Automatic Generation of Assembly System Configuration with Equipment Selection for Automotive Battery Manufacturing Sha Li, *The University of Michigan, Ann Arbor, MI, USA* Hui Wang, *The University of Michigan, Ann Arbor, MI, USA* Dr. Jack Hu, *The University of Michigan, Ann Arbor, MI, USA* Yhu-Tin Lin, *General Motors, Warren, MI, USA* Jeffrey Abell, *General Motors, Warren, MI, USA*
2-43	NAMRC39-4720	An Evolutionary Operation Sequence Optimization Tool for Robotic Spot Welding Based on Collision-Free Path Planner in Virtual Manufacturing Mohammad Givehchi, *University of Skovde, Skovde, Sweden* Amos Ng, *University of Skovde, Skovde, Sweden* Dr. Lihui Wang, *University of Skovde, Skovde, Sweden*
2-44	NAMRC39-4774	A Web-based Framework for Semantic Supplier Discovery for Discrete Part Manufacturing Farhad Ameri, *Texas State University, San Marcos, TX, USA* Christian McArthur, *Texas State University, San Marcos, TX, USA* Bahram Asiabanpour, *Texas State University, San Marcos, TX, USA* Mohammad Hayasi, *Texas State University, San Marcos, TX, USA*

3-Burlingham/Elle (Alumni Center)	1-16 Machining and Grinding Tribology	
Tues 1300-1430	Session Chair: Session Co-Chair:	Dr. Burak Ozdoganlar, *Carnegie Mellon University, Pittsburgh, PA, USA* Dr. Manuel Estrems, *Clemson University, Greenville, SC, USA*
3-45	NAMRC39-4734	CFD Investigation of the Impact of the Fluid Properties and Delivery Conditions on Flow and Heat Transfer in Grinding Stefan Mihic, *University of Toledo, Toledo, OH, USA* Sorin Cioc, *University of Toledo, Toledo, OH, USA* Dr. Ioan D. Marinescu, *University of Toledo, Toledo, OH, USA* Michael C. Weismiller, *Master Chemical Corporation, Perrysburg, OH, USA*
3-46	NAMRC39-4741	Effects of Tool Micro-Geometry and Coatings in Turning of Ti-6Al-4V Titanium Alloy Mohammed Sima, *Rutgers University, Piscataway, NJ, USA* Durul Ulutan, *Rutgers University, Piscataway, NJ, USA* Dr. Tugrul Ozel, *Rutgers University, Piscataway, NJ, USA*

3-47	NAMRC39-4794	Study of Specific Energy and Friction Coefficient in MQL Grinding Using Oil-Based Nanolubricants Parash Kalita, *University of Arkansas, Fayetteville, AR, USA* Dr. Ajay P. Malshe, *University of Arkansas, Fayetteville, AR, USA* Arun Kumar S., *Central Manufacturing Technology Institute, Bangalore, Karnataka, India* V.G. Yoganath, *Central Manufacturing Technology Institute, Bangalore, Karnataka, India* T Gurumurthy, *Central Manufacturing Technology Institute, Bangalore, Karnataka, India*

4-Austin Auditorium (LSC)	3-6-1 Manufacturing Research Towards Sustainable Transportation	
Tues 1300-1430	Session Chair: Session Co-Chairs:	Jeonghan Ko, *University of Nebraska-Lincoln, Lincoln, NE, USA* Umesh Gandhi, *Toyota Technical Center, AnnArbor, MI, USA* Wayne Cai, *GM, Warren, MI, USA*
4-48	MSEC2011-50316 Panel Presentation	High Volume Battery Pack Manufacturing for Passenger Vehicles Jeffrey Abell, *General Motors, Warrne, MI, USA*
4-49	MSEC2011-50317 Panel Presentation	Challenges and Opportunities for Lithium Ion Battery Manufacturing S.J. Hu, *University of Michigan, Ann Arbor, MI, USA*
4-50	MSEC2011-50329 Panel Presentation	Materials Joining Technologies for Lightweight and Multi-Materials Body Structures Zhili Feng, *Oak Ridge National Laboratory, Oak Ridge, TN, USA*
4-51	MSEC2011-50330 Panel Presentation	Key Automotive Trends and Material Solutions to Enable Sustainable Transportation David Glasscock, *Dupont, Wilmington, NC, USA*

5-Construction & Engineering Hall (LSC)	3-1-2 Mechanical Characterization and Measurement Techniques 2	
Tues 1300-1430	Session Chair: Session Co-Chair:	Kenji Kaneko, *Tokyo University of Science, Tokyo, Japan* Ikuo Ihara, *Nagaoka University of Technology, Nagaoka, Niigata, Japan*
5-52	MSEC2011-50209	Flow Stress Experimental Determination for Warm-Forming Process Ting Fai Kong, *The Hong Kong Polytechnic University, Hong Kong, China* Tia Chiu Lee, *Department of Industrial and Systems Engineering, Hung Hom, Kowloon, Hong Kong, China*
5-53	ICMP2011-51112	Fretting Creep, a Material Degradation Process Muhammad Hamdy, *Misr. University for Science & Technology, Sixth of October City, Egypt*

5-54	ICMP2011-51147	Microscopic Determination of Stress-strain Relationship by Continuous Multiple Nano-indentation Technique Randy Gui Guan Fatt, *Nagaoka University of Technology, Niigata, Japan* Ikuo Ihara, *Nagaoka University of Technology, Niigata, Japan* Takahiro Yudate, *Nagaoka University of Technology, Niigata, Japan* Masatoshi Ichimura, *Nagaoka University of Technology, Niigata, Japan* Jun-ichi Uegaki, *Elioniz Inc., Hachioji, Tokyo, Japan* Yoshikazu Shima, *Elioniz Inc., Hachioji, Tokyo, Japan*
5-55	ICMP2011-51148	Non-contact Techniques for Profiling Surface Temperature Distributions by Laser-Ultrasound Akira Kosugi, *Nagaoka University of Technology, Nagaoka, Niigata, Japan* Ikuo Ihara, *Nagaoka University of Technology, Nagaoka, Niigata, Japan*
5-56	ICMP2011-51129	Non-destructive Testing for CFRP by Using Pulse-Phase Thermography Masashi Ishikawa, *The Graduate University for Advanced Studies, Kanagawa, Japan* Hiroshi Hatta, *Japan Aerospace Exploration Agency, Kanagawa, Japan* Yoshio Habuka, *Krautkramer Japan Co., Ltd., Tokyo, Japan* Sayaka Jinnai, *Krautkramer Japan Co., Ltd., Tokyo, Japan* Shin Utsunomiya, *Japan Aerospace Exploration Agency, Ibaraki, Japan*

6-Agriculture Production Room (LSC)	4-7-1 Ultra-Precision and Mico/Nano Forming of Materials	
Tues 1300-1430	Session Chair: Session Co-Chair:	Yasunori Saotome, *Tohoku University, Sakai, Osaka, Japan* Ming Yang, *Tokyo Metropolitan University, Tokyo, Japan* Masaaki Otsu, *Fukui University, Fukui, Japan*
6-57	ICMP2011-51082	Superplastic Nanoforming of ZR-based Metallic Glass at High Strain Rate Under Rapid Heating Yasunor Saotome, *Tohoku University, Sakai, Osaka, Japan* Hiroshi Miyasaka, *Gunma University, Kiryu, Gunma, Japan* Kenji Amiya, *Tohoku University, Sakai, Osaka, Japan* Akihisa Inoue, *Tohoku University, Sendai, Miyagi, Japan*
6-58	ICMP2011-51099	Search for Ni-NB-ZR-X Amorphous Alloys for Glass Lens Molding Die Materials Shengxian Jiang, *Tokyo Institute of Technology, Yokohama, Japan* Mitsuhiro Abe, *Tokyo Institute of Technology, Yokohama, Japan* Masayuki Ando, *Tokyo Institute of Technology, Yokohama, Japan* Yuko Aono, *Tokyo Institute of Technology, Yokohama, Japan* Junpei Sakurai, *Tokyo Institute of Technology, Yokohama, Japan* Seiichi Hata, *Tokyo Institute of Technology, Yokohama, Japan*
6-59	ICMP2011-51135	Evaluation of Welding Properties of Metallic Foil with an Electron Beam Ming Yang, *Tokyo Metropolitan University, Tokyo, Japan* Hiroki Ogawa, *Tokyo Metropolitan University, Tokyo, Japan* Shoji Fujioka, *Tokyo Metropolitan University, Tokyo, Japan*

6-60	ICMP2011-51157	Effect of Forming Conditions on Crystallization in Laser Forming of Palladium Based Thin Film Metallic Glass Masaaki Otsu, *Fukui University, Fukui, Japan* Yuki Ide, *Kumamoto University, Kumamoto, Japan* Mitsuhiro Matsuda, *Kumamoto University, Kumamoto, Japan* Kazuki Takashima, *Kumamoto University, Kumamoto, Japan*

7-Agriculture Leaders Room (LSC)	2-10-2 Machining Processes 1	
Tues 1300-1430	Session Chair: Session Co-Chair:	Yung Shin, *Purdue University, West Lafayette, IN, USA* Laine Mears, Ph.D, P.E., *Clemson University, Greenville, SC, USA*
7-61	MSEC2011-50118	Finite Element Modeling of Orthogonal Cutting of Pyrolytic Carbon Gautam Salhotra, *University of Texas at Austin, Austin, TX, USA* Vivek Bajpai, *Indian Institute of Technology Bombay, Mumbai, Maharashtra, India* Ramesh Singh, *Indian Institute of Technology Bombay, Mumbai, Maharashtra, India*
7-62	MSEC2011-50158	Finite Element Modeling of the Workpiece Thermal Distortion in MQL Deep-Hole Drilling Bruce L. Tai, *University of Michigan, Ann Arbor, MI, USA* Steven B. White, *University of Michigan, Ann Arbor, MI, USA* David A. Stephenson, *University of Michigan, Ann Arbor, MI, USA* Albert Shih, *University of Michigan, Ann Arbor, MI, USA*
7-63	MSEC2011-50175	An Analysis of the Wear of Tungsten Carbide and Polycrystalline Diamond Inserts Turning TI-6AL-4V David Schrock, *Michigan State University, East Lansing, MI, USA* Xin Wang, *Michigan State University, East Lansing, MI, USA* Patrick Kwon, *Michigan State University, East Lansing, MI, USA*
16-64	MSEC2011-50197	The Periodical Fluctuation Residual Stress In Hard Turned Surface Xueping Zhang, *Shanghai Jiao Tong University, Shanghai, China* Shenfeng Wu, *Shanghai Jiao Tong University, Shanghai, China* C. Richard Liu, *Purdue University, West Lafayette, IN, USA*

8-Agriculture Science Room (LSC)	2-1-1 Microforming	
Tues 1300-1430	Session Chair: Session Co-Chair:	N. Venkata Reddy, *Indian Institute of Technology Kanpur, Uttar Pradesh, India* Gracious Ngaile, *North Carolina State University, Raleigh, NC, USA*
8-65	MSEC2011-50135	Experimental Study of High-frequency Vibration Assisted Micro/meso-scale Forming of Metallic Materials Zhehe Yao, *Zhejiang University, Zhejiang, China* Gap-Yong Kim, *Iowa State University, Ames, IA, USA* LeAnn Faidley, *Iowa State University, Ames, IA, USA* Qingze Zou, *Rutgers University, Piscataway, NJ, USA* Deqing Mei, *Zhejiang University, Zhejiang, China* Zichen Chen, *Zhejiang University, Zhejiang, China*
8-66	MSEC2011-50183	Cold Drawing of Magnesium Alloy Tubes for Medical Akinobu Koiwa, *Tokai University, Hiratsuka, Japan* Kazunari Yoshida, *Tokai University, Hiratsuka, Japan*
8-67	MSEC2011-50258	Characterization of Tensile and Compressive Behavior of Microscale Sheet Metals using a Transparent Micro-Wedge Device James Magargee, *Northwestern University, Evanston, IL, USA* Jian Cao, *Northwestern University, Evanston, IL, USA* Rui Zhou, *Northwestern University, Evanston, IL, USA* Morgan McHugh, *Northwestern University, Evanston, IL, USA* Fabrice Morestin, *INSA de Lyon, Villeurbanne, France*
8-68	MSEC2011-50273	An Investigation on Deformation-Based Micro Surface Texturing Rui Zhou, *Northwestern University, Evanston, IL, USA* Jian Cao, *Northwestern University, Evanston, IL, USA* Kornel F. Ehmann, *Northwestern University, Evanston, IL, USA* Chun Xu, *Shanghai University, Shanghai, China*

9-Wells Fargo Room (LSC)	1-1-2 Mechanical Properties 2	
Tues 1300-1430	Session Chair: Session Co-Chair:	Masayuki Nakada, *Kanazawa Institute of Technology, Hakusan, Japan* Hiroyuki Kawada
9-69	ICMP2011-51005	Effects of Curing Temperature on the Interfacial Failure Criterion in a Glass Fiber/Epoxy Composite Shinji Ogihara, *Tokyo University of Science, Noda, Chiba, Japan* Akihiro Kashima, *Tokyo University of Science, Noda, Chiba, Japan* Jun Koyanagi, *JAXA, Sagamihara, Kanagawa, Japan* Kenichi Watanabe, *Mitsubishi Rayon, Toyohashi, Aichi, Japan* Satoshi Kobayashi, *Tokyo Metropolitan University, Hachioji, Japan*
9-70	ICMP2011-51024	Analysis on Filament Winding Sphere Surface Component with Three Polar-Holes Rong Min, *Northwestern Polytechnical University, Xi'an, China* Yongjun Wang, *Northwestern Polytechnical University, Xi'an, China* Weichao Wu, *Northwestern Polytechnical University, Xi'an, China* Junbiao Wang, *Northwestern Polytechnical University, Xi'an, China*

9-71	ICMP2011-51074	Synthesis of Virltical Aligned CNT and Effects of CNT Length on its Polymer Composite Properties Toshiyuki Tasuhara, *Tokyo Institute of Technology, Tokyo, Japan* Naoto Ohtake, *Tokyo Institute of Technology, Tokyo, Japan* Hidetoshi Ando, *Tokyo Institute of Technology, Tokyo, Japan*

Concurrent Technical Sessions, Papers (72-102) 1445-1615 on Tuesday, June 14, 2011		
1-Willamette Room (Alumni Center)	4-2-1 Nanomaterials, Nanofabrication and Their Applications 1	
Tues 1445-1615	Session Chair: Session Co-Chair:	Mikio Muraoka, *Akita University, Akita, Japan* Yang Ju, *Nagoya University, Nagoya, Japan*
1-72	MSEC2011-50045	Design and Fabrication of an Automatic Nanoscale Tool-tip Exchanger for Scanning Probe Microscopy Curtis Taylor, *University of Florida, Gainesville, FL, USA* Bijoyraj Sahu, *University of Florida, Gainesville, FL, USA* Robert Riddle, *University of Nevada, Reno, NV, USA* Kam K. Leang, *University of Nevada, Reno, NV, USA*
1-73	MSEC2011-50067	Sol-Gel Synthesis and Magnetic, Optical and Impedance Behaviour of Strontium Ferrite Powder Shivendra Kumar Jaiswal, *Indian Institute of Technology, Kanpur, India* Jitendra Kumar, *Indian Institute of Technology, Kanpur, India*
1-74	MSEC2011-50268	Nanoscale Surface Modifications by Magnetic Field-Assisted Finishing Raul Riveros, *University of Florida, Gainesville, FL, USA* Jared Hann, *University of Florida, Gainesville, FL, USA* Hitomi Yamaguchi, *University of Florida, Gainesville, FL, USA* Curtis Taylor, *University of Florida, Gainesville, FL, USA*
1-75	ICMP2011-51062	Strategy for Advanced Fabrication of Metallic Micro/Nano Materials using Atomic Diffusion Phenomenon Masumi Saka, *Tohoku University, Sendai, Japan* Shien Ri, *Tohoku University, Sendai, Japan*

2-Trysting Tree (Alumni Center)	1-2 Forming 2	
Tues 1445-1615	Session Chair: Session Co-Chair:	Dr. Jian Cao, *Northwestern University, Evanston, IL, USA* Dr. Brad Kinsey, *University of New Hampshire, Durham, NH, USA*
2-76	NAMRC39-4777	Optimal Load Path Input in Tube Hydroforming Machines Dr. Gracious Ngaile, *North Carolina State University, Raleigh, NC, USA* Grant Welch, *North Carolina State University, Raleigh, NC, USA*
2-77	NAMRC39-4735	Optimization of Parameters in Roll Forming Process of Aluminum Automotive Component by Neural Network and Genetic Algorithm Park Hong-Seok, *University of Ulsan, Ulsan, Korea* Tran Viet Anh, *University of Ulsan, Ulsan, Korea*

3-Burlingham/Elle (Alumni Center)	1-5 Manufacturing Systems 2	
Tues 1445-1615	Session Chair: Session Co-Chair:	Dr. Lihui Wang, *University of Skovde, Skovde, Sweden* Dr. Jamie Camelio, *Virginia Tech, Blacksburg, VA, USA*
3-78	NAMRC39-4744	Compensability of Errors in Product Quality in Multistage Manufacturing Processes Yibo Jian, *The University of Texas at Austin, Austin, TX, USA* Dr. Dragan Djurdjanovic, *The University of Texas at Austin, Austin, TX, USA*
3-79	NAMRC39-4814	Segmentation and Segment Dynamics of a Serial Manufacturing System Saumil Ambani, *University of Michigan, Ann Arbor, MI, USA* Dr. Lin Li, *University of Illinois at Chicago, Chicago, IL, USA* Jun Ni, *University of Michigan, Ann Arbor, MI, USA*

4-Austin Auditorium (LSC)	3-3-1Surface Modification Technology, Wear, and Trbology 1	
Tues 1445-1615	Session Chair: Session Co-Chair:	Qiang Wu, *Kennametal Inc, Latrobe, PA, USA* Kevin Chou, *The University of Alabama, Tuscaloosa, AL, USA*
4-80	ICMP2011-51066	Polymer Effects on Turbulence in Flowing Soap Films Studied with Film Interference Flow Imaging Method Ruri Hidema, *Yamagata University, Yonezawa, Japan* Hidemitsu Furukawa, *Yamagata University, Yonezawa, Japan* Hideharu Ushiki, *Tokyo University of Agriculture and Technology, Fuchu, Japan*
4-81	ICMP2011-51096	Surface Rolling Characteristics and Load Bearing Capacity of 1.5Cr-0.2Mo High Density Sintered Steel Rollers and Gears Teruie Takemasu, *Tokyo University of Science, Suwa, Chino, Japan* Takao Koide, *Tottori University, Tottori, Japan* Yoshiobu Takeda, *Hoganas Japan K.K., Minatoku, Tokyo, Japan* Daisuke Kamimura, *Tokyo University of Science, Suwa, Chino, Japan* Masato Nakamoto, *Tokyo University of Science, Suwa, Chino, Japan*
4-82	MSEC2011-50035	Study of Carbon Nonatubes on Wear Performance of Aluminum Matrix Composites by Friction Stir Processing Weiping Xu, *Nanchang Hangkong University, Nanchang, Jiangxi, China* Ke Liming, *Nanchang Hangkong University, Nanchang, Jiangxi, China* Li Xing, *Nanchang Hangkong University, Nanchang, Jiangxi, China* Zhifeng Zhang, *Nanchang Hangkong University, Nanchang, Jiangxi, China* Xia Zhao, *Jiangling Motors Corporation Ltd., Nanchang, Jiangxi, China*
4-82A	MSEC2011-50278	On the Volumetric Assessment of Tool Wear in Machining Inserts with Complex Geometries: Need, Methodology & Validation Mathew Kuttolamadom, *CU-ICAR, Greenville, SC, USA* Laine Mears, *Ph.D., P.E., Clemson University, Greenville, SC, USA*

5-Construction & Engineering Hall (LSC)	3-7-1 Advances in Quality and Process Control in Manufacturing Systems	
Tues 1445-1615	Session Chair: Session Co-Chair:	Robert X. Gao, Ph.D., *University of Connecticut, Storrs, CT, USA* Yong Huang, *Clemson University, Clemson, SC, USA*
5-83	MSEC2011-50007	Comparison of Process Capability Index and SPC Control Limits Calculations When Using Different Inspection Tools Mohamed Gadalla, *Alabama A&M University, Normal, AL, USA* Miroslaw Popielarczyk, *Pratt & Whitney, East Hartford, CT, USA*
5-84	MSEC2011-50152	Standardization of CMM Fitting Algorithms and Development of Inspection Maps for Use in Statistical Process Control Neelakantan Mani, *Arizona State University, Batavia, OH, USA* Jami Shah, *Arizona State University, Tempe, AZ, USA* Joseph Davidson, *Arizona State University, Tempe, AZ, USA*
5-85	MSEC2011-50267	A Bio-Inspired Framework for a Self-Healing Assembly System Lee Wells, *Virginia Teach, Blacksburg, VA, USA* Jamie Camelio, *Virginia Tech, Blacksburg, VA, USA* Giovannina Zapata, *Virginia Tech, Blacksburg, VA, USA*
5-86	MSEC2011-50029	Research and Demonstrations to Realize Interoperable Manufacturing – A STEP-NC Approach Martin Hardwick, *Rensselaer Polytechnic Institute, Troy, NY, USA* Yaoyao (Fiona) Zhao, *National Institute of Standards and Technology, Gaithersburg, MD, USA* Frederick M. Proctor, *National Institute of Standards and Technology, Gaithersburg, MD, USA* Sid Venkatesh, *Boeing Company, Renton, WA, SUA* Xun Xu, *University of Auckland, Auckland, New Zealand*

6-Agriculture Production Room (LSC)	2-3-2 Advanced Powder Processing Technique 2	
Tues 1445-1615	Session Chair: Session Co-Chair:	Hideshi Miura Hideki Kyogoku, *Kinki University, Higashihiroshima, Hiroshima, Japan*
6-87	ICMP2011-51009	Creation of High Strength and High Ductility Sintered Materials with Harmonic Microstructure Kei Ameyama, *Ritsumeikan University, Kusatsu, Shiga, Japan*
6-88	ICMP2011-51064	Shape Memory Characteristics of Ni-rich Ti-Ni Shape Memory Alloys by Powder-Metallurgical Process Akira Terayama, *Hiroshima Prefectural Technology Research Institute, Kure, Japan* Hideki Kyogoku, *Kinki University, Higashihiroshima, Hiroshima, Japan*

6-89	ICMP2011-51083	Fabrication of Composite material Using Coal Ash and Aluminum Sludge by Spark Plasma Sintering Eijiro Nakamura, *Okinawa Industrial Technology Center, Uruma, Okinawa, Japan* Isao Fukumoto, *University of the Ryukus, Nishihara-cho, Okinawa, Japan* Yasuyuki Kanda, *University of the Ryukus, Nishihara-cho, Okinawa, Japan*
6-90	ICMP2011-51130	Magnetic Properties of Injection Molded Permalloys (Fe-50%Ni) Hideshi Miura

7-Agriculture Leaders Room (LSC)	2-10-3 Design, Materials, and Nontraditional Processes 1	
Tues 1445-1615	Session Chair: Session Co-Chair:	Burak Ozdoganlan, *Carnegie Mellon University, Pittsburgh, PA, USA* John Morehouse, *Georgia Institute of Technology, Atlanta, GA, USA*
7-91	MSEC2011-50049	Application of Topology Optimization in Product Design and Manufacturing Ihab Ragai, *Hitachi Construction Truck Manufacturing Ltd. Guelph, ON, Canada* Harry Tempelman, *Hitachi Construction Truck Manufacturing Ltd. Guelph, ON, Canda* David Kirby, *Altair Engineering, Toronto, ON, Canada*
7-92	MSEC2011-50228	Optimal Senso Location to Estimate Temperature Distribution in an Injection Mould Jaho Seo, *University of Waterloo, Waterloo, ON, Canada* Amir Khajepour, *University of Waterloo, Waterloo, ON, Canada* Jan P. Huissoon, *University of Waterloo, Waterloo, ON, Canada*
7-93	MSEC2011-50229	Effect on Flow Stress of a Rapid Phase Transition in AISI 1045 Steel Timothy Burns, *National Institute of Standards and Technology, Gaithersburg, MD, USA* Steven P. Mates, *National Institute of Standards and Technology, Gaithersburg, MD, USA* Richard L. Rhorer, *National Institute of Standards and Technology, Gaithersburg, MD, USA* Eric P. Whitenton, *National Institute of Standards and Technology, Gaithersburg, MD, USA* Debasis Basak, *Orbital Sciences Corporation, Dulles, VA, SUA*
7-94	MSEC2011-50128	Intelligent Metal-Forming Simulation ManSoo Joun, *Gyeongsang National University, Jinju, Gyeongnam, Korea* MinCheol Lee, *Gyeongsang National University, Jinju, Gyeongnam, Korea* JaeGun Eom, *Gyeongsang National University, Jinju, Gyeongnam, Korea*
7-95	MSEC2011-50219	Numerical Modeling of Transport and Dendritic Growth in laser Conduction Welding of 304 Stainless Steel Wenda Tan, *Purdue University, West Lafayette, IN, USA* Neil Bailey, *Purdue University, West Lafayette, IN, USA* Yung Shin, *Purdue University, West Lafayette, IN, USA*

8-Agriculture Science Room (LSC)	2-1-2 Incremental Forming	
Tues 1445-1615	Session Chair: Session Co-Chair:	Gap-Yong Kim, *Iowa State University, Ames, IA, USA* Serhat Kaya, *RTI International Metals, Inc., Niles, OH, USA*
8-96	MSEC2011-50235	Theoretical and Numerical Analysis of Incremental Sheet Forming by Using High Pressure Water Jet B Lu, *Shanghai Jiao Tong University, Shanghai, China* Jian Cao, *Northwestern University, Evanston, IL, USA* H Ou, *University of Nottingham, Nottingham, United Kingdom*
8-97	MSEC2011-50262	Improvement of Geometric Accuracy in Incremental Forming Using a Squeezing Toolpath Strategy with Two Forming Tools Rajiv Malhotra, *Northwestern University, Evanston, IL, USA* Jian Cao, *Northwestern University, Evanston, IL, USA* Z. Cedric Xia, *Ford Motor Company, Dearborn, MI, USA* Vijitha Kiridena, *Ford Motor Company, Dearborn, MI, USA* Feng Run, *Ford Motor Company, Dearborn, MI, USA*
8-98	MSEC2011-50284	Formability and Surface Finish Studies in Single Point Incremental Forming N. Venkata Reddy, *Indian Institute of Technology, Kanpur, Uttar Pradesh, India* Anirban Bhattacharya, *Indian Institute of Technology, Kanpur, Uttar Pradesh, India* SamarJit Singh, *Indian Institute of Technology, Kanpur, Uttar Pradesh, India* K. Maneesh, *Indian Institute of Technology, Kanpur, Uttar Pradesh, India* Jian Cao, *Northwestern University, Evanston, IL, USA*
8-99	MSEC2011-50031	Study on Discrete Die Stretch Bending for Strip and L Section Profile Rui Liu, *Northwestern Polytechnical University, Xi'an, Shanixi, China* Yongjun Wang, *Northwestern Polytechnical University, Xi'an, Shanixi, China* Hao Zhang, *Northwestern Polytechnical University, Xi'an, Shanixi, China* Weichao Wu, *Northwestern Polytechnical University, Xi'an, Shanixi, China*

9-Wells Fargo Room (LSC)	1-1-3 Natural Composites and Recycling	
Tues 1445-1615	Session Chair: Session Co-Chair:	Shinji Ogihara, *Tokyo University of Science, Noda, Chiba, Japan* Junichiro Yamabe, *Kyushu University, Fukuoka, Japan*
9-100	ICMP2011-51028	Tensile of Carbon Fibers Reclaimed from CF/Epoxy Using Sub- and Supercritical Fluids Yoshinobu Shimamura, *Shizuoka University, Hamamatsu, Shizuoka, Japan* Toshiro Ueda, *Shizuoka University, Hamamatsu, Shizuoka, Japan* Keiichiro Tohgo, *Shizuoka University, Hamamatsu, Shizuoka, Japan* Tomoyuki Fujii, *Shizuoka University, Hamamatsu, Shizuoka, Japan* Idzumi Okajima, *Shizuoka University, Hamamatsu, Shizuoka, Japan* Masataka Hiramatsu, *Shizuoka University, Hamamatsu, Shizuoka, Japan* Takeshi Sako, *Shizuoka University, Hamamatsu, Shizuoka, Japan*
9-101	ICMP2011-51031	A Study on the Basalt Fiber Reinforced Composites Yuqiu Yang, *Kyoto Institute of Technology, Kyoto, Japan* Kenichi Takao, *Kyoto Institute of Technology, Kyoto, Japan* Guijun Xian, *Harbin Institute of Technology, Harbin, China* Hiroyuki Hamada, *Kyoto Institute of Technology, Kyoto, Japan*

9-102	ICMP2011-51090	A Study on Structural Stiffness, Strength and Touchness of Kenaf Random Short-Fiber Reinforced Polylactide Composites Kohji Suzuki, *Chiba Institute of Technology, Chiba, Japan* Manabu Misawa, *Chiba Institute of Technology, Chiba, japan*

Early Career Forum 1615-1815 on Tuesday, June 14, 2011		
1-Willamette Room (Alumni Center)	5-1-2 Early Research Career Forum	
Tues 1615-1815	Session Chair:	Yong Huang, *Clemson University, Clemson, SC, USA*
1-103	MSEC2011-50328 Panel Presentations	Research Life and How to be Successful Professionally <u>Panelists:</u> *Irem Y. Tumer, Professor, Mechanical , Industrial, and Manufacturing Engineering, Oregon State University* *Cedric Xia, Technical Leader, Global Materials & Manufacturing CAE Research; and Group Leader, Sheet Metal Research; Research & Advanced Engineering, Ford Motor Company* *George A. Hazelrigg, Deputy Division Director, Civil, Mechanical and Manufacturing (CMMI) Division, National Science Foundation*

TECHNICAL PROGRAM - WEDNESDAY, JUNE 15, 2011

Concurrent Technical Sessions, Papers (104-137) 1030-1200 on Wednesday, June 15, 2011		
1-Willamette Room (Alumni Center)	2-9-1 Bio-Fabrication Processes	
Wed 1030-1200	Session Chair: Session Co-Chair:	Andy Christensen, *Medical Modeling Inc, Golden, CT, USA* Binil Starly, *University of Oklahoma, Norman, OK, USA*
1-104	MSEC2011-50139	Fabrication of Conformal Ultrasound Transducer Arrays and Horns Based on Multi-Axis CNC Accumulation Yong Chen, *University of Southern California, Los Angeles, CA, USA* Chi Zhou, *University of Southern California, Los Angeles, CA, USA* Yayue Pan, *University of Southern California, Los Angeles, CA, USA* Jouni Partanen, *Aalto University, Aalto, Finland*
1-105	MSEC2011-50166	Thermosensitive/Photocrosslinkable Hydrogel for Soft Tissue Scaffold Printing Chris Geisler, *Drexel University, Philadelphia, PA, USA* Ho-Lung Li, *Drexel University, Philadelphia, PA, USA* David M. Wooton, *Cooper Union, New York, NY, USA* Peter I. Lelkes, *Drexel University, Philadelphia, PA, USA* Jack G. Zhou, *Drexel University, Philadelphia, PA, USA* Qingwei Zhang, *Drexel University, Philadelphia, PA, USA*
1-106	MSEC2011-50176	A New Flexible and Multi-Purpose System Design for 3-Dimensional Printing Ho-Lung Li, *Drexler University, Philadelphia, PA, USA* Chris G. Geisler, *Drexler University, Philadelphia, PA, USA* David M. Wootton, *Cooper Union, New York, NY, USA* Jack G. Zhou, *Drexel University, Phildelphia, PA, USA*
1-107	MSEC2011-50259	Development of HA-PLGA Scaffold Encapsulating Intact BMP-2 Using Solid Freeform Fabrication Technology Jin-Hyung, *POSTECH, Pohang, Kyungbuk, Korea* Jong Young Kim, *Andong National University, Andong, Kyungbuk, Korea* Kyung Shin Kang, *POSTECH, Pohang, Kyungbuk, Korea* Jung Kyu Park, *POSTECH, Pohang, Kyungbuk, Korea* Sei Kwang Hahn, *POSTECH, Pohang, Kyungbuk, Korea* Dong-Woo Cho, *POSTECH, Pohang, Kyungbuk, Korea*

2-Trysting Tree (Alumni Center)	1-17 Metrology 1	
Wed 1030-1200	Session Chair: Session Co-Chair:	Dr. Tony Schmitz, *University of Florida, Gainesville, FL, USA* Dr. Laine Mears, *Clemson University, Greenville, SC, USA*
2-108	NAMRC39-4727	Probing System for Measurement of Micro-Scale Components Chan-Seo Goo, *University of Victoria, Victoria, BC, Canada* Dr. Martin Jun, *University of Victoria, Victoria, BC, Canada* Akinori Saito, *Nihon University, Koriyama, Fukushima, Japan*
2-109	NAMRC39-4791	On-Machine Monitoring of Tool Wear with Touch Probes Andrew Henderson, *Clemson University, Greenville, SC, USA* Cristina/C.J. Bunget, *Clemson University, Greenville, SC, USA* Dr. Thomas R. Kurfess, *Clemson University, Greenville, SC, USA*

2-110	NAMRC39-4724	Effect of Shape Change of the Elastic Model of the Flexible Sensor for Three-Axis Load Measurement of Normal Load and Shearing Load Kang Ning Tan, *Shinshu University, Nagano-shi, Nagano, Japan* Noboru Nakayama, *Shinshu University, Nagano-shi, Nagano, Japan* Masato Kobayashi, *Shinshu University, Nagano-shi, Nagano, Japan* Sung-Moo Song, *Shinshu University, Nagano-shi, Nagano, Japan* Hiroyuku Takeishi, *Chiba Institute of Technology, Narashino, Chiba, Japan* Hiroaki Fukui, *Sanko Co., Ltd., Azumino-shi, Nagano, Japan* Takuya Suzuki, *Precion Co., Ltd., Kanuma-shi, Tochigi, Japan*

3-Burlingham/Elle (Alumni Center)	1-7 Sustainable Manufacturing 1	
Wed 1030-1200	Session Chair: Session Co-Chair:	Dr. Fazleena Badurdeen, *University of Kentucky, Lexington, KY, USA* Dr. Karl R. Haapala, *Oregon State University, Corvallis, OR, USA*
3-111	NAMRC39-4722	An Ontology-based Approach to Develop Sustainable Manufacturing Metrics for Supply Chain Evaluation Dr. Fazleena Badurdeen, *University of Kentucky, Lexington, KY, USA* Mohannad Shuaib, *University of Kentucky, Lexington, KY, USA* Haritha Metta, *University of Kentucky, Lexington, KY, USA* Chris Stovall, *University of Kentucky, Lexington, KY, USA* Dr. I.S. Jawahir, *University of Kentucky, Lexington, KY, USA* Thomas Goldsby, *University of Kentucky, Lexington, KY, USA*
3-112	NAMRC39-4750	Greenhouse Gas Emission Mitigation of Global Automotive Manufacturing Through Clean Energy Supply Huajun Cao, *University of Wisconsin, Milwaukee, WI, USA* Qiang Zhai, *University of Wisconsin, Milwaukee, WI, USA* Xiang Zhao, *General Motors Company, Warren, MI, USA* Chris Yuan, *University of Wisconsin, Milwaukee, WI, USA*
3-113	NAMRC39-4797	Environmental Impact and Coast Assessment of Product Service Systems Using IDEF0 Modeling Hao Zhang, *Oregon State University, Corvallis, OR, USA* Dr. Karl R. Haapala, *Oregon State University, Corvallis, OR, USA* Mary E. Vanlue, *Oregon State University, Corvallis, OR, USA* Kenneth H. Funke II, *Oregon State University, Corvallis, OR, USA*

4-Austin Auditorium (LSC)	2-10-4 Machining Processes 2	
Wed 1030-1200	Session Chair: Session Co-Chair:	Cristina Bunget, *Clemson University, Greenville, SC, USA* Ihab Ragai, *Hitachi Construction Truck Manufacturing Ltd., Guelph, ON, Canada*
4-114	MSEC2011-50279	Temperature Field Correlation With Surface Integrity in Hard Milling Hardik Singh, *The University of Alabama, Tuscaloosa, AL, USA* Y.B. Guo, *The University of Alabama, Tuscaloosa, AL, USA*

4-115	MSEC2011-50275	Geometric Modeling and Analysis of Single Point Cutting Tools with Generic Profile Kumar Sambhav, *Indian Institute of Technology, Kanpur, Uttar Pradesh, India* Puneet Tandon, *PDPM Indian Institute of Information Technology, Jabalpur, Madhya Pradesh, India* Sanjay G. Dhande, *Insitute of Technology Kanpur, Uttar Pradesh, India*
4-116	MSEC2011-50234	Size Effects in Cutting with a Diamond-coated Tool Feng Qin, *University of Alabama, Tuscaloosa, AL, USA* Kevin Chou, *University of Alabama, Tuscaloosa, AL, USA*
4-117	MSEC2011-50216	Theoretical Modeling of Cutting Temperature Distribution by Consideringn the Material Thermal Properties as Functions of Temperature Zheng Kang, *Shanghai Jiao Tong University, Shanghai, China* Xia Ji, *Shanghai Jiao Tong University, Shanghai, China* Xueping Zhang, *Shanghai Jiao Tong University, Shanghai, China* Y.Steven Liang, *Georgia Institute of Technology, Atlanta, GA, USA*

5-Construction & Engineering Hall (LSC)	1-3-1 Ceramics and Ceramic Matrix Composites 1	
Wed 1030-1200	Session Chair: Session Co-Chair:	Shuichi Wakayama, *Tokyo Metropolitan University, Tokyo, Japan* Yasuo Kogo, *Tokyo University of Science, Noda, Chiba, Japan*
5-118	ICMP2011-51030	Application of Random Walk Theory to Grain Motion During Superplastic Deformation in TZP Ceramics Taku Okamoto, *Tokyo Institute of Technology, Tokyo, Japan* Kouichi Yasuda, *Tokyo Institute of Technology, Tokyo, Japan* Tadashi Shiota, *Tokyo Institute of Technology, Tokyo, Japan*
5-119	ICMP2011-51059	Hydrothermally Synthesized and Spark Plasma Sintered Multi Wall carbon Nanotube (MWCNT) Reinforced Boehmite (AlOOH) Derived Alumina Ceramics Ali Can Zaman, *Yildiz Technical University, Istanbul, Turkey* Cem B. Ustundag, *Yildiz Technical University, Istanbul, Turkey* Ali Celik, *Anadolu University Eskiehir, Turkey* Alpagut Kara, *Anadolu University Eskiehir, Turkey* Figen Kaya, *Zonguldak Karaelmas University, Zonguldak, Turkey* Cengiz Kaya, Yildiz Technical University, Instanbul, Turkey
5-120	ICMP2011-51093	Accurate Quantitative Evaluation of Oxidation rate of SiC Under Elevated Temperatures Yuuki Kubota, *The Graduate University for Advanced Studies, Sagamihara, Kanagawa, Japan* Toshinari Yoshinaka, *Japan Aerospace Exploration Agency, Sagamihara, Japan* Yasuo Kogo, *Tokyo University of Science, Noda, Japan* Takashi Goto, *Tohoku University, Sendai, Japan* Rong Tu, *Tohoku University, Sendai, Japan*

5-121	ICMP2011-51104	Non-Destructive Evaluation for C/C Composites Using Electrical Measurements Method Masashi Koyama, *Tokyo University of Science, Noda, Japan* Hitoshi Saito, *Tokyo University of Science, Noda, Japan* Hiroshi Hatta, *Japan Aerospace Exploration Agency, Kanagawa, Japan* Hiroshi Fukuda, *Tokyo University of Science, Noda, Chiba, Japan*

6-Agriculture Production Room (LSC)	2-7-1 Advances in Nontraditional/Hybrid Manufacturing 1	
Wed 1030-1200	Session Chair: Session Co-Chair:	Lin Gu, *Shangahi Jiao Tong University, Shanghai, China* Brigit Bohlmann, *Karlsruhe University of Applied Sciences, Karlsruhe, Germany*
6-122	MSEC2011-50068	Development of a Multi-Axis WEM Process Birgit Bohlmann, *Karlsruhe University of Applied Sciences, Karlsruhe, Germany* Josef Buresch, *Karlsruhe University of Applied Sciences, Karlsruhe, Germany* Rudiger Haas, *Karlsruhe University of Applied Sciences, Karlsruhe, Germany*
6-123	MSEC2011-50105	Rapid-Tooling of Bunched Electrode for EDM Lei Li, *Shanghai Jiao Tong University, Shanghai, China* Xiaoli Xiang, *Shanghai Jiao Tong University, Shanghai, China* Lin Gu, *Shanghai Jiao Tong University, Shanghai, China* Wansheng Zhao, *Shanghai Jiao Tong University, Shanghai, China*
6-124	MSEC2011-50161	Research on Dry EDM Processing Performance with Two Kinds of Pulse Generator Modes Liqing Li, *Harbin Institute of Technology, Harbin, Heilongjiang, China* Yi Fu, *Harbin Institute of Technology, Harbin, Heilongjiang, China* Yingjie Song, *Northeast Mine Equipments Leasing Co. Ltd., Harbin, China*
6-125	MSEC2011-50198	Methods to Rationalize the Generation of Parameter Technologies in Sinking EDM Henrik Juhr, *Karlsruhe University of Applied Science, Karlsruhe, BW, Germany* Rudiger Haas, *Karlsruhe University of Applied Science, Karlsruhe, BW, Germany* Klaus Kunanz, *TU Dresden, Dresden, Germany*

7-Agriculture Leaders Room (LSC)	4-2-2 Nanomaterials, Nanofabrication and Their Applications 2	
Wed 1030-1200	Session Chair: Session Co-Chair:	Xinnan Wang, *North Dakota State University, Fargo, ND, USA* Dave (Dae-Wook) Kim, *Washington State University, Vancouver, WA, USA*
7-126	MSEC2011-50270	Molecular Dynamics Simulation of AFM-Based Nanomachining Processes Rapeepan Promyoo, *IUPUI, Indianapolis, IN, USA* Hazim El-Mounayri, *IUPUI, Indianapolis, IN, USA* Kody Varahramyan, *IUPUI, Indianapolis, IN, USA* Ashlie Martini, *Purdue University, West Lafayette, IN, USA*
7-127	MSEC2011-50302	Capillary Force Induced Elastic Deformation on ZnS Nanobeams Xinnan Wang, *North Dakota State University, Fargo, ND, USA* Xiaodong Li, *University of South Carolina, Columbia, SC, USA*

7-128	ICMP2011-51078	Success Conditions of Welding Ultrathin Pt Wires by Joule Heat Hironori Tohmyoh, *Tohoku University, Sendai, Japan* Satoru Fukui, *Tohoku University, Sendai, Japan* Masumi Saka, *Tohoku University, Sendai, Japan*
7-129	ICMP2011-51081	Imaging the Nano-Structure Materials Utilizing Microwave-AFM Lan Zhang, *Nagoya University, Nagoya, Japan* Yang Ju, *Nagoya University, Nagoya, Japan* Atsushi Hosoi, *Nagoya University, Nagoya, Japan* Akifumi Fujimoto, *Nagoya University, Nagoya, Japan*

8-Agriculture Science Room (LSC)	2-5-1 Thermal and Cold Spray Coatings, and Surface Treatment	
Wed 1030-1200	Session Chair: Session Co-Chair:	Kazuhiro Ogawa, *Tohoku University, Sendai, Japan* Kazuhiko Sakaki, *Shinsh University, Nagano, Japan*
8-130	ICMP2011-51035	Improvement of Mechanical Property of WC – Cermet Coatings Prepared by High Velocity Air Fuel Spraying (Influence of Powder Composition and Spray Condition on the Mechanical Property of HVAF Sprayed) Kazuhiko Sakaki, *Shinsh University, Nagano, Japan* Kiyoaki Takizawa, *Shinshu University, Nagano, Japan* Hidenori Miyajima, *Shinshu University, Nagano, Japan* Junya Kitamura, *Fujimi Incorporated, Kakamigahara, Gifu, Japan* Kazuto Satou, *Fujimi Incorporated, Kakamigahara, Gifu, Japan*
8-131	ICMP2011-51086	Splat Formation Mechanism in Thermal Spraying Masahiro Fukumoto, *Toyohashi University of Technology, Toyohashi, Japan* Kun Yang, *Toyohashi University of Technology, Toyohashi, Japan* Motohiro Yamada, *Toyohashi University of Technology, Toyohashi, Japan* Toshiaki Yasui, *Toyohashi University of Technology, Toyohashi, Japan*
8-132	ICMP2011-51029	Numerical Analysis of Interfacial Bonding of Aluminum Powder Particle and Aluminum Substrate by Cold Spray Technique using the SPH Method Abreeza Manap, *Tohoku University, Sendai, Miyagi, Japan* Tomonaga Okabe, *Tohoku University, Sendai, Miyagi, Japan* Kazuhiro Ogawa, *Tohoku University, Sendai, Miyagi, Japan*
8-133	ICMP2011-51041	Improvement of Deposition Efficiency and Control of Hardness for Cold Sprayed Coatings using High Carbon Steel/Mild Steel Mixture Powder Kazuhiro Ogawa, *Tohoku University, Sendai, Japan* Satoshi Amao, *Tohoku University, Sendai, Japan* Nobuyuki Yokoyama, *East Japan Railway Company, Saitama, Japan* Kousuke Ootaki, *East Japan Railway Company, Saitama, Japan*

9-Wells Fargo Room (LSC)	1-6-1 Smart Actuators and Sensors	
Wed 1030-1200	Session Chair: Session Co-Chair:	Hiroshi Asanuma, *Chiba University, Chiba-shi, Japan* Hidemitsu Furukawa, *Yamagata University, Yonezawa, Japan*
9-134	ICMP2011-51106	Detection of Impact Strain Wave in Composites by FBG Sensor System with AWG Filter Yoji Okabe, *The University of Tokyo, Toyko, Japan* Naoko Watanabe, *The University of Tokyo, Toyko, Japan* Mamoru Shimazaki, *The University of Tokyo, Toyko, Japan* Hideki Soejima, *Fuji Heavy Industries Ltd., Tochigi, Japan* Toshimichi Ogisu, *Fuji Heavy Industries Ltd., Tochigi, Japan*
9-135	ICMP2011-51116	Development of Cylindrical AE Probes Using Optical Fiber Interferometric Sensors Tatsuro Kosaka, *Kochi University of Technology, Kochi, Kami-City, Japan* Katsuhiko Osaka, *Osaka City University, Osaka, Japan* Yoshihiro Sawada, *Osaka City University, Osaka, Japan*
9-136	ICMP2011-51139	High Responsiveness of Recovery Motion of Hydrogen Storage Film Driven by Direct Resistance Heating for Micro Actuator Shota Lizuka, *Tokai University, Hiratuka, Kanagawa, Japan* Junya Okawa, *Tokai University, Hiratsuka, Kanagawa, Japan* Kenji Aikawa, *Tokai University, Hiratsuka, Kanagawa, Japan* Haru-Hisa Uchida, *Tokai University, Hiratsuka, Kanagawa, Japan* Yoshitake Nishi, *Tokai University, Hiratsuka, Kanagawa, Japan*
9-137	ICMP2011-51164 Invited Speaker	Review of Ionic Polymer Metal Composites (IPMCs) Mohsen Shahinpoor, *University of Maine, Orono, ME, USA*

Concurrent Technical Sessions, Papers (138-169) 1315-1445 on Wednesday, June 15, 2011		
1-Willamette Room (Alumni Center)	1-10 Machining 1	
Wed 1315-1445	Session Chair: Session Co-Chair:	Dr. Shuting Lei, *Kansas State University, Manhattan, KS, USA* Dr. Yajun Fan, *Caterpillar Inc., Champaign, IL, USA*
1-138	NAMRC39-4742	Statistically Based Process Optimization for Improved Surface Quality in Micro-end Milling of Ti-5Al-4V Titanium Alloy Thanongsak Thepsonthi, *Rutgers University, Piscataway, NJ, USA* Dr. Tugrul Ozel, *Rutgers University, Piscataway, NJ, USA*
1-139	NAMRC39-4785	A Solid Modeler Based Simulation of Chip Load in Broaching Operation Hossam Kishawy, *University of Ontario Institute of Technology, Oshawa, ON, Canada* Ali Hosseini, *University of Ontario Institute of Technology, Oshawa, ON, Canada* Hazim Elmounayri, *Purdue School of Engineering and Technology at IUPUI, Indianapolis, IN, USA*

1-140	NAMRC39-4815	Efficient Machining of Hardened AISI 52100 Steel using a Laser-based Hybrid Process Satyanarayanan Raghaven, *Georgia Institute of Technology, Atlanta, GA, USA* Fukuo Hashimoto, *The Timken Company, Canton, OH, USA* Dr. Shreyes N. Melkote, *Georgia Institute of Technology, Atlanta, GA, USA*

2-Trysting Tree (Alumni Center)	1-6 Additive and Polymer Manufacturing	
Wed 1315-1445	Session Chair: Session Co-Chair:	Yong Chen, *University of Southern California, Los Angeles, CA, USA* Dr. Wei Li, *The University of Texas at Austin, Austin, TX, USA*
2-141	NAMRC39-4725	Additive Manufacturing Based on Optimized Mask Video Projection for Improved Accuracy and Resolution Chi Zhou, *University of Southern California, Los Angeles, CA, USA* Dr. Young Chen, *University of Southern California, Los Angeles, CA, USA*
2-142	NAMRC39-4752	Optimal Part Orientation in Rapid Manufacturing Process for Achieving Geometric Tolerances Ratnadeep Paul, *University of Cincinnati, Cincinnati, OH, USA* Dr. Sam Anand, *University of Cincinnati, Cincinnati, OH, USA*
2-143	NAMRC39-4796	Modeling of a Subcritical CO2 Microcellular Foam Extrusion Process Yongha Kim, *The University of Texas at Austin, Austin, TX, USA* Dr. Wei Li, *The University of Texas at Austin, Austin, TX, USA*

3-Burlingham/Elle (Alumni Center)	1-8 Sustainable Manufacturing 2	
Wed 1315-1445	Session Chair: Session Co-Chair:	Dr. Toshiki Hirogaki, *Doshisha University, Kyoto, Japan* Dr. Fu Zhao, *Purdue University, West Lafayette, IN, USA*
3-144	NAMRC39-4711	A New Approach to Scheduling in Manufacturing for Power Consumption and Carbon Footprint Reduction Kan Fang, *Purdue University, West Lafayette, IN, USA* Nelson Uhan, *Purdue University, West Lafayette, IN, USA* Dr. John W Sutherland, *Purdue University, West Lafayette, IN, USA* Dr. Fu Zhao, *Purdue University, West Lafayette, IN, USA*
3-145	NAMRC39-4712	Feature Level Energy Assessments for Discrete Part Manufacturing Amit Deshpande, *TechSolve, Cincinnati, OH, USA* John Snyder, *TechSolve, Cincinnati, OH, USA* Dan Scherrer, *TechSolve, Cincinnati, OH, USA*
3-146	NAMRC39-4804	Software-based Tool Path Evaluation for Environmental Sustainability Daeyoung Kong, *UC Berkeley, Berkeley, CA, USA* Seungchoun Choi, *UC Berkeley, Berkeley, CA, USA* Yusuuke Yasui, *UC Berkeley, Berkeley, CA, USA* Sushrut Pavanaskar, *UC Berkeley, Berkeley, CA, USA* Dr. David Dornfeld, *UC Berkeley, Berkeley, CA, USA* Paul Wright, *UC Berkeley, Berkeley, CA, USA*

4-Austin Auditorium (LSC)	2-1-3 Tube Hydroforming	
Wed 1315-1445	Session Chair: Session Co-Chair:	Fadi Abu-Farha, *Pennsylvania State, Erie, PA, USA* Serhat Kaya, *RTI International Metals Inc., Niles, OH, USA*
4-147	MSEC2011-50151	Tube Press Hardening for Light Weight Design Reimund Neugebauer, *Fraunhofer Institute for Machine Tools and Forming Technology IWU, Chemnitz, Germany* Frank Schieck, *Fraunhofer Institute for Machine Tools and Forming Technology IWU, Chemnitz, Germany* Markus Werner, *Fraunhofer Institute for Machine Tools and Forming Technology IWU, Chemnitz, Germany*
4-148	MSEC2011-50153	A New Method for Determination of the Pre-form Shapes and Their Corresponding Pressures in Tube-Hydroforming Process of SUS 034 in a Square Die Seyyed Ahmad Tabatabaei, *University of Tehran, Tehran, Iran* Masoud Shariat Panahi, *University of Tehran, Tehran, Iran* Seyyed Mostafa Tabatabaei, *Iran University of Science and Technology, Tehran, Iran* Mahmoud Mosavi Mashhadi, *University of Tehran, Tehran, Iran*
4-149	MSEC2011-50165	Real Time Friction Error Compensation in Tube Hydroforming Process Control Gracious Ngaile, *North Carolina State University, Raleigh, NC, USA* Obadiah Kilonzo, *North Carolina State University, Raleigh, NC, USA* Chen Yang, *North Carolina State University, Raleigh, NC, USA*
4-150	MSEC2011-50254	Loading Path Design of Tubular Hydroforming Process for Complicated Shaped Mg Alloy Components Wei Chen, *Hong Kong Polytechnic University, Hong Kong, China* Tai Chiu Lee, *Hong Kong Polytechnic University, Hong Kong, China*

5-Construction & Engineering Hall (LSC) (LSC)	1-3-2 Ceramics and Ceramic Matrix Composites 2	
Wed 1315-1445	Session Chair: Session Co-Chair:	Yasuo Kogo, *Tokyo University of Science, Noda, Japan* Shuichi Wakayama, *Tokyo Metropolitan University, Tokyo, Japan*
5-151	ICMP2011-51134	Strengthening of Transparent Silicate Glasses Treated by Dissolution in Water Shinichirou Nanba, *Tokai University, Hiratsuka, Kanagawa, Japan* Tatsuya Yamamoto, *Tokai University, Hiratsuka, Kanagawa, Japan* Keisuke Iwata, *Tokai University, Hiratsuka, Kanagawa, Japan* Yoshitake Nishi, *Tokai University, Hiratsuka, Kanagawa, Japan*
5-152	ICMP2011-51131	AE Monitoring of Damage Accumulation in Transparent Conductive Oxide Film Under Mechanical Strain Shuichi Wakayama, *Tokyo Metropolitan University, Tokyo, Japan* Nobuyuki Takagi, *Tokyo Metropolitan University, Tokyo, Japan* Akihiro Mizutani, *Tokyo Metropolitan University, Tokyo, Japan* Tsutomu Miyasaka, *Toin University of Yokohama, Kanagawa, Japan* Masashi Ikegami, *Toin University of Yokohama, Kanagawa, Japan* Takenobu Sakai, *Tokyo Metropolitan University, Tokyo, Japan*

5-153	ICMP2011-51153	Mechanical Properties of CNF Reinforced Ceramic Composites Sintered with SPS Technique Kosuke Umino, *Tokyo Metropolitan University, Tokyo, Japan* Shuichi Wakayama, *Tokyo Metropolitan University, Tokyo, Japan* Yuka Umehara, *Tokyo Institute of Technology, Yokohama, Japan* Takashi Akatsu, *Tokyo Institute of Technology, Yokohama, Japan* Takenobu Sakai, *Tokyo Metropolitan University, Tokyo, Japan*

6-Agriculture Production Room (LSC)	2-7-2 Advances in Nontraditional/Hybrid Manufacturing 2	
Wed 1315-1445	Session Chair: Session Co-Chair:	Sam Anand, *University of Cincinnati, Cincinnati, OH, USA* Murali Sundaram, *University of Cincinnati, Cincinnati, OH, USA*
6-154	MSEC2011-50052	An Investigation on Top Surface Quality for Direct Metal Laser Fabrication Yang Jialin, *China Academics of Engineering Physics, Mianyang, Sichuan, China* Xu Chao, *China Academics of Engineering Physics, Mianyang, Sichuan, China* Wang Yang, *China Academics of Engineering Physics, Mianyang, Sichuan, China*
6-155	MSEC2011-50179	Rapid Prototyping of Full Scale House Structures Sangju Lee, *University of Utah, Salt Lake City, UT, USA* Eberhard Bamberg, *University of Utah, Salt Lake City, UT, USA* Charles Eason, *OPTEMA Development Corporation, Fairfield, CA, USA*
6-156	MSEC2011-50283	A Vertex Translation Algorithm for Adaptive Modification of STL File in Layered Manufacturing Gaurav Navangul, *University of Cincinnati, Cincinnati, OH, USA* Ratnadeep Paul, *University of Cincinnati, Cincinnati, OH, USA* Sam Anand, *University of Cincinnati, Cincinnati, OH, USA*

7-Agriculture Leaders Room (LSC)	5-1-3 Student Manufacturing Design Competition 1	
Wed 1315-1445	Session Chair: Session Co-Chair:	Brad Kinsey, *University of New Hampshire, Durham, NH, USA* Z. Cedric Xia, *Ford Motor Company, Dearborn, MI, USA*
7-157	MSEC2011-50318	Lightweight Engineering Focused Redesign, Manufacture, and Validation of an Unsprung Vehicle Component for Total Life-Cycle Cost Savings Mathew Kuttolamadom, *CU-ICAR, Greenville, SC, USA*
7-158	MSEC2011-50320	Electromagnetic Metal Forming Machine Ethan Thibaudeau, *University of New Hampshire, Durham, NH, USA*
7-159	MSEC2011-50321	Micro Electrode Tube Non-Circular Flaring Process and Desktop Micro Flaring System Weichao Wu, *Northwestern Polytechnical University, Xi'an, China*
7-160	MSEC2011-50322	M1A1 Abrams Tank Model Alex Weisser, *RPI, Troy, USA*
7-161	MSEC2011-50323	Smart Tool Torque Calibration Test Stand Anthony Morin, *University of New Hampshire, Durham, NH, USA*

8-Agriculture Science Room (LSC)	3-11-1 Manufacturing System Operations 1	
Wed 1315-1445	Session Chair: Session Co-Chair:	Lin Li, *University of Illinois at Chicago, Chicago, IL, USA* Qing Chang, *New York Institute of Technology, Old Westbury, NY, USA*
8-162	MSEC2011-50089	Methodology for Solving the Assembly System Reconfiguration Planning Problem April Bryan, *University of the West Indies, Curepe, Trinidad and Tobago* S.J. Hu, *University of Michigan, Ann Arbor, MI, USA* Yoram Koren, *University of Michigan, Ann Arbor, MI, USA*
8-163	MSEC2011-50107	Alternative Shop-floor Re-layout Design Due to Dynamic Operation Changes Lihui Wang, *University of Skovde, Skovde, Sweden*
8-164	MSEC2011-50071	On Some Eco-indicators of Cutting Tools AMM Sharif Ullah, *Kitami Institute of Technology, Kitami, Hokkaido, Japan* Koichi Kitajima, *Kansai University, Suita, Osaka, Japan* Takeshi Akamatsu, *Hitachi Tool, Yasu, Shiga, Japan* Masahiro Funro, *Hitachi Tool, Yasu, Shiga, Japan* Jun'ichi Tamaki, *Kitami Institute of Technology, Kitami, Hokkaido, Japan* Akihiko Kubo, *Kitami Institute of Technology, Kitami, Hokkaido, Japan*

9-Wells Fargo Room (LSC)	1-5-1 Multi-Functional Materials (Metal and Ceremics Base)	
Wed 1315-1445	Session Chair: Session Co-Chair:	Satoshi Kishimoto, *National Institute for Materials Science, Tsukuba, Ibaraki, Japan* Hideki Kyogoku, *Kinki University, Higashihiroshima, Hiroshima, Japan*
9-165	ICMP2011-51136	Photo-Polymerization of Fullerene Thin Film Using Optical Vortex Irradiation Nobuyuki Aoki, *Chiba University, Chiba, Japan* Tatsuya Doi, *Chiba University, Chiba, Japan* Xiaojun Wei, *Chiba University, Chiba, Japan* Kyouhei Koyama, *Chiba University, Chiba, Japan* Katsuhiko Miyamoto, *Chiba University, Chiba, Japan* Takashige Omatsu, *Chiba University, Chiba, Japan* Johnathan P. Bird, State University of New York, Buffalo, NY, USA Yyuichi Ochiai, *Chiba University, Chiba, Japan*
9-166	ICMP2011-51065	Fabrication of Functionally Graded TiNi Shape Memory Alloy Wire Ryosuke Matsui, *Hiroshima University, Higashi-Hiroshima, Hiroshima, Japan* Hideki Kyogoku, *Kinki University, Higashihiroshima, Hiroshima, Japan* Fusahito Yoshida, *Hiroshima University, Higashi-Hiroshima, Hiroshima, Japan*
9-167	ICMP2011-51114	A ESR Study of UV Polymerized Fullerene Nano Whisker Tatsuya Doi, *Chiba University, Chiba, Japan* Kyouhei Koyama, *Chiba University, Chiba, Japan* Nobuyuki Aoki, *Chiba University, Chiba, Japan* Johnathan P. Bird, *State University of New York, Buffalo, NY, USA* Yuichi Ochiai, *Chiba University, Chiba, Japan*

9-168	ICMP2011-51104	Mechanical Properties of Metallic Cellular Materials Containing Polymer Satoshi Kishimoto, *National Institute for Materials Science, Tsukuba, Ibaraki, Japan* Toru Shimizu, *AIST, Tsukuba, Ibaraki, Japan* Fuxing Yin, *National Institute for Materials Science, Tsukuba, Ibaraki, Japan* Kimiyoshi Naito, *National Institute for Materials Science, Tsukuba, Ibaraki, Japan*
9-169	MSEC2011-50263	Dielectric and Piezoelectric Ceramics for high Temperature Applications Natthaphon Raengthon, *Oregon State University, Corvallis, OR, USA* Jason Nikkel, *Oregon State University, Corvallis, OR, USA* Troy Ansell, *Oregon State University, Corvallis, OR, USA* David P. Cann, *Oregon State University, Corvallis, OR, USA*

Poster Session 1400-1600 on Wednesday, June 15, 2011		
Giustina Gallery (LSC)	5-1-1 Poster Session	
Wed 1400-1600	Session Chair: Session Co-Chair:	Kevin Chou, *University of Alabama, Tuscaloosa, AL, USA* Shinji Ogihara, *Tokyo University of Science, Noda, Chiba, Japan* Hitomi Yamaguchi, *University of Florida, Gainesville, FL, USA* Wataru Nakao, *Yokohama National University, Yokohama, Japan*
10-600	MSEC2011-50306	Inkjet Printed Confuctive Silver Films from Chemical Reaction Ying-Chih Liao, *National Taiwan University, Taipei, Taiwan, China* Zhen-Kai Kao, *National Taiwan University, Taipei, Taiwan, China* Ying-Han Hung, *National Taiwan University, Taipei, Taiwan, China* Hao-Ming Hsiao, *National Taiwan University, Taipei, Taiwan, China*
10-601	MSEC2011-50307	Modeling and Simulation of Pad Surface Shape Due to Diamond Disc Conditioning in Chemical Mechanical Planarization (CMP) Zhichao Li, *North Carolina Agricultural & Technical State University, Greensboro, NC, USA* Emmanuel Baisie, *North Carolina Agricultural & Technical State University, Greensboro, NC, USA* X.H. Zhang, *Seagate Technology, Minneapolis, MN, USA*
10-602	MSEC2011-50308	Interface Engineered Diamond Coating for Dry Machining Humberto Gomez, *USF, Tampa, FL, USA* Delcie Durham, *USF, Tampa, FL, USA* Ping Lu, *University of Alabama, Tuscaloosa, AL, USA* Xingcheng Xiao, *General Motors, Warren, MI, USA* Michael Lukitsch, *General Motors, Warren, MI, USA* Kevin Chou, *University of Alabama, Tuscaloosa, AL, USA* Askok Kumar, *USF, Tampa, FL, USA*
10-603	MSEC2011-50309	Life Cycle Management of Abrasive Tools and Effects on Sustainable Grinding Barbara Linke, *University of California, Berkeley, Berkeley, CA, USA*

10-604	MSEC2011-50310	Development of an Automated Tool-tip Exchanger for Tip-Based Nanomanufacturing Curtis Taylor, *University of Florida, Gainesville, FL, USA* Bijoyraj Sahu, *University of Florida, Gainesville, FL, USA* Robert Riddle, *University of Nevada, Reno, NV, USA* Kam K. Leang, *University of Nevada, Reno, NV, USA*
10-605	MSEC2011-50311	Investigation of Deformation Path During Micro-Tube Flaring Chetan Nikhare, *University of New Hampshire, Durham, NH, USA* Brad Kinsey, *University of New Hampshire, Durham, NH, USA* Weichao Wu, *Northwestern Polytechnical University, Xi'an, China* Jian Cao, *Northwestern University, Evanston, IL, USA*
10-606	MSEC2011-50312	Novel Hybrid Material Crash Structure for Front Rail Chetan Nikhare, *University of New Hampshire, Durham, NH, USA* Peter Hodgson, *Deakin University, Geelong, Victoria, Australia*
10-607	MSEC2011-50313 Poster Presentation Only	Drop-on-Demand-Based Fabrication of Alginate Microspheres C. Leigh Herran, *Clemson University, Clemson, SC, USA* Changxue Xu, *Clemson University, Clemson, SC, USA* Yong Huang, *Clemson University, Clemson, SC, USA* Nicole Curtis, *Clemson University, Clemson, SC, USA* Wenxuan Chai, *Clemson University, Clemson, SC, USA*
10-608	MSEC2011-50314 Poster Presentation Only	Substrate Surface Etching Effects on Machining Performance of Diamond-Coated Cutting Tools Raymond Thompson, *Vista Engineering & Consulting LLC, Birmingham, AL, USA* Kevin Chou, *University of Alabama, Tuscaloosa, AL, USA* Dustin Nolen *Vista Engineering & Consulting LLC, Birmingham, AL, USA* Xibing Gong, *University of Alabama, Tuscaloosa, AL, USA*
10-609	MSEC2011-50315	Enhancing Friction Stir Welding Through Temperature Control Axel Fehrenbacher, *University of Wisconsin-Madison, Madison, WI, USA* Neil A. Duffie, *University of Wisconsin-Madison, Madison, WI, USA* Nicola J. Ferrier, *University of Wisconsin-Madison, Madison, WI, USA* Frank E. Pfefferkorn, *University of Wisconsin-Madison, Madison, WI, USA* Michael R. Zinn, *University of Wisconsin-Madison, Madison, WI, USA*
10-610	MSEC2011-50331 Poster Presentation Only	Wrinkle Analysis in the Tube-Hydroforming Process Fuh-Kuo Chen, *National Taiwan University, Taipei, Taiwan*
10-611	ICMP2011-51155	Effect of Layer Thickness on the Impact Damages of Hoop-Wrapped Composite Vessels Satoshi Kobayashi, *Tokyo Metropolitan University, Hachioji, Japan* Mari Kawahara, *Tokyo Metropolitan University, Tokyo, Japan* Shinji Ogihara, *Tokyo University of Science, Noda, Chiba, Japan*
10-612	ICMP2011-51020	Laser Polymerization of Fulleren Nanofibers Kunichi Miyazawa, *National Institute for Materials Science, Tsukuba, Ibaraki, Japan* Ryoei Kato, *National Institute for Materials Science, Tsukuba, Ibaraki, Japan*

10-613	ICMP2011-51049	Novel Optical Devices Developed with High-Strength Gels Tomohiro Yokoo, *Yamagata University, Yonezawa, Japan* Ruri Hidema, *Yamagata University, Yonezawa, Japan* Hidemitsu Furukawa, *Yamagata University, Yonezawa, Japan*
10-614	ICMP2011-51050	Development of Ultrahigh Ductile Gels Go Takada, *Yamagata University, Yonezawa, Japan* Ruri Hidema, *Yamagata University, Yonezawa, Japan* Hidemitsu Furukawa, *Yamagata University, Yonezawa, Japan*
10-615	ICMP2011-51119	High Resolution Transmission Electron Microscopy of Aluminum/Glass Substrate Interface Bonded by Ultrasonic Wire Welding Chihiro Iwamoto, *Kumamoto University, Kumamoto, Japan* Shinobu Satonaka, *Kumamoto University, Kumamoto, Japan* Akio Yoshida, *Toshiba Mitsubishi-Electric Industrial Systems Corporation, Kobe, Japan* Tomoyuki Nichinaka, *Toshiba Mitsubishi-Electric Industrial Systems Corporation, Tokyo, Japan* Ken Yamada, *Toshiba Mitsubishi-Electric Industrial Systems Corporation, Tokyo, Japan*
10-616	ICMP2011-51013	Finite Element Analysis of Cutting Deformation of Stacked Polycarbonate Sheets Subjected to Two-Line Wedge Indentation Shigeru Nagasawa, *Nagaoka University of Technology, Nagaoka, Niigata, Japan* Masatoshi Fujikura, *Nagaoka University of Technology, Nagaoka, Niigata, Japan* Yasushi Fukuzawa, *Nagaoka University of Technology, Nagaoka, Niigata, Japan*
10-616A	ICMP2011-51142	Research of Ductility Increase of Magnesium Alloy on Forming by Temperature Control Liqun Ruan, *Japan/Kumamoto University, Kumamoto-shi, Kumamoto-ken, Japan* Yusuke Iguchi, *Toyota Motor Kyushu Inc., Miyawaka, Fukuoka, Japan* Masafumi Noda, *Chiba Institute of Technology, Narashino, Thiba, Japan* Yasuo Marumo, *Kumamoto University, Kumamoto-shi, Kumamoto, Japan* Yoshihito Kawamura, *Kumamoto University, Kumamoto-shi, Kumamoto, Japan*
10-617	ICMP2011-51163	Evaluation of Pre Bending Process of Bamboo Beam in Kyo-Chochin (Japanese Lantern) Making Process Mamoru Kojima, *Kojima-Shoten, Kyoto, Japan* Sun Kojima, *Kojima-Shoten, Kyoto, Japan* Masaki Sakata, *Kyoto Institute of Technology, Kyoto, Japan* Mio Arai, Kyoto *Institute of Technology, Kyoto, Japan* Tetsushi Koshino, *Niihama National College of Technology, Niihama, Japan* Takashi Yoshikawa, *Niihama National College of Technology, Niihama, Japan* Yuka Takai, *Kyoto Institute of Technology, Kyoto, Japan* Akihiko Goto, *Osaka Sangyo University, Daito, Japan* Hiroyuki Hamada, *Kyoto Institute of Technology, Kyoto, Japan*
10-618	ICMP2011-51165	Influence of Interlayer on Wear and Corrosion Resistance of DLC Film Naoto Ohtake, *Tokyo Institute of Technology, Tokyo, Japan* Mai Takashima*, Tokyo Institute of Technology, Tokyo, Japan*

10-619	ICMP2011-51166	Effect of Prepreg Cut on the Mechanical Properties in CFRP Laminates Shinji Ogihara, *Tokyo University of Science, Noda, Chiba, Japan* Hayato Nakatani, *Tokyo University of Science, Noda, Chiba, Japan*
10-620	ICMP2011-51167	A Study on the Mechanical Property of Injection Molded Natural Fiber Hybrid Sandwich Composites Putinun Uawongsuwan, *Kyoto Institute of Technology, Kyoto, Japan* Tomoko Ota, *Kyoto Institute of Technology, Kyoto, Japan* Yuqiu Yang, *Kyoto Institute of Technology, Kyoto, Japan* Hiroyuki Hamada, *Kyoto Institute of Technology, Kyoto, Japan*
10-621	ICMP2011-51168 Poster Presentation Only	Functionally Graded Ceramics Formed by Crack Healing and Low Energy Electron Beam Irradiation Koji Asanuma, *Yokohama National University, Yokohama, Kanagawa, Japan* Wataru Nakao, *Yokohama National University*, *Yokohama, Kanagawa, Japan* Yoshitake Nishi, *Tokai University, Hiratsuka*, *Kanagawa, Japan*

Concurrent Technical Sessions, Papers (170-201) 1500 – 1630 on Wednesday, June 15, 2011		
1-Willamette Room (Alumni Center)	1-9 Machining 2	
Wed 1500-1630	Session Chair: Session Co-Chair:	Dr. Tugrul Ozel, *Rutgers University, Piscataway, NJ, USA* Dr. Simon Park, *University of Calgary, Calgary, AB, USA*
1-170	NAMRC39-4805	Orthogonal Machining of Single-Crystal and Coarse-Grained Aluminum Nithyanand Kota, *Carnegie Mellon University, Pittsburgh, PA, USA* Dr. Burak Ozdoganlar, *Carnegie Mellon University, Pittsburgh, PA, USA*
1-171	NAMRC39-4798	Model for the Indentation Force in Metal Cutting Amit Deshpande, *Wichita State University, Wichita, KS, USA* Dr. Vis Madhavan, *Wichita State University, Wichita, KS, USA* Amir Adibi-Sedeh, *Wichita State University, Wichita, KS, USA*
1-172	NAMRC39-4812	Tool Temperatures in Orthogonal Cutting of Alloyed Titanium Dr. Robert Ivester, *NIST, Gaithersburg, MD, USA*

2-Trysting Tree (Alumni Center)	1-18 Metrology 2	
Wed 1500-1630	Session Chair: Session Co-Chair:	Sathyan Subbiah, *Nanyang Technological University, Singapore* Mr. John Morehouse, *Georgia Institute of Technology, Atlanta, GA, USA*
2-173	NAMRC39-4704	Comparison of Process Capability Index and Uncertainty Calculations When Using Conventional and Coordinate Metrology Tools Mohamed Gadalla, *Alabama A&M University, Normal, AL, USA* Miroslaw Popielarczyk, *Pratt & Whitney, Hartford, CT, USA*

2-174	NAMRC39-4759	Evaluation of Optical Fiber Positioning Using Silicon V-Grooves Matthew Rueff, *University of Florida, Gainesville, FL, USA* Dr. Tony Schmitz, *University of Florida, Gainesville, FL, USA* Benjamin Griffin, *University of Florida, Gainesville, FL, USA* David Mills, *University of Florida, Gainesville, FL, USA* Mark Sheplak, *University of Florida, Gainesville, FL, USA*
3-Burlingham/Elle (Alumni Center)	1-15 Nontraditional Machining	
Wed 1500-1630	Session Chair: Session Co-Chair:	Dr. Yong Huang, *Clemson University, Clemson, SC, USA* Dr. Murali Sundaram, *University of Cincinnati, Cincinnati, OH, USA*
3-175	NAMRC39-4761	Experimental Study on Cutting Temperature in Rotary Ultrasonic Machining Weilong Cong, *Kansas State University, Manhattan, KS, USA* Qiang Feng, *Kansas State University, Manhattan, KS, USA* Dr. Z.J. Pei, *Kansas State University, Manhattan, KS, USA* Timothy Deines, *Kansas State University, Manhattan, KS, USA* Clyde Treadwell, *Sonic Mill Inc., Albuquerque, NM, USA*
3-176	NAMRC39-4743	Study of Coated Microtools in Electrochemical Machining (ECM) Ajaya Swain, *Texas Tech University, Lubbock, TX, USA* Dr. Murali M. Sundaram, *University of Cincinnati, Cincinnati, OH, USA* Dr. Kamlakar P Rajurkar, *University of Nebraska, Lincoln, NE, USA*
3-177	NAMRC39-4788	Application of Chemical Transformation Induced Fracture for Cutting of Superhard Materials Dinesh Kalyanasundaram, *Iowa State University, Ames, IA, USA* Dr. Pal Molian, *Iowa State University, Ames, IA, USA* Pranav Shrotriya, *Iowa State University, Ames, IA, USA*

4-Austin Auditorium (LSC)	2-10-5 Machining Processes 3	
Wed 1500-1630	Session Chair: Session Co-Chair:	John Ziegert Timothy Burns, *National Institute of Standards and Technology, Gaithersburg, MD, USA*
4-178	MSEC2011-50014	Five-Axis CNC Tool Grinding Part 1: Rake Face Grinding Mahmoud Rbabah, *Concordia University, Montreal, QC, Canada* Zezhong Chen, *Concordia University, Montreal, QC, Canada*
4-179	MSEC2011-50015	Five-Axis CNC Tool Grinding Part 2: Flute Surface Grinding Mahmoud Rbabah, *Concordia University, Montreal, QC, Canada* Zezhong Chen, *Concordia University, Montreal, QC, Canada*
4-180	MSEC2011-50040	Three-Dimensional Endmill Dynamics: Model Development and Experimental Validation Bekir Bediz, *Carnegie Mellon University, Pittsburgh, PA, USA* Uttar Kumar, *University of Florida, Gainesville, FL, USA* Burak Ozdonganlar, *Carnegie Mellon University, Pittsburgh, PA,USA* Tony L. Shmitz, Ph.D., *University of Florida, Gainesville, FL, USA*

4-181	MSEC2011-50055	Ultrasonic-Vibration-Assisted Grinding of Brittle Materials: A Mechanistic Model for Cutting Force Na Qin, *Kansas State University, Manhattan, KS, USA* Zhijian Pei, *Kansas State University, Manhattan, KS, USA* Weilong Cong, *Kansas State University, Manhattan, KS, USA* Clyde Treadwell, *Sonic Mill, Albuquerque, NM, USA* Dongming Guo, *Dalian University of Technology, Dalian, China*

5-Construction & Engineering Hall (LSC)	4-4-1 Nano/Micro/Meso Manufacturing 1	
Wed 1500-1630	Session Chair: Session Co-Chair:	Xinyu Liu, *Lamar University, Beaumont, TX, USA* Keith A. Bourne, *University of Illinois, Urbana, IL, USA*
5-182	ICMP2011-51070	Electric Discharge Machined Surface of the Insulating ZrO2 Ceramics Yasushi Fukuzawa, *Nagaoka University of Technology, Nagaoka, Japan* Daiki Hanaoka, *Nagaoka University of Technology, Nagaoka, Japan* Ryuji Ito, *Nagaoka University of Technology, Nagaoka, Japan*
5-183	ICMP2011-51075	Analysis of Micro Punch Penetration Using Scale-up Experiement Kazuhiko Kitamura, *Nagaoka University of Technology, Nagaoka, Japan* Fumihiro Itoigawa, *Nagaoka University of Technology, Nagaoka, Japan* Takafumi Kobayashi, *Nagaoka University of Technology, Nagaoka, Japan* Shin Nakasai, *Nagaoka University of Technology, Nagaoka, Japan*
5-184	MSEC2011-50143	Effect of Machining Parameters on Surface Roughness in Vibration-Assisted Grinding Kuan-Ming Li, *National Taiwan University, Taipei, Taiwan* Yang-Ming Hu, *National Sun Yat-sen University, Kaohsiung, Taiwan* Zhong-Yi Yang, *Metal Industries Research and Development Centre, Kaohsiung, Taiwan* Ming-Yaun Chen, *Metal Industries Research and Development Centre, Kaohsiung, Taiwan* Fu-Chuan Hsu, *Metal Industries Research and Development Centre, Kaohsiung, Taiwan*
5-185	MSEC2011-50244	Experimental and Numerical Modeling Analysis of Micro-milling of Hardened H13 Tool Steel Hongtao Ding, *Purdue University, West Lafayette, IN, USA* Ninggang Shen, *Purdue University, West Lafayette, IN, USA* Yung Shin, *Purdue University, West Lafayette, IN, USA*

6-Agriculture Production Room (LSC)	3-2-1 Fretting and Fretting Fatigue	
Wed 1500-1630	Session Chair: Session Co-Chair:	Masanobu Kubota, *Kyushu University, Fukuoka, Japan* Kanetaka Miyazawa, *Sanden Corporation, Isesaki-shi, Gunma, Japan*
6-186	ICMP2011-51118	Inprovement of Torsional Fretting Fatigue Strength of Splined Shaft Used For Car Air Conditioning Compressors by Hybrid Joint Kantaka Miyazawa, *Sanden Corporation, Isesaki-shi, Gunma, Japan* Masanobu Kubota, *Kyushu University, Fukuoka, Japan* Yoshiyuki Kondo, *Kyushu University, Fukuoka, Japan* Tatsuro Aoki, *Kyushu University, Fukuoka, Japan* Akihiro Tashiro, *Yasukawa Electric Corporation, Kitakyushu, Fukuoka, Japan* Masato Miwa, *Sanden Corporation, Isesaki-shi, Gunma, Japan*
6-187	ICMP2011-51138	Effect of Hydrogen of Fretting Fatigue Strength of SUS304 And SUS316L Austenitic Stainless Steels Koshiro Mizobe, *Kyunshu University, Fukuoka, Japan* Masanobu Kubota, *Kyunshu University, Fukuoka, Japan* Yoshiyuki Kondo, *Kyunshu University, Fukuoka, Japan* Yuki Shiraishi, *Kyunshu University, Fukuoka, Japan*
6-188	ICMP2011-51154	Failure Behavior of Sensitized SUS304 Stainless Steel with Small Surface Pre-Cracks in 288 Degree Celsius Pure Water Anchalee Saengsai, *Nagaoka University of Technology, Niigata, Japan* Yuichi Otsuka, *Nagaoka University of Technology, Niigata, Japan* Yoshiharu Mutoh, *Nagaoka University of Technology, Niigata, Japan*

7-Agriculture Leaders Room (LSC)	5-1-4 Student Manufacturing Design Competition 2	
Wed 1500-1630	Session Chair: Session Co-Chair:	Brad Kinsey, *University of New Hampshire, Durham, NH, USA* Z. Cedric Xia, *Ford Motor Company, Dearborn, MI, USA*
7-189	MSEC2011-50324	Wireless Real-Time Data Acquisition System for Process Instrumentation and Closed-Loop Control of Friction Stir Welding Axel Fehrenbacher, *University of Wisconsin, Madison, WI, USA*
7-190	MSEC2011-50325	Automation of Non-Destructive Ultrasonic Transmission Scanning of Piping and Tubing Matthew Standley, *University of New Hampshire, Durham, NH, USA*
7-191	MSEC2011-50326	Paintbrush Rework SOP Michael Church, *Oregon State University, Corvallis, OR, USA*
7-192	MSEC2011-50327	G.I.A.N.T. Wind Turbine Model Austin Jolley, *RPI, Troy, USA*

8-Agriculture Science Room (LSC)	3-5-1 Monitoring, Sensing, and Control for Manufacturing 1	
Wed 1500-1630	Session Chair: Session Co-Chair:	Radu Pavel, Ph.D., *TechSolve, Inc., Cincinnati, OH, USA* Anil K. Srivastava, Ph.D., *TechSolve, Inc., Cincinnati, OH, USA*
8-193	MSEC2011-50297	Measurement of Transient Tool Internal Temperature Fields During Hard Turning by Embedded Thin Film Sensors Dirk Werschmoeller, *University of Wisconsin-Madison, Madison, WI, USA* Xiaochun Li, Ph.D., *University of Wisconsin-Madison, Madison, WI, USA* Kornel F. Ehmann, *Northwestern University, Evanston, IL, USA*
8-194	MSEC2011-50059	Dynamic Evaluation of a Nanocomposite Force Sensor Andrew Werner, *Clemson University, Clemson, SC, USA* Laine Mears, Ph.D., P.E., *Clemson University, Clemson, SC, USA* Andrew Clark, *SensonTech Corp., Greenville, SC, USA*
8-195	MSEC2011-50099	Study of Microphone Array for Noise Reduction in Sound Based Micro-Tool Wear Monitoring Chi-Feng Huang, *National Chung Hsing University, Taichung, Taiwan* Ming-Chyuan Lu, *National Chung Hsing University, Taichung, Taiwan*
8-196	MSEC2011-50178	A Quantitative Study of Illumination Techniques for Machine Vision Based Inspection Michael Yan, *Queens University, Kingston, ON, Canada* Brian Surgenor, *Queens University, Kingston, ON, Canada*

9-Wells Fargo Room (LSC)	1-6-2 Advanced Smart Materials	
Wed 1500-1630	Session Chair: Session Co-Chair:	Yoji Okabe, *The University of Tokyo, Tokyo, Japan* Tatsuro Kosaka, *Kochi University of Technology, Kochi, Kami-City, Japan*
9-197	ICMP2011-51048	Fast and Slow Relaxation Modes in Shrunken Phase of Thermoresponsible N-Isopropylacrilmide Gels Studied with Scanning Microscopic Light Scattering (SMILS) Hidemitsu Furukawa, *Yamagata University, Yonezawa, Japan* Ruri Hidema, *Yamagata University, Yonezawa, Japan* Kazuyuki Horie, *Tokyo University of Agriculture and Technology, Koganei, Japan* Shunsuke Hirotsu, *Tokyo Institute of Technology, Yokohama, Japan*
9-198	ICMP2011-51061	Strain Sensors Made From Polymer Nanocomposites With Two Kinds of MWNTs Ning Hu, *Chiba University, Chiba, Japan* Yuan Li, *Chiba University, Chiba, Japan* Yaolu Liu, *Chiba University, Chiba, Japan*
9-199	ICMP2011-51079	Fracture Behavior of Stampable Sheets Composites Hiroshi Sakai, *Kyoto Institute of Technology, Kyoto, Japan* Yuqiu Yang, *Kyoto Institute of Technology, Kyoto, Japan* Ying Yu, *Kyoto Institute of Technology, Kyoto, Japan* Hiroyuki Hamada, *Kyoto Institute of Technology, Kyoto, Japan*
9-200	ICMP2011-51042	Development of Third Generation Self-Healing Ceramics Wataru Nakao, *Yokohama National University, Yokohama, Japan*
9-201	ICMP2011-51085	Advanced Self-Healing Agent for Next Generation Self-Healing Ceramics Yuya Iida, *Yokohama National University, Yokohama, Japan* Wataru Nakao, *Yokohama National University, Yokohama, Japan*

TECHNICAL PROGRAM - THURSDAY, JUNE 16, 2011

Panel Sessions 0850-1015 on Thursday, June 16, 2011		
8-Agriculture Science (LaSells Stewart Center)	Panel 4-"*Quo Vadimus*:" Manufacturing Education for US Competitiveness in the 21st Century	
Thurs 0850-1015	Organizer: Presenters:	Ajay Malshe, *University of Arkansas* Bin Wei, *GE Global Research* Yoram Koren, *University of Michigan* K.P. Rajurkar, *University of Nebraska-Lincoln* Ralph Resnick, *National Center for Defense Manufacturing & Machining*

3-Burlingham/Elle (Alumni Center)	Panel 5- Case Studies in Lean Manufacturing	
Thurs 0850-1015	Organizer: Presenters:	John Parmigiani, *Oregon State University* Kyle R. Stavig, *Myers Container* Toni Doolen, *Oregon State University* *Scott Simmons, Climax Portable Machine Tools*

Concurrent Technical Sessions, Papers (202-216) 0900-1015 on Thursday, June 16, 2011		
1-Willamette Room (Alumni Center)	3-3-2 Surface Modification Technology, Wear, and Tribology 2	
Thurs 0900-1015	Session Chair: Session Co-Chair:	Jianwen Hu, *Silgan Containers LLC, Oconomowoc, WI, USA* Dr. Yong Huang, *Clemson University, Clemson, SC, USA*
1-202	ICMP2011-51067	Fabrication of Textured DLC Films Using Three-Dimensional Masking System Mai Takashima, *Tokyo Institute of Technology, Tokyo, Japan* Kei Kanzawa, *Tokyo Institute of Technology, Tokyo, Japan* Shin Matsuo, *iMott Inc., Yokohama, Japan* Makoto Matsuo, *iMott Inc., Yokohama, Japan* Yoshinao Iwamoto, *iMott Inc., Yokohama, Japan* Naoto Ohtake, *Tokyo Institute of Technology, Tokyo, Japan*
1-204	MSEC2011-50295	Surface Texturing of Metals by Cathode Spots of Atmospheric Arc Rouzbeh Sarrafi, *Research Center for Advanced Manufacturing, Dallas, TX, USA* Mehdi Asgharifar, *Southern Methodist University, Dallas, TX, USA* Radovan Kovacevic, *Southern Methodist University, Dallas, TX, USA*

4-Austin Auditorium (LSC)	2-1-4 Material Characterization 1	
Thurs 0900-1015	Session Chair: Session Co-Chair:	Markus Werner, *Fraunhofer Institute for Machine Tools and Forming Technology IWU, Cheminitz, Germany* Scott Wagner, *Michigan Technological University, Houghton, MI, USA*
4-205	MSEC2011-50002	Application of Different Hills Yield Criteria to Predict Limit Strains for Aerospace Titanium and Aluminum Sheet Alloys Milad Janbakhsh, *Iran University of Science and Technology, Tehran, Iran* Faramarz Djavanroodi, *Iran University of Science and Technology, Tehran, Iran* Mohammad Riahi, *Iran University of Science and Technology, Tehran, Iran*
4-206	MSEC2011-50177	Sheet Orientation Effects on the Formability Limits of the AZ31B Magnesium Alloy at SPF Conditions Fadi Abu-Farha, *Pennsylvania State, Erie, PA, USA* Brad Deeter, *Pennsylvania State, Erie, PA, USA*
4-207	MSEC2011-50213	Effect of Element Type on Failure Prediction Using a Stress-Based Forming Limit Curve Raed Hasan, *University of New Hampshire, Durham, NH, USA* Igor Tsukrov, *University of New Hampshire, Durham, NH, USA* Brad Kinsey, *University of New Hampshire, Durham, NH, USA*

6-Agriculture Production Room (LSC)	2-7-3 Advances in Nontraditional/Hybrid Manufacturing 3	
Thurs 0900-1015	Session Chair: Session Co-Chair:	Wansheng Zhao, *Shanghai Jiao Tong University, Shanghai, China* Murali Sundaram, *University of Cincinnati, Cincinnati, OH, USA*
6-209	MSEC2011-50140	Study on Numerical Control Electrochemical Machining with Inner-spraying Spherical Cathode Min Kang, *Nanjing Agricultural University, Nanjing, Jiangsu Province, China* Xiuqing Fu, *Nanjing Agricultural University, Nanjing, Jiangsu Province, China* Yong Yang, *Nanjing Agricultural University, Nanjing, Jiangsu Province, China*
6-210	MSEC2011-50206	Parametric Investigation on the Hybrid Processing of Jet Electrochemical Machining and Laser Beam Machining Zhao Jianshe, *Nanjing University of Aeronautics and Astronautics, Nanjing, JiangSu, China* Yuan LiXin, *Nanjing University of Aeronautics and Astronautics, Nanjing, JiangSu, China* Jia wen Xu, *Nanjing University of Aeronautics and Astronautics, Nanjing, JiangSu, China*
6-211	MSEC2011-50113	Experimental Study of Micro Abrasive Tool Making by Electroplating Anuj Dabholkar, *University of Cincinnati, Cincinnati, OH, USA* Murali Sundaram, *University of Cincinnati, Cincinnati, OH, USA*

Agriculture Leaders Room (LSC)	2-10-6 Design, Materials, and Nontraditional Processes 2	
Thurs 0900-1015	Session Chair: Session Co-Chair:	J. Brian Jordon, *The University of Alabama, Tuscaloosa, AL, USA* Ihab Ragai, *Hitachi Construction Truck Manufacturing Ltd., Guelph, ON, Canada*
7-212	ICMP2011-51123	Prediction of Free Surface Rouchening by 2D and 3D FE Model Considering Material Inhomogeneity Tsuyoshi Furushima, *Tokyo Metropolitan University, Tokyo, Japan* Ken-ichi Manabe, *Tokyo Metropolitan University, Tokyo, Japan* Tetsuro Masuda, *Tokyo Metropolitan University, Tokyo, Japan* Sergei Alexandrov, *Russian Academy of Sciences, Moscow, Russia*
7-213	MSEC2011-50149	Diamond Disc Pad Conditioning in Chemical Mechanical Planarization (CMP): A Mathematical Model to Predict Pad Surface Shape Zhichao Li, *North Carolina Agricultural and Technical State University, Greensboro, NC, USA* Emmanuel Baisie, *North Carolina Agricultural and Technical State University, Greensboro, NC, USA* X.H. Zhang, *Seagate Technology, Minneapolis, MN, USA*
7-214	MSEC2011-50102	Holistic Approach for a Simulation-Based Twist Drill Geometry Optimization Eberhard Abele, *Technische Universitat Darmstadt, Germany* Dominik Schafer, *Technische Universitat Darmstadt, Germany* Marian Fujara, *Technische Universitat Darmstadt, Germany*

9-Wells Fargo Room (LSC)	1-6-3 Advanced Smart Materials	
Thurs 0900-1015	Session Chair: Session Co-Chair:	Wataru Nakao, *Yokohama National University, Yokohama, Japan* Satoshi Kishimoto, *National Institute for Materials Science, Tsukuba, Ibaraki, Japan*
7-215	ICMP2011-51003 Technical Presentation Only	Development of an Aluminum Based Active Composite Embedded with Oxidized Titanium Fiber Hiroshi Asanuma, *Chiba University, Chiba-shi, Japan*
7-216	ICMP2011-51144 Technical Presentation Only	Effects of Temperatures, Operating Potentials and HCl on Recovering WC from Cemented Tungsten Carbide Scraps Saharat Wongsisa, *Rajamangala University of Technology Phra Nakhon, Bangkok, Thailand*

Concurrent Technical Sessions, Papers (217-252) 1030-1200 on Thursday, June 16, 2011		
1-Willamette Room (Alumni Center)	1-2-1 Microstructure, Simulation and Modeling	
Thurs 1030-1200	Session Chair: Session Co-Chair:	Katsuhiro Nishiyama, *Tokyo University of Science, Suwa, Chino, Japan* Hiroshi Asanuma, *Chiba University, Chiba-shi, Japan*
1-217	ICMP2011-51008	Microstructure and Mechanical Properties of Mg-Zn-Y Alloy Sheet with a Long Period Staking Ordered Phase Takaomi Itoi, *Chiba University, Chiba, Japan* Toshiharu Inazawa, *Chiba University, Chiba, Japan* Michiaki Yamasaki, *Kumamoto University, Kumamoto, Japan* Yoshihito Kawamura, *Kumamoto University, Kumamoto, Japan* Mitsuji Hirohashi, *Chiba University, Chiba, Japan*
1-218	ICMP2011-51137	CFRP/Light Metals Joining Reinforced by Carbon Fibers Atsushi Kasai, *Tokai University, Hiratsuka, Kanagawa, Japan* Nobuhiro Harigae, *Tokai University, Hiratsuka, Kanagawa, Japan* Sho Ishi, *Tokai University, Hiratsuka, Kanagawa, Japan* Noriyoshi Miwa, *Tokai University, Hiratsuka, Kanagawa, Japan* Yoshitake Nishi, *Tokai University, Hiratsuka, Kanagawa, Japan*
1-219	ICMP2011-51107	Simulation of Low-Pressure Infiltration for Fabrication Process of Aluminum Alloy Matrix Composites Gen Sasaki, *Hiroshima University, Higashi-Hiroshima, Japan* Kenjiro Sugio, *Hiroshima University, Higashi-Hiroshima, Japan* Yong-bum Choi, *Hiroshima University, Higashi-Hiroshima, Japan* Kazuhiro Matsugi, *Hiroshima University, Higashi-Hiroshima, Japan*
1-220	ICMP2011-51149	Material Modeling of 980 MPa High Strength Steel Sheet based on Biaxial Stress Tests Tatsuya Nakajima, *Tokyo University of Agriculture and Technology, Tokyo, Japan* Toshihiko Kuwabara, *Tokyo University of Agriculture and Technology, Tokyo, Japan*

2-Trysting Tree (Alumni Center)	4-4-2 Nano/Micro/Meso Manufacturing 2	
Thurs 1030-1200	Session Chair: Session Co-Chair:	Sathyan Subbiah, *Nanyang Technological University, Singapore* Hazim El-Mounayri, *IUPU, Indianapolis, IN, USA*
2-221	MSEC2011-50248	A Study on Machining and Environmental Characteristics of Micro-Drilling Process Using NanoFluid Minimum Quantity Lubrication Jung Soo Nam, *Sungkyunkwan University, Suwon, Korea* Pil-Ho Lee, *Sungkyunkwan University, Suwon, Korea* Sang Won Lee, *Sungkyunkwan University, Suwon, Korea*
2-222	MSEC2011-50076	Study of the Mechanics of the Micro-Groove Cutting Process Keith A. Bourne, *University of Illinois, Urbana, IL, USA* Shiv G. Kapoor, *University of Illinois, Urbana, IL, USA* Richard E. DeVor, *University of Illinois, Urbana, IL, USA*

2-223	MSEC2011-50122	Comparative Analysis of the Process Mechanics in Micro-Electrical Discharge Machining (EDM) and Reverse Micro-EDM Sachin Mastud, *Indian Institute of Technology, Bombay, Mumbai, Maharashtra, India* Ramesh Singh, *Indian Institute of Technology, Bombay, Mumbai, Maharashtra, India* Johnson Samuel, *Indian Institute of Technology, Bombay, Mumbai, Maharashtra, India* Suhas Hoshi, *Indian Institute of Technology, Bombay, Mumbai, Maharashtra, India*
2-224	MSEC2011-50256	Orthogonal Cutting Study of the Micro-cutting Thin Workpiece Kushendarsyah Saptaji, *Nanyang Technological University, Singapore* Sathyan Subbiah, *Nanyang Technological University, Singapore*

3-Burlingham/Elle (Alumni Center)	1-22 Laser Processing	
Thurs 1030-1200	Session Chair: Session Co-Chair:	Dr. Frank Pfefferkorn, *University of Wisconsin-Madison, Madison, WI, USA* Dr. Yung Shin, *Purdue University, West Lafayette, IN, USA*
3-225	NAMRC39-4751	Effect of Processing Medium and Condition on Absorption Enhancement of Femtosecond Laser Treated a-Si:H Thin Film Honglian Wang, *Columbia University, New York, NY, USA* Panjawat Kaonsuwan, *Columbia University, New York, NY, USA* Gen Satoh, *Columbia University, New York, NY, USA* Dr. Y. Lawrence Yao, *Columbia University, New York, NY, USA*
3-226	NAMRC39-4807	Strength and Microstructure of Laser Fusion Welded Ti-SS Dissimilar Material Pair Gen Satoh, *Columbia University, New York, NY, USA* Dr. Y. Lawrence Yao, *Columbia University, New York, NY, USA*
3-227	NAMRC39-4811	Modeling of Transport Phenomena and Thermal Stress in Spot Laser Keyhole Welding Jun Zhou, *Pennsylvania State University, Erie, PA, USA* Amir Khalilollahi, *Pennsylvania State University, Erie, PA, USA* Hai-Lung Tsai Tsai, *Missouri University of Science and Technology, Rolla, MO, USA*

4-Austin Auditorium (LSC)	2-1-5 Electrical and Thermal Assisted Forming	
Thurs 1030-1200	Session Chair: Session Co-Chair:	Brad Kinsey, *University of New Hampshire, Durham, NH, USA* Anupam Agrawal, *Indian Institute of Technology Ropar, Rupnagar, Punjab, India*
4-228	MSEC2011-50250	Thermo-Mechanical Investigations of the Electroplastic Effect Wesley Salandro, *Clemson University, Greenville, SC, USA* Cristina Bunget, *Clemson University, Greenville, SC, USA* Laine Mears, Ph.D., P.E. , *Clemson University, Greenville, SC, USA*
4-229	MSEC2011-50257	Influence of Continuous Direct Current on the Micro Tube Hydroforming Process Scott Wagner, *Michigan Technological University, Houghton, MI, USA* Kenny Ng, *Michigan Technological University, Houghton, MI, USA* William Emblom, *University of Louisiana, Lafayette, LA, USA* Jaime Camelio, *Virginia Tech, Blacksburg, VA, USA*

4-230	MSEC2011-50287	Constant Current Density Compression Behavior of 304 Stainless Steel and Ti-3Al-4V During Electrically-Assisted Forming Joshua Jones, *Clemson University, Greenville, SC, USA* Laine Mears, Ph.D, P.E., *Clemson University, Greenville, SC, USA*
4-231	MSEC2011-50332 Technical Presentation Only	Mechanical versus Pneumatic Stretching: Evaluation of Limiting Strains in Sheet Metals at Elevated Temperatures Mohammad Albakri, *Masdar Institute of Science & Technology, Abu Dhabi, United Arab Emirates* Fadi Abu-Farha, *Pennsylvania State, Erie, PA, USA* Marwan Khraisheh, *Masdar Institute of Science & Technology, Abu Dhabi, United Arab Emirates*

5-Construction & Engineering Hall (LSC) (LSC)	3-4-1 Dynamic Behavior of Materials and Structures 2	
Thurs 1030-1200	Session Chair: Session Co-Chair:	J. Brian Jordon, *The University of Alabama, Tuscaloosa, AL, USA* Kevin Chou, *The University of Alabama, Tuscaloosa, AL, USA*
5-232	MSEC2011-50018	Influence of Machine Tool Covers on Feed Drives Petr Kolar, *Czech Technical University in Prague, Praha, Czech Republic* Jan Masek, *Czech Technical University in Prague, Praha, Czech Republic* Jiri Sveda, *Czech Technical University in Prague, Praha, Czech Republic* Jan Hudex, *Czech Technical University in Prague, Praha, Czech Republic*
5-233	MSEC2011-50155	Application of Sandwich Based Designs on Main Structural Parts of Machine Tools Jan Smolik, *Czech Technical University in Prague, Praha, Czech Republic* Viktor Kulisek, *Czech Technical University in Prague, Praha, Czech Republic* Miroslav Janota, *Czech Technical University in Prague, Praha, Czech Republic*
5-234	MSEC2011-50204	Multidisciplinary Design Optimization of a Hybrid Composite Wind Turbine Blade Jin Woo Lee, *Embry-Riddle Aeronautical University, Daytona Beach, FL, USA* Sathya N. Gangadharan, *Embry-Riddle Aeronautical University, Daytona Beach, FL, USA* Maj Mirmirani, *Embry-Riddle Aeronautical University, Daytona Beach, FL, USA* Amanda Raffa, *Embry-Riddle Aeronautical University, Daytona Beach, FL, USA*
5-235	MSEC2011-50220	Dislocation Density-Based Grain Refinement Modeling of Orthogonal Cutting of Commercially Pure Titanium Hongtao Ding, *Purdue University, West Lafayette, IN, USA* Yung Shin, *Purdue University, West Lafayette, IN, USA*
5-236	MSEC2011-50056	Fatigue Behavior, Bridging Stresses and Fatigue Reliability in Silicon Nitride Ceramics Rawley Greene, *Oregon State University, Corvallis, OR, USA* Jamie J. Kruzic, *Oregon State University, Corvallis, OR, USA*

6-Agriculture Production Room (LSC)	2-4-1 Advanced Welding and Bonding Technology 1	
Thurs 1030-1200	Session Chair: Session Co-Chair:	Akio Suzumura, *Tokyo Institute of Technology, Tokyo, Japan* Takashi Tokoyama, *Okayama University of Science, Okayama, Japan*
6-237	ICMP2011-51019	Effect of Friction Welding Condition and Weld Faying Surface Properties on Tensile Strength of Friction Welded Joint Between Pure Titanium and Pure Copper Masaaki Kimura, *University of Hyogo, Himeji, Japan* Yoshitaka Saitoh, *University of Hyogo, Himeji, Japan* Masahiro Kusaka, *University of Hyogo, Himeji, Japan* Koichi Kaizu, *University of Hyogo, Himeji, Japan* Akiyoshi Fuji, *National University Corporation-Kitami Institute of Technology, Kitami, Japan*
6-238	ICMP2011-51034	Stirring Phenomenon of Aluminum Sheets by Ultrasonic Vibration and its Application to Clinching Daisuke Mizushima, *Tokyo Institute of Technology, Tokyo, Megroku, Japan* Takashi Sato, *NONK, Tokyo, Megroku, Japan* Hiroya Murakami, *Tokyo Institute of Technology, Tokyo, Megroku, Japan* Naoto Ohtake, *Tokyo Institute of Technology, Tokyo, Megroku, Japan*
6-239	ICMP2011-51037	In-Situ HRTEM Studies of Brazing Process Chihiro Iwamoto, *Kumamoto University, Kumamoto, Japan* Shinobu Satonaka, *Kumamoto University, Kumamoto, Japan*
6-240	ICMP2011-51045	Motion Study of the Expert Concerning Sheet Metal Working of Automobile Parts by All Hands Sadayoshi Sawada, *NPO Dentou Mirai, Kyoto, Japan* Hejiro Inaba, *Inaba Ltd., Kyoto, Japan* Mio Arai, *Kyoto Institute of Technology, Kyoto, Japan* Masaki Sakata, *Kyoto Institute of Technology, Kyoto, Japan* Natsumi Sasaoka, *Kyoto Institute of Technology, Kyoto, Japan* Masashi Kume, *Kyoto Bunkyo Junior College, Kyoto, Japan* Akihiko Goto, *Osaka Sangyo University, Daito, Japan* Hiroyuki Hamada, *Kyoto Institute of Technology, Kyoto, Japan*

7-Agriculture Leaders Room (LSC)	2-10-7 Machining Process 4	
Thurs 1030-1200	Session Chair: Session Co-Chair:	Timothy Burns, *National Institute of Standards and Technology, Gaithersburg, MD, USA* Laine Mears, Ph.D, P.E., *Clemson University, Greenville, SC, USA*
7-241	MSEC2011-50114	A Comparative Study of Carbide Tools in Drilling of CFRP and CRFP-TI Stacks Dave (Dae-Wook) Kim, *Washington State University, Vancouver, WA, USA* Aaron Beal, *Washington State University, Vancouver, WA, USA* Kyunghee Park, *Michigan State University, East Lansing, MI, USA* Patrick Kwon, *Michigan State University, East Lansing, MI, USA*

7-242	MSEC2011-50208	Predicting the High Speed Cutting Process of Titanium Alloy by Finite Element Method Xiangqin Zhang, *Shanghai Jiao Tong University, Shanghai, China* Xueping Zhang, *Shanghai Jiao Tong University, Shanghai, China* Anil K. Srivastava, Ph. D., *TechSolve, Inc., Cincinnati, OH, USA*
7-243	MSEC2011-50005	Constrained Optimization of Surface Roughness in Longitudinal Turning via Novel Modified Harmony Search Reza Farshbaf Zinati, *AmirKabir University of Technology, Tehran, Iran* Mohammad Reza Razfar, *AmirKabir University of Technology, Tehran, Iran*
7-244	MSEC2011-50218	Estimation of Milling Tool Temperature Considering Coolant and Wear Hsin-Yu Kuo, *University of Michigan, Ann Arbor, MI, USA* Kevin Meyer, *GE Aviation, Cincinnati, OH, USA* Roger Lindle, *GE Aviation, Cincinnati, OH, USA* Jun Ni, *University of Michigan, Ann Arbor, MI, USA*
7-245	MSEC2011-50100	Design of Rotary Ultrasonic Vibrator for Flat Grinding and Effects of Tight Nut on Vibration Chunmu Chen, *Guangdong University Technology, Guangzhou, China* Yongjun Tang, *Guangdong University Technology, Guangzhou, China* Yongjun Zhang, *Guangdong University Technology, Guangzhou, China* Yuanbo Li, *Guangdong University Technology, Guangzhou, China* Zhongning Guo, *Guangdong University Technology, Guangzhou, China* Xiakang Liu, *South China University of Technology, Guangzhou, China*

8-Agriculture Science Room (LSC)	2-6-1 Energy Manufacturing 1	
Thurs 1030-1200	Session Chair: Session Co-Chair:	Hong Liu, *Oregon State University, Corvallis, OR, USA* Wenqiao Yuan, *Kansas State University, Manhattan, KS, USA*
8-246	MSEC2011-50025	A Study on Amount of Biomass Pellets Used in Durbility Testing Qi Zhang, *Kansas State University, Manhattan, KS, USA* Pengfei Zhang, *Kansas State University, Manhattan, KS, USA* Zhijian Pei, *Kansas State University, Manhattan, KS, USA* Xiaoxu Song, *Kansas State University, Manhattan, KS, USA* Meng Zhang, *Kansas State University, Manhattan, KS, USA* Timothy Deines, *Kansas State University, Manhattan, KS, USA*
8-247	MSEC2011-50215	An Experimental Comparison of Two Pelelting Methods for Cellulosic Ethanol Manufacturing Qi Zhang, *Kansas State University, Manhattan, KS, USA* Pengfi Zhang, *Kansas State University, Manhattan, KS, USA* Jonathan Wilson, *Kansas State University, Manhattan, KS, USA* Graham Pritchett, *Kansas State University, Manhattan, KS, USA* Zhijian Pei, *Kansas State University, Manhattan, KS, USA* McKinney Leland, *Kansas State University, Manhattan, KS, USA*

8-248	MSEC2011-50230	Microwave Torrefaction of Corn Stover and Tech-Economic Analysis Hanwu Lei, *Washington State University, Richland, WA, USA* Shoujie Ren, *Washington State University, Richland, WA, USA* James Julson, *South Dakota State University, Brookings, WA, USA* Lu Wang, *Washington State University, Richland, WA, USA* Quan Bu, *Washington State University, Richland, WA, USA* Roger Ruan, *University of Minnesota, St. Paul, WA, USA*
8-249	MSEC2011-50274	Biohydrogen Production from Glycerol in Microbial Electrolysis Cells and Prospects for Energy Recovery for Biodiesel Wastes Hong Liu, *Oregon State University, Corvallis, OR, USA* Jeremy Chignell, *Oregon State University, Corvallis, OR, USA*

9-Wells Fargo Room (LSC)	1-11 Machining 3	
Thurs 1030-1200	Session Chair: Session Co-Chair:	Dr. Barry Fussell, *University of New Hampshire, Durham, NH, USA* Dr. Anil Srivastava, *TechSolve, Inc., Cincinnati, OH, USA*
9-250	NAMRC39-4733	Fixture Shape Rigidity Evaluation by an Integrate Machining & Vibration Analysis Dr. Yajun Fan, *Caterpillar Inc., Champaign, IL, USA* Richard Huff, *Caterpillar Inc., Champaign, IL, USA*
9-251	NAMRC39-4808	The Effect of Machining Variables on the Machinability of Turning/Boring Compacted Graphite Iron Dr. John Agapiou, *General Motors, Warren, MI, USA*
9-252	NAMRC39-4757	Influence of Size Effect and Radial Runouts on the End Milling of a Nickel-Based Superalloy Dr. Manuel Estremes, *Clemson University, Greenville, SC, USA* Horacio/H.T. Sanchez, *Technical University of Cartagena, Caragena, Murcia, Spain* Dr. Thomas R. Kurfess, *Clemson University, Greenville, SC, USA* Cristina/C.J. Bunget, *Clemson University, Greenville, SC, USA* Andrew Henderson, *Clemson University, Greenville, SC, USA* Boyce/B.J. Richardson, *Clemson University, Greenville, SC, USA*

Concurrent Technical Sessions, Papers (253-282) 1315 -1445 on Thursday, June 16, 2011		
1-Willamette Room (Alumni Center)	4-5-1 Micro-Nano Assembly	
Thurs 1315-1445	Session Chair: Session Co-Chair:	Philippe Lutz, *University of Franche Comte, Besancon, France* Sylvain Martel, *Ecole Polytechnique de Montreal (EPM), Montreal, QC, Canada*
1-253	MSEC2011-50070	Millimeter-scale Thin Part Self-Assembly in the Fluidic Phase and its Sensitivity to Part Scaling Kwang Soon Park, *University of Washington, Seattle, WA, USA* Rajashree Baskaran, *Intel Corp., Hillsboro, OR, USA* Karl F. Bohringer, *University of Washington, Seattle, WA, USA*
1-254	MSEC2011-50160	Modular and Reconfigurable 3D Micro-Optical Benches: Concept, Validation, and Characterization Kanty Rabenorosoa, *FEMTO-ST, Besancon, France* Cedric Clevy, *FEMTO-ST, Besancon, France* Sylwester Bargiel, *FEMTO-ST, Besancon, France* Jean Philippe Mascaro, *FEMTO-ST, Besancon, France* Philippe Lutz, *University of Franche-Comte, Besancon, France* Chistophe Gorecki, *FEMTO-ST, Besancon, France*
1-255	MSEC2011-50171	Towards Mass-Scale Micro-Assembly Systems Using Magnetotactic Bacteria Sylvain Martel, *Ecole Polytechnique de Montreal (EPM), Montreal, QC, Canada* Mahmood Mohammadi, *Ecole Polytechnique de Montreal (EPM), Montreal, QC, Canada*

2-Trysting Tree (Alumni Center)	1-23 Residual Stress in Manufacturing	
Thurs 1315-1445	Session Chair: Session Co-Chair:	Dr. Robert Ivester, *NIST, Gaithersburg, MD, USA* Dr. Kevin Chou, *The University of Alabama, Tuscaloosa, AL, USA*
2-256	NAMRC39-4710	Modeling of Autofrettage-Induced Deformations When Manufacturing High Pressure Parts Dirk Baehre, *Saarland University, Saarbruecken, Germany* Horst Bruennet, *Saarland University, Saarbruecken, Germany*
2-257	NAMRC39-4731	Modeling Residual Stresses Included by Hole Punching 6013 Aluminum Alloy Side Rails Dan Mashack, *Virginia Tech, Blacksburg, VA, USA* Neremy Rickli, *Virginia Tech, Blacksburg, VA, USA* Dr. Jaime Camelio, *Virginia Tech, Blacksburg, VA, USA* Tory Smith, *Virginia Tech, Blacksburg, VA, USA* Sean Flemming, *Metalsa Roanoke, Roanoke, VA, USA*

3-Burlingham/Elle (Alumni Center)	1-19 Manufacturing Uncertainty	
Thurs 1315-1445	Session Chair: Session Co-Chair:	Dr. Robert Gao, *University of Connecticut, Storrs, CT, USA* Dr. Gap-Yong Kim, *Iowa State University, Ames, IA, USA*
3-258	NAMRC39-4738	The Effect of Cutting Force Model Coefficient Variability on Process Planning in Milling Firat Eren, *University of New Hampshire, Durham, NH, USA* Dr. Robert Jerard, *University of New Hampshire, Durham, NH, USA* Dr. Barry Fussell, *University of New Hampshire, Durham, NH, USA*
3-259	NAMRC39-4764	Tool Life Prediction Using Bayesian Updating Jaydeep Karandikar, *University of Florida, Gainesville, FL, USA* Dr. Tony Schmitz, *University of Florida, Gainesville, FL, USA* Ali Abbas, *University of Illinois at Urbana-Champaign, Urbana, IL, USA*
3-260	NAMRC39-4789	Model-Augmented Methods for Estimation of Contact Pressure Distribution Sripati Sah, *University of Connecticut, Storrs, CT, USA* Dr. Robert Gao, *University of Connecticut, Storrs, CT, USA* Timothy Krup, *University of Connecticut, Storrs, CT, USA*

4-Austin Auditorium (LSC)	2-1-6 Springback and Bending	
Thurs 1315-1445	Session Chair: Session Co-Chair:	William Emblom, *University of Louisiana, Lafayette, LA, USA* Cristina Bunget, *Clemson University, Greenville, SC, USA*
4-261	MSEC2011-50094	Determination of Minimum Blankholding Pressure for Producing Wrinkle Free Products in Multistage Deep Drawing Anupam Agrawal, *Indian Institute of Technology Ropay, Rupangar, Punjab, India* N. Venkata Reddy, *Indian Institute of Technology Kanpur, Kanpur, Utta Pradesh, India* PM Dixit, *Indian Institute of Technology Kanpur, Kanpur, Utta Pradesh, India*
4-262	MSEC2011-50120	Numerical and Experimental Study on Warm Tension-Rotation Bending of Extruded AZ31 Profile Shi-Hong Zhang, *Chinese Academy of Sciences, Shenyang, China* Han Xiao, *Dalian University of Technology, Dalian, China* Jin-Song Liu, *Chinese Academy of Sciences, Shenyang, China* Ming Cheng, *Chinese Academy of Science, Shenyang, China*
4-263	MSEC2011-50202	Properties Development of IF Steel Sheets During Constrained Groove Pressing Technique Hadi Miyanaji, *Iran University of Science and Technology, Tehran, Iran* Ali Keshavarz Panahi, *Iran University of Science and Technology, Tehran, Iran* Hosien Bisadi, *Iran University of Science and Technology, Tehran, Iran* Milad Janbakhsh, *Iran University of Science and Technology, Tehran, Iran*
4-264	MSEC2011-50212	Investigation of Strain Gradients and Magnitudes During Microbending Lijie Wang, *University of New Hampshire, Durham, NH, USA* Yannis Korkolis, *University of New Hampshire, Durham, NH, USA* Brad Kinsey, *University of New Hampshire, Durham, NH, USA*

5-Construction & Engineering Hall (LSC) (LSC)	3-1-3 Mechanical Property Testing	
Thurs 1315-1445	Session Chair: Session Co-Chair:	Hitomi Yamaguchi, *University of Florida, Gainesville, FL, USA* Kevin Chou, *The University of Alabama, Tuscaloosa, AL, USA*
5-265	MSEC2011-50048	Effects of Aspect Ratio and Side Constraint on Buckling of Multi-Wall Structures and Tube Arka P. Chattopadhyay, *Kansas State University, Manhattan, KS, USA* Elizabeth Frink, *Kansas State University, Manhattan, KS, USA* Kevin Lease, *Kansas State University, Manhattan, KS, USA* Jack Xin, *Kansas State University, Manhattan, KS, USA*
5-266	MSEC2011-50207	Mechanical Properties of Some Plant Fibres Compared with Glass Fibre Malachy Sumaila, *Ahmadu Bello University, Zaria, Kaduna, Nigeria* Akaehomen O. Akii Ibhadode, *University of Benin, Benin, Edo, Nigeria*
5-267	MSEC2011-50282	Surface Integrity and Fatigue Strength of Hard Millied Surfaces W. Li, *The University of Alabama, Tuscaloosa, AL, USA* Y.B. Guo, *The University of Alabama, Tuscaloosa, AL, USA* M. Barkey, *The University of Alabama, Tuscaloosa, AL, USA* C. Guo, *United Technologies Research Center, East Hartford, CT, USA* Zhanqiang Liu, *Shandong University, Jinan, Shandong, China*
5-268	MSEC2011-50245	Research on Carrying Capacity of Hydrostatic Slideway on Heavy-Duty Gantry CNC Machine Guo Tieneng, *Beijing University of Technology, Beijing, China* Dai Qin, *Beijing University of Technology, Beijing, China* Liu Zhifeng, *Beijing University of Technology, Beijing, China* Cai Ligang, *Beijing University of Technology, Beijing, China*

6-Agriculture Production Room (LSC)	2-4-2 Advanced Welding and Bonding Technology 2	
Thurs 1315-1445	Session Chair: Session Co-Chair:	Naoto Ohtake, *Tokyo Institute of Technology, Tokyo, Japan* Masaaki Kimura, *University of Hyogo, Himeji, Japan*
6-269	ICMP2011-51072	The Tightening Characteristics and Effectiveness of Magnesium Alloy Bolts Yu Kurakake, *Kurume National College of Technology, Jurume, Fukuoka, Japan* Shinji Hashimura, *Kurume National College of Technology, Jurume, Fukuoka, Japan* Yukio Miyashita, *Nagaoka University of technology, Nagaoka, Niigata, Japan* Sigeru Yamanaka, *Maruemu Works. Co. Ltd., Daito, Osaka, Japan* Genki Hibi, *Maruemu Works. Co. Ltd., Daito, Osaka, Japan*

6-270	ICMP2011-51132	Shear Strength of Brazed Joint Between Titanium and C/C Composites with Various Cross-Ply Angles Toshi-Taka Ikeshoji, *Tokyo Institute of Technology, Meguro, Tokyo, Japan* Tetsutaro Amanuma, *Tokyo Institute of Technology, Tokyo, Japan* Akio Suzumura, *Tokyo Institute of Technology, Tokyo, Japan* Takahisa Yamazaki, *Tokyo Institute of Technology, Tokyo, Japan*
6-271	ICMP2011-51158	Effect of Welding Speed on Tensile Properties and Fracture Behavior of Friction Stir Welded AA6061-T6 Joints Takashi Yokoyama, *Okayama University of Science, Okayama, Japan* Kenji Nakai, *Okayama University of Science, Okayama, Japan* Eiichi Sukedai, *Okayama University of Science, Okayama, Japan* Kazuyoshi Katoh, *Nihon University, Narashino, Japan*

7-Agriculture Leaders Room (LSC)	4-6-1 Micro/Nano-Scale Surface 3D Structuring	
Thurs 1315-1445	Session Chair: Session Co-Chair:	Yi Zhang, *Purdue University, West Lafayette, IN, USA* Madhu Vadali, *University of Wisconsin-Madison, Madison, WI, USA*
7-272	MSEC2011-50222	Microvia Formation for Multi-Layer PWB by Laser Direct Drilling: Improvement of Hole Quality by Silica Fillers in Build-up Layer Keiji Ogawa, *The University of Shiga Prefecture, Hikone-shi, Shiga Prefecture, Japan* Toshiki Hirogaki, *Doshisha University, Kyotanabe-shi, Kyoto, Japan* Eiichi Aoyama, *Doshisha University, Kyotanabe-shi, Kyoto, Japan* Kuniyoshi Obata, *Doshisha University, Kyotanabe-shi, Kyoto, Japan* Tsukasa Ayuzawa, *Doshisha University, Kyotanabe-shi, Kyoto, Japan*
7-273	MSEC2011-50260	Comparative Assessment of the Laser Induced Plasma Micro-Machining (LIP-MM) and the Micro-EDM Processes Kumar Pallav, *Northwestern University, Evanston, IL, USA* Peidong Han, *Northwestern University, Evanston, IL, USA* Janakrajan Ramkumar, *Indian Institute of Technology, Kanpur, Uttar Pradesh, India* Naga Hanumaiah, *Central Mechanical Engineering Research Insittute, Durgapur, West Bengal, India* Kornel F. Ehmann, *Northwestern University, Evanston, IL, USA*
7-274	MSEC2011-50301	Laser Shock Based Controlled Forming of Silver Nanowires Ji Li, *Purdue University, West Lafayette, IN, USA* Yiliang Liao, *Purdue University, West Lafayette, IN, USA* Gary Cheng, *Purdue University, West Lafayette, IN, USA*

8-Agriculture Science Room (LSC)	3-5-2 Monitoring, Sensing, and Control for Manufacturing 2	
Thurs 1315-1445	Session Chair: Session Co-Chair:	Barry Fussell, Ph. D., *University of New Hampshire, Durham, NH, USA* Dragan Djurdjanovic, Ph.D., *University of Texas, Austin, TX, USA*
8-275	MSEC2011-50019	Legacy Machine Monitoring Using Power Signal Analysis Amit Deshpande, *TechSolve, Cincinnati, OH, USA* Ron Pieper, *TechSolve, Cincinnati, OH, USA*
8-276	MSEC2011-50132	Development of a Condition Based Maintenance Program for a CNC Machine: Part 1 Signal Acquisition, Processing, and Network Commuinication Andrew Werner, *Clemson University, Greenville, SC, USA* Parikshit Mehta, *Clemson University, Greenville, SC, USA* Laine Mears, Ph.D. P.E. , *Clemson University, Greenville, SC, USA*
8-277	MSEC2011-50168	Analysis of the Simultaneous CNC Turning and Boring Operation via Multisensor Monitoring Erick Deane, *University of Central Florida, Orlando, FL, USA* Manuel Hernandez, *University of Central Florida, Orlando, FL, USA* Schadrick Collins, *University of Central Florida, Orlando, FL, USA* David Giesecke, *University of Central Florida, Orlando, FL, USA* Chengying Xu, *University of Central Florida, Orlando, FL, USA* Matthew Meanor, *University of Central Florida, Orlando, FL, USA* Yingfeng Ji, *University of Central Florida, Orlando, FL, USA*
8-278	MSEC2011-50211	Machine Anomaly Detection and Diagnosis Incorporating Operational Data Applied to Feed Axis Health Monitoring Linxia Liao, *Siemens Corporate Research, Princeton, NJ, USA* Radu Pavel, Ph.D., *TechSolve, Inc., Cincinnati, OH, USA*
8-279	ICMP2011-51105	Monitoring of Robot Assisted Polishing Through Parameters of Acoustic Emission Ruslan Lazarev, *University of Southern Denmark, Sonderborg, Denmark* Soren Top, *University of Southern Denmark, Sonderborg, Denmark* Arne Bilberg, *University of Southern Denmark, Sonderborg, Denmark*

9-Wells Fargo Room (LSC)	1-13 Micro/Nano Machining 1	
Thurs 1315-1445	Session Chair: Session Co-Chair:	Dr. Rhett Mayor, *Georgia Institute of Technology, Atlanta, GA, USA* Dr. Martin Jun, *University of Victoria, Victoria, BC, Canada*
9-280	NAMRC39-4728	Influence of Cutting Edge Roughness on Brittle Cracking in the Milling Process on Soda Lime Glass Takenori Ono, *Tsuyama National College of Technology, Tsuyama-shi, Okayama, Japan*
9-281	NAMRC39-4732	Experimental Study of the Effect of Tool Orientation on Surface Quality in Five-Axis Micro-Milling of Brass Using Ball-End Mills Mohammad Javad Barakchi Fard, *The University of Western Ontario, London, ON, Canada* Dr. Evgeuini Bordatchev, *NRC-IMI-CAMM, London, ON, Canada*
9-282	NAMRC39-4763	Micro Dimple Milling on Cylinder Surfaces Dr. Takashi Matsumura, *Tokyo Denki University, Tokyo, Japan* Satoru Takahashi, *Tokyo Denki University, Tokyo, Japan*

Concurrent Technical Sessions, Papers (283-316) 1500 - 1630 on Thursday, June 16, 2011		
1-Willamette Room (Alumni Center)	1-2-2 Mechanical and Other Properties	
Thurs 1500-1630	Session Chair: Session Co-Chair:	Gen Sasaki, *Hiroshima University, Higashi-Hiroshima, Japan* Takaomi Itoi, *Chiba University, Chiba, Japan*
1-283	ICMP2011-51014	Oxide Layers Sinking on Stress Shot Peened Surface, The Effects of the Parabolic Leaf Spring Surface Residual Stress and Fatigue Performance Mustafa Karaagac, *OlgunCelik, Manisa, Turkey* Murathan Soner, *OlgunCelik, Manisa, Turkey* Tolga Erdogus, *OlgunCelik, Manisa, Turkey* Ahmet Kanbloat, *OlgunCelik, Manisa, Turkey*
1-284	ICMP2011-51097	Effect of CNT Size on Wear Property of Cu-Based CNT Composite Electrodes in EDM Tsunehisa Suzuki, *Yamagata Research Institute of Technology, Yamagata, Japan* Mutsuto Kato, *Yamagata Research Institute of Technology, Yamagata, Japan* Hiroshi Saito, *Yamagata Research Institute of Technology, Yamagata, Japan* Hiroshi Iizuka, *Yamagata University, Yonezawa, Yamagata, Japan*
1-285	ICMP2011-51160	Powder Magnetic Core Strengthened by Resin Binder Masahisa Miyahara, *Diamet Corporation, Niigata-shi, Niigata, Japan* Isami Nitta, *Niigata University, Niigata-shi, Niigata, Japan*

2-Trysting Tree (Alumni Center)	1-12 Machining 4	
Thurs 1500-1630	Session Chair: Session Co-Chair:	Dr. Vis Madhavan, *Wichita State University, Wichita, KS, USA* Dr. John Agapiou, *General Motors, Warren, MI, USA*
2-286	NAMRC39-4800	Evaluation of Tool-Grade Ceramics for Use as Precision Cutting Tools K. Prashanth Anandan, *Carnegie Mellon University, Pittsburgh, PA, USA* Dr. Burak Ozdoganlar, *Carnegie Mellon University, Pittsburgh, PA, USA*
2-287	NAMRC39-4737	Aero-Lap Polishing of Poly Crystalline Diamond Inserts Using Multicon Media Ramesh Kuppuswamy, *University of Cape Town, Cape Town, South Africa* Serdar Ozbayraktar, *Diamond Research Laboratory, E6 Group, Spring, South Africa* Habib Saridikmen, *Element 6 Ltd, Springs, South Africa*
2-288	NAMRC39-4787	Micro-Scratch Testing and Simulations for Adhesion Characterizations of Diamond-Coated Tools Ping Lu, *University of Alabama, Tuscaloosa, AL, USA* Xingcheng Xiao, *General Motors, Warren, MI, USA* Michael Lukitsch, *General Motors, Warren, MI, USA* Dr. Kevin Chou, *University of Alabama, Tuscaloosa, AL, USA*

3-Burlingham/Elle (Alumni Center)	1-20 Joining 1	
Thurs 1500-1630	Session Chair: Session Co-Chair:	Dr. Y. Lawrence Yao, *Columbia University, New York, NY, USA* Dr. Ramesh Kumar Singh, *Indian Institute of Technology Bombay, Mumbai, Maharashtra, India*
3-289	NAMRC39-4792	Cooling Rate Limitations in the Diffusion Bonding of Microchannel Arrays Dr. Brian Paul, *Oregon State University, Corvallis, OR, USA* Gopi Lingam, *Oregon State University, Corvallis, OR, USA*
3-290	NAMRC39-4773	An Investigation of Hydroxide Catalysis Bonding Strength Hyo Soo Kim, *University of Florida, Gainesville, FL, USA* Dr. Tony Schmitz, *University of Florida, Gainesville, FL, USA*
3-291	NAMRC39-4745	Laser Welding of Nonwoven Polyglycolic Acid (PGA) Scaffold Sambit Rout, *Kansas State University, Manhattan, KS, USA* Dr. Shuting Lei, *Kansas State University, Manhattan, KS, USA*

4-Austin Auditorium (LSC)	2-1-7 New Processes	
Thurs 1500-1630	Session Chair: Session Co-Chair:	Richard M. Onyancha, *Rose-Hulman Institute of Technology, Terre Haute, IN, USA* Jianwen Hu, *Silgan Containers LLC, Oconomowoc, WI, USA*
4-292	MSEC2011-50126	Newest Developments on the Manufacture of Helical Profiles by Hot Extrusion Nooman Ben Khalifa, *TU Dortmund, Dortmund, Germany* A. Erman Tekkaya, *TU Dortmund, Dortmund, Germany*
4-293	MSEC2011-50146	Sizing Extreme Environmental Condition Influences on the Multiphase Polymeric Composites CTE Petru/A. Pop, *University of Oradea, Oradea, Bihor, Romania* Dana Luda Motoc, *Transilvania University, Brasov, Romania* Gheroghe Bejinaru Mihoc, *Transilvania University, Brasov, Romania*
4-294	ICMP2011-51023	Development of Precision Profile Control System with Fuzzy Model and Correction Function for Tube Dieless Drawing Sugeng Supriadi, *Tokyo Metropolitan University, Tokyou, Japan* Tsuyoshi Furushima, *Tokyo Metropolitan University, Tokyou, Japan* Ken-ichi Manabe, *Tokyo Metropolitan University, Tokyou, Japan*
4-295	ICMP2011-51159	Backward Extrusion Method With Pulsating Lubricant Supply on Servo Press Ryo Matsumoto, *Osaka University, Osaka, Japan* Shinkichi Sawa, *Osaka University, Osaka, Japan* Hiroshi Utsunomiya, *Osaka University, Osaka, Japan* Kozo Osakada, *Osaka University, Osaka, Japan*

5-Construction & Engineering Hall (LSC) (LSC)	3-11-2 Manufacturing System Operations 2	
Thurs 1500-1630	Session Chair: Session Co-Chair:	Tamas Szecsi, *Dublin City University, Dublin, Ireland* Lihui Wang, *University of Skovde, Skovde, Sweden*
5-2963	MSEC2011-50069	Energy Consumption Reduction for Sustainable Manufacturing Systems Considering Machines With Multiple-Power States Zeyi Sun, *University of Illinois at Chicago, Chicago, IL, USA* Stephan Biller, *General Motors, Warren, MI, USA* Fangming Gu, *General Motors, Warren, MI, USA* Lin Li, *University of Illinois at Chicago, Chicago, IL, USA*
5-297	MSEC2011-50098	Energy Management in Manufacturing Systems Qing Chang, *New York Institute of Technology, Old Westbury, NY, USA* Guoxian Xiao, *General Motors, Warren, MI, USA* Lin Li, *University of Illinois at Chicago, Chicago, IL, USA* Stephan Biller, *General Motors, Warren, MI, USA*
5-298	MSEC2011-50174	Energy Consumption Reduction in Serial Production Lines Via Optimal Startup Schedule Guorong Chen, *University of Wisconsin-Madison, Madison, WI, USA* Liang Zhang, *University of Wisconsin-Madison, Madison, WI, USA* Jorge Arinez, *General Motors, Warren, MI, USA* Stephan Biller, *General Motors, Warren, MI, USA*
5-299	MSEC2011-50233	Plant Layout Optimization Considering the Effect of Maintenance Seungchul Lee, *The University of Michigan, Ann Arbor, MI, USA* Adam John Brzezinski, *The University of Michigan, Ann Arbor, MI, USA* Jun Ni, *The University of Michigan, Ann Arbor, MI, USA*

6-Agriculture Production Room (LSC)	2-7-4 Advances in Nontraditional/Hybrid Manufacturing 4	
Thurs 1500-1630	Session Chair: Session Co-Chair:	Zhijian Pei, *Kansas State University, Manhattan, KS, USA* Anil K. Srivastava, Ph.D., *TechSolve, Inc., Cincinnati, OH, USA*
6-300	MSEC2011-50065	Enhancement of Surface Quality and Study on Material Removal Mechanism in Micro Ultrasonic Machining Hamid Zarepour, *Nanyang Technological University, Singapore* Swee Hock Yeo, *School of Mechanical and Aerospace Engineering, Singapore*
6-301	MSEC2011-50116	Dry Machining in Rotary Ultrasonic Machining of Carbon Fiber Reinforced Plastic Composite: Effects of Machining Variables Weilong Cong, *Kansas State University, Manhattan, KS, USA* Qiang Feng, *Kansas State University, Manhattan, KS, USA* Zhijian Pei, *Kansas State University, Manhattan, KS, USA* Timothy W Deines, *Kansas State University, Manhattan, KS, USA* Clyde Treadwell, *Sonic Mill, Albuquerque, NM, USA*
6-302	MSEC2011-50131	Development of a New Vibrator for Elliptical Vibration Texturing Ping Guo, *Northwestern University, Evanston, IL, USA* Kornel F. Ehmann, *Northwestern University, Evanston, IL, USA*

6-303	MSEC2011-50240	Indirect Approach to Ultrasonic Superposition in Micro-EDM Andreas Schubert, *Chemnitz University of Technology, Chemnitz, Germany* Nicolas Wolf, *Fraunhofer Institute for Machine Tools and Forming Technology, Chemnitz, Germany* Henning Zeidler, *Chemnitz University of Technology, Chemnitz, Germany* Jorg Schneider, *Fraunhofer Institute for Machine Tools and Forming Technology, Chemnitz, Germany*

7-Agriculture Leaders Room (LSC)	4-2-3 Nanomaterials, Nanofabrication and Their Applications 3	
Thurs 1500-1630	Session Chair: Session Co-Chair:	Curtis Taylor, *University of Florida, Gainesville, FL, USA* Jitendra Kumar, *IIT Kanpur, UP, India*
7-304	ICMP2011-51113	Development of Simulation of Nanostructure Production Due to Electromigration Considering Specimens Damage Kazuhiko Sasagawa, *Hirosaki University, Hirosaki, Aomori, Japan* Takehiro Abo, *Hirosaki University, Hirosaki, Aomori, Japan* Jun Unuma, *Hirosaki University, Hirosaki, Aomori, Japan*
7-305	ICMP2011-51120	Effect of Film Thickness on Helical Formation of Coated Nanowires in an Enhanced-Bending Technique Yuhki Toku, *Akita University, Akita, Japan* Mikio Muraoka, *Akita University, Akita, Japan*
7-306	MSEC2011-50115	A Preliminary Study on Machinability of Polymethymethacrylate (PMMA)/Multi-Walled Carbon Nanotube (MWCNT) Nanocomposites in Focused Ion Beam Micromachining Pengfei Li, *Washington State University, Vancouver, WA, USA* Wei Xue, *Washington State University, Vancouver, WA, USA* Dave (Dae-Wook) Kim, *Washington State University, Vancouver, WA, USA* Young-Bin Park, *Ulsan National Institute of Science and Technology, Ulsan, Korea*
7-307	MSEC2011-50170	Investigation on the Effect of SiC Nanoparticles on Cutting Forces for Micro-Milling Magnesium Matrix Composites Jian Liu, *University of Central Florida, Orlando, FL, USA* Juan Li, *University of Central Florida, Orlando, FL, USA* Yingfeng Ji, *University of Central Florida, Orlando, FL, USA* Chengying Xu, *University of Central Florida, Orlando, FL, USA*
7-308	MSEC2011-50288	Inverse Hall-Petch Effect in Atomistic Machining of Polycrystalline Copper Structures Jing Shi, *North Dakota State University, Fargo, ND, USA* Xiaoping Yang, *Cummins Inc., Columbus, IN, USA* Yachao Wang, *North Dakota State University, Fargo, ND, USA*

8-Agriculture Science Room (LSC)	3-5-3 Monitoring, Sensing, and Control for Manufacturing 3	
Thurs 1500-1630	Session Chair: Session Co-Chair:	Xiaochun Li, Ph.D., *University of Wisconsin, Madison, Madison, WI, USA* Robert X. Gao, Ph.D., *University of Connecticut, Storrs, CT, USA*
8-309	ICMP2011-51018	Development of an Efficient Inverse Analysis Technique for Monitoring of Electroplating Current Density on Target Region in LSI Fabrication Yoshinao Kishimoto, *Tokyo City University, Tokyo, Japan* Yukiyoshi Kobayashi, *Tokyo City University, Tokyo, Japan* Toshihisa Ohtsuka, *Tokyo City University, Tokyo, Japan*
8-310	ICMP2011-51043	Measurement of Die Deformation in Cold Forging by the Combination of Laser Displacement Sensor and Strain Gauge Method Yoshimi Murata, *Meiji University, Kawasaki, Japan* Takuro Yoshihira, *Meiji University, Kawasaki, Japan* Takuya Takahashi, *Meiji University, Kawasaki, Japan*
8-311	MSEC2011-50041	Dynamic Feature Monitoring Technique Applied to Thin Film Deposition Processes in an Industrial PECVD Tool Alexander Bleakie, *University of Texas, Austin, TX, USA* Dragan Djurdjanovic, Ph.D., *University of Texas, Austin, TX, USA*
8-312	MSEC2011-50133	Algorithms and Data Structures for Fast Surface Quality Estimation in Milling Cuneyt Yalcin, *University of New Hampshire, Durham, NH, USA* Barry Fussell, Ph.D., *University of New Hampshire, Durham, NH, USA* Robert B. Jerard, *University of New Hampshire, Durham, NH, USA*
8-313	MSEC2011-50154	Model Based Prediction and Control of Machining Deflection Error in Turning Slender Bars Parikshit Mehta, *Clemson University, Greenville, SC, USA* Laine Mears, Ph.D., P.E., *Clemson University, Greenville, SC, USA*

9-Wells Fargo Room (LSC)	1-14 Micro/Nano Machining 2	
Thurs 1500-1630	Session Chair: Session Co-Chair:	Dr. Takashi Matsumura, *Tokyo Denki University, Tokyo, Japan* Dr. Evgueni Bordatchev, *NRC-IMI-CAMM, London, ON, Canada*
9-314	NAMRC39-4709	Modeling and Interpretation of Fiber Orientation-Based Failure Mechanisms in Machining of Carbon Fiber-Reinforced Polymer Composites Kevin A. Calzada, *University of Illinois, Urbana, IL, USA* Shiv G. Kapoor, *University of Illinois, Urbana, IL, USA* Richard E. DeVor, *University of Illinois, Urbana, IL, USA* Johnson Samuel, *University of Illinois, Urbana, IL, USA* Dr. Anil Srivastava, *TechSolve, Inc., Cincinnati, OH, USA*

9-315	NAMRC39-4730	Experimental Investigation of the Machinability of Polystyrene Reinforced with Single Walled Carbon Nanotubes Chan-Seo Goo, *University of Victoria, Victoria, BC, Canada* Le Hien Huynh, *University of Victoria, Victoria, BC, Canada* Chris Papadopoulos, *University of Victoria, Victoria, BC, Canada* Dr. Martin Jun, *University of Victoria, Victoria, BC, Canada* Dr. Simon Park, *University of Calgary, Calgary, AB, Canada*
9-316	NAMRC39-4790	AFM Prove Based Nano Mechanical Machining of Glass M.G. Mostofa, *University of Calgary, Calgary, AB, Canada* Chaneel Park, *University of Calgary, Calgary, AB, Canada* Dr. Simon Park, *University of Calgary, Calgary, AB, Canada*

TECHNICAL PROGRAM - FRIDAY, JUNE 17, 2011

Concurrent Technical Sessions Papers (317-335) 0800-930 on Friday, June 17, 2011		
1-Willamette Room (Alumni Center)	2-9-2 Biomaterials Processing	
Fri 0800-0930	Session Chair: Session Co-Chair:	Binil Starly, *University of Oklahoma, Norman, OK, USA* Andy Christensen, *Medical Modeling Inc., Golden, CT, USA*
1-317	MSEC2011-50205	Effect of Film Formulation Method and Annealing on Crystallinity of Poly (L-Lactic Acid) Films Shan-Ting Hsu, *Columbia University, New York, NY, USA* Y. Lawrence Yao, *Columbia University, New York, NY, USA*
1-318	MSEC2011-50247	An Investigation Into Machinability of Sintered Nanocrystaline Hydroxyapatite Sanket S. Kulkarni, *Kansas State University, Manhattan, KS, USA* Mark Haynes, *Kansas State University, Manhattan, KS, USA* Lorraine Reimers, *Kansas State University, Manhattan, KS, USA* Kaushik R. Achanta, *Kansas State University, Manhattan, KS, USA* Shuting Lei, *Kansas State University, Manhattan, KS, USA*
1-319	MSEC2011-50281	Cutting Mechanics of High Speed Dry Machining of Magnesium-Calcium Biomedical Alloy Using State Variable Plasticity Model M. Salahshoor, *University of Alabama, Tuscaloosa, AL, USA* Y.B. Guo, *University of Alabama, Tuscaloosa, AL, USA*
1-320	ICMP2011-51073	A Study on the Cutting Rate Performance of A Novel Sagittal Bone Saw Matthew Kelly, *Tufts University, Medford, MA, USA* Timothy Lannin, *Tufts University, Medford, MA, USA* Thomas James, *Tufts University, Medford, MA, USA*

2-Trysting Tree (Alumni Center)	1-24 Design for Manufacturing	
Fri 0800-0930	Session Chair: Session Co-Chair:	Dr. Elsayed Orady, *University of Michigan, Dearborn, MI, USA* Dr. Z.J. Pei, *Kansas State University, Manhattan, KS, USA*
2-321	NAMRC39-4715	Prediction in Casting Junctions Using a Mathematical Model Developed Through Design Experiments Dr. Elsayed Orady, *University of Michigan, Dearborn, MI, USA* Abhay Mane, *University of Michigan, Dearborn, MI, USA* James Knight, *University of Michigan, Dearborn, MI, USA* Mahmoud Awad, *Alhosn University, Abu Dhabi, United Arab Emirates*
2-322	NASMRC39-4754	Design for Manufacture of Bipolar Plates for a PEMFC: A Numerical Study Jaikp Mallory, *Georgia Institute of Technology, Atlanta, GA, USA* Dr. Tequila Harris, *Georgia Institute of Technology, Atlanta, GA, USA* Albert Brown, III, *Morehouse College, Atlanta, GA, USA*

2-323	NAMRC39-4755	System for Computer Aided Cavity Layout Design for Diecasting Dies Jatinder Madan, *Sant Longowal Institute of Engineering and Technology, Sangur, Punjab, India* Vijay Kumar, *Anand International College of Engineering, Jaipur, Rajsthan, India*

4-Austin Auditorium (LSC)	2-1-8 Material Characterization 2	
Fri 0800-0930	Session Chair: Session Co-Chair:	Yannis Korkolis, *University of New Hampshire, Durham, NH, USA* Gracious Ngaile, *North Carolina State University, Raleigh, NC, USA*
4-324	MSEC2011-50142	Effects of Pre-Strain and Annealing on Post-Anneal Mechanical Properties and Forming Limits of AA5182-O Jinjing Li, *University of Michigan, Ann Arbor, MI, USA* S.J. Hu, *University of Michigan, Ann Arbor, MI, USA* John E. Carsley, *General Motors, Warren, MI, USA* Theresa M. Lee, *General Motors, Warren, MI, USA* Sushil Mishra, *General Motors, Bangalore, India* Louis G. Hector, Jr., *General Motors, Warren, MI, USA*
4-325	MSEC2011-50169	Investigating the Effect of Miniaturization on the Microtensile Properties of Brass (CuZn30) Lauren B. Wuertemberger, *Rose-Hulman Institute of Technology, Terre Haute, IN, USA* Megan N. Chann, *Rose-Hulman Institute of Technology, Terre Haute, IN, USA* Richard M. Onyancha, *Rose-Hulman Institute of Technology, Terre Haute, IN, USA*
4-326	MSEC2011-50038	Effect of Coiling Temperature of Hot Rolling on the Mechanical Properties of a Nb-Microalloyed Steel Sheet Daavood Mirahmadi Khaki, *Shahid Rajee Teacher Training University, Tehran, Iran* Vahid Alizaadeh Otaaghvar, *Islamic Azad University, Tehran, Iran*
4-327	MSEC2011-50075	Determination of Biaxial Stress-Strain Relationships for Aluminum Alloys Considering the Anisotropy Milad Janbakhsh, *Iran University of Science and Technology, Tehran, Iran* Mohammad Riahi, *Iran University of Science and Technology, Tehran, Iran* Faramarz Djavanroodi, *Iran University of Science and Technology, Tehran, Iran* Hamid Karimi-Nemch, *Iran University of Science and Technology, Tehran, Iran* Ali Keshavarz Panahi, *Iran University of Science and Technology, Tehran, Iran* Hadi Miyanaji, *Iran University of Science and Technology, Tehran, Iran*

5-Construction & Engineering Hall (LSC)	3-11-3 Manufacturing System Operations 3	
Fri 0800-0930	Session Chair: Session Co-Chair:	April Bryan, *University of the West Indies, Curepe, Trinidad and Tobago* Dragan Djurdjanovic, Ph.D., *University of Texas, Austin, TX, USA*
5-328	MSEC2011-50157	The Use of Hybrid System of Classification for the Retrieval and Modification of Mechanically Oriented Products Adeyinka Adeoye, *Afe Babalola University, Ado-Ekiti, Nigeria* Tamas Szecsi, *Dublin City University, Dublin, Ireland*

5-329	MSEC2011-50232	Consideration of Manufacturing Processes and the Supply Chain in Product Design Ahmde J. Alsaffar, *Oregon State University, Corvallis, OR, USA* Karl R. Haapala, *Oregon State University, Corvallis, OR, USA* Zhaohui Wu, *Oregon State University, Corvallis, OR, USA*
6-330	MSEC2011-50172	Sesitivity Analysis on Inventory Classification Methods for Oilfield Equipment Industry Juan Hincapie, *University of Louisiana, Lafayette, LA, USA* Jim Lee, *University of Louisiana, Lafayette, LA, USA* William Emblom, *University of Louisiana, Lafayette, LA, USA*

6-Agriculture Production Room (LSC)	4-4-3 Nano/Micro/Meso Manufacturing 3	
Fri 0800-0930	Session Chair: Session Co-Chair:	Tahany El-Wardany, *United Technologies Research Center, East Hartford, CT, USA* Liqing Li, *Harbin Institute of Technology, Harbin, Heilongjiang, China*
6-331	MSEC2011-50026	Investigating Turning of Hard-to-cut Material Using Self-Propelled Rotary Tools Hazim El-Mounayri, *IUPU, Indianapolis, IN, USA* Latif Razak, *IUPU, Indianapolis, IN, USA* Mike Kessler, *IUPU, Indianapolis, IN, USA*
6-332	MSEC2011-50144	Multi-Objective Optimization for the Micro-Milling Process with Adaptive Data Modeling Xinyu Liu, *Lamar University, Beaumont, TX, USA* Weihang Zhu, *Lamar University, Beaumont, TX, USA* Victor Zaloom, *Lamar University, Beaumont, TX, USA*
6-333	MSEC2011-50285	Numerical Modeling of Minimum Uncut Chip Thickness for Micromachining with Different Rake Angle Zhenyu Shi, *Shandong University, Jinan, Shandong, China* Zhanqiang Liu, *Shandong University, Jinan, Shandong, China*

8-Agriculture Science Room (LSC)	1-21 Joining 2	
Fri 0800-0930	Session Chair: Session Co-Chair:	Dr. Steven Hayashi, *GE Global Research, Niskayuna, NY, USA* Dr. William J. Emblom, *University of Louisiana, Lafayette, LA, USA*
7-334	NAMRC39-4705	The Bauschinger Effect for Cold Finished Mild Steel After Friction Stir Processing Brennan S. Domec, *Franks Casing Crew & Rental Tools, Inc., Lafayette, LA, USA* Dr. William J. Emblom, *University of Louisiana, Lafayette, LA, USA* Theodore A. Kozman, *University of Louisiana, Lafayette, LA, USA* Jim Lee, *University of Louisiana, Lafayette, LA, USA*
7-335	NAMRC39-4739	Mechanical and Microstructural Properties Prediction by Artificial Neural Networks in FSW Processes of Dual Phase Titanium Alloys Gianluca Buffa, *University of Palermo, Palermo, Italy* Livan Fratinii, *University of Palermo, Palermo, Italy* Fabrizio Micari, *University of Palermo, Palermo, Italy*

Concurrent Technical Sessions, Papers (336-349)
945 -1115 on Friday, June 17, 2011

4-Austin Auditorium (LSC)	4-3-2 Sustainable Nanomanufacturing 2	
Fri 0945-1115	Session Chair: Session Co-Chair:	Chris Yingchun Yuan, *University of Wisconsin, Milwaukee, WI, USA* Fu Zhao, *Purdue University, West Lafayette, IN, USA*
4-336	MSEC2011-50246	Evaluation of a Reverse Oscillatory Flow Microreactor Design for the Synthesis of Uniformly-Sized Nanoparticles Daniel A. Peterson, *Oregon State University, Corvallis, OR, USA* Anna Garrison, *Oregon State University, Corvallis, OR, USA* Brian K. Paul, *Oregon State University, Corvallis, OR, USA*
4-337	MSEC2011-50271	Sustainability in Nanomanufacturing: Status and Vision for the Future Puttagounder Dhanasekara Swaminathan, *Wichita State University, Wichita, KS, USA* Devi Kalla, *Wichita State University, Wichita, KS, USA* Ramazan Asmatulu, *Wichita State University, Wichita, KS, USA* Bangwei Zhang, *Wichita State University, Wichita, KS, USA*
4-338	MSEC2011-50300	A Review of Recent Research in Sustainable Manufacturing Karl R. Haapala, *Oregon State University, Corvallis, OR, USA* Fu Zhao, *Purdue University, West Lafayette, IN, USA* Jaime Camelio, *Virginia Tech, Blacksburg, VA, USA* John W. Sutherland, *Division of Ecological and Environmental Engineering, Purdue, IN, USA* Steven J. Skerlos, *University of Michigan, Ann Arbor, MI, USA* David Dornfeld, *UC Berkeley, Berkeley, CA, USA* I.S. Jawahir, *University of Kentucky, Lexington, KY, USA* Hong-Chao Zhang, *Texas Tech University, Lubbock, TX, USA* Andres Clarens, *University of Virginia, Charlottesville, VA, USA*

6-Agriculture Production Room (LSC)	2-7-5 Advances in Nontraditional/Hybrid Manufacturing 5	
Fri 0945-1115	Session Chair: Session Co-Chair:	Markus Heilmann, *Technische Universitat Dortmund, Dortmund, Germany* Lin Gu, *Shanghai Jiao Tong University, Shanghai, China*
6-339	MSEC2011-50109	Preparation of Porous Metal Nickel by Jet Electrodeposits Li-Da Shen, *Nanjing University of Aeronautics and Astronautics, Nanjing, China* Zong-jun Tian, *Nanjing University of Aeronautics and Astronautics, Nanjing, China* Zhi-dong Liu, *Nanjing University of Aeronautics and Astronautics, Nanjing, China* Yin-hui Tian, *Nanjing University of Aeronautics and Astronautics, Nanjing, China*
6-340	MSEC2011-50145	Microstructure Characteristics and High-Temperature Oxidation Behavior of Plasma-Sprayed and Laser-Remelted MCrAlY Coatings on TiAl Intermetallics Zong-jun Tian, *Nanjing University of Aeronautics and Astronautics, Nanjing, China* Li-Da Shen, *Nanjing University of Aeronautics and Astronautics, Nanjing, China* Zhi-dong Liu, *Nanjing University of Aeronautics and Astronautics, Nanjing, China* Yin-hui Huang, *Nanjing University of Aeronautics and Astronautics, Nanjing, China*

6-341	MSEC2011-50226	Hybrid Manufacturing of Deep Holes with Small Diameters Dirk Biermann, *Technische Universitat Dortmund, Dortmund, Germany* Markus Heilmann, *Technische Universitat Dortmund, Dortmund, Germany*
6-342	MSEC2011-50111	Investigation of Corrosion Processing for Ti-6Al-4V in Hydrofuoric-nitric Acid System Cui Lin, *Nanchang Hangkong University, Nanchang, Jiangxi, China* Xin Pei Hong, *Nanchang Hangkong University, Nanchang, Jiangxi, China*

7-Agriculture Leaders Room (LSC)	4-6-2 Thermal Based Micro/Nano-Scale Laser Processing	
Fri 0945-1115	Session Chair: Session Co-Chair:	Keiji Ogawa, *The University of Shiga Prefecture, Hikone-Shi, Shiga Prefecture, Japan* Ji Li, *Purdue University, West Lafayette, IN, USA*
7-343	MSEC2011-50180	Pulsed Laser Micro Polishing: An Analytical Method for Predicting Surface Finish Madhu Vadali, *University of Wisconsin-Madison, Madison, WI, USA* Chao Ma, *University of Wisconsin-Madison, Madison, WI, USA* Neil A. Duffie, *University of Wisconsin-Madison, Madison, WI, USA* Xiaochun Li, Ph.D. , *University of Wisconsin-Madison, Madison, WI, USA* Frank E. Pfefferkorn, *University of Wisconsin-Madison, Madison, WI, USA*
7-344	MSEC2011-50294	Controlled Nanocrystallization of NiTi Shape Memory Alloy by Laser Shock Peening Chang Ye, *Purdue University, West Lafayette, IN, USA* Gary Cheng, *Purdue University, West Lafayette, IN, USA*
7-345	MSEC2011-50296	Nanoscale Size Dependence on Metallic Particles: Case Study of Titanium Nanoparticles on Pulsed Laser Sinterting of Hydroxyapatite/Titanium Nanoparticles Yi Zhang, *Purdue University, West Lafayette, IN, USA* Gary Cheng, *Purdue University, West Lafayette, IN, USA*

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8-Agriculture Science Room (LSC)	2-6-2 Energy Manufacturing 2	
Fri 0945-1115	Session Chair: Session Co-Chair:	Zhijian Pei, *Kansas State University, Manhattan, KS, USA* Devi Kalla, *Wichita State University, Wichita, KS, USA*
8-346	MSEC2011-50080	Survey of Courses on Renewable Energy Manufacturing at American Universities Weilong Cong, *Kansas State University, Manhattan, KS, USA* Zhijian Pei, *Kansas State University, Manhattan, KS, USA*
8-347	MSEC2011-50117	Size Reduction of Cellulosic Biomass in Biofuel Manufacturing: Effects of Milling Orientation on Sugar Yield Meng Zhang, *Kansas State University, Manhattan, KS, USA* Pengfei Zhang, *Kansas State University, Manhattan, KS, USA* Xiaoxu Song, *Kansas State University, Manhattan, KS, USA* Qi Zhang, *Kansas State University, Manhattan, KS, USA* Zhijian Pei, *Kansas State University, Manhattan, KS, USA* Timothy W. Deines, *Kansas State University, Manhattan, KS, USA* Donghai Wang, *Kansas State University, Manhattan, KS, USA*
8-348	MSEC2011-50136	Cost Estimates of Cellulosic Ethanol Manufacturing: A Literature Review Pengfei Zhang, *Kansas State University, Manhattan, KS, USA* Zhihian Pei, *Kansas State University, Manhattan, KS, USA*
8-349	MSEC2011-50163	Energy Consumption in Discrete Part Production Devi Kalla, *Wichita State University, Wichita, KS, USA* Samantha Corcoran, *Wichita State University, Wichita, KS, USA* Janet Twomey, *Wichita State University, Wichita, KS, USA* Michael Overcash, *Wichita State University, Wichita, KS, USA*

MSEC ABSTRACTS

MSEC2011-50002

APPLICATION OF DIFFERENT HILL'S YIELD CRITERIA TO PREDICT LIMIT STRAINS FOR AEROSPACE TITANIUM AND ALUMINUM SHEET ALLOYS

Milad Janbakhsh — Iran University of Science and Technology

Faramarz Djavanroodi — Iran University of Science and Technology

Mohammad Riahi — Iran University of Science and Technology

Due to increasing demands for manufacturing light vehicles, automotive and aerospace industries have been using sheet materials with higher strength to weight ratios. More recently, Titanium alloys are gaining more interests to be implemented in hydro-forming applications. It is necessary to predict forming limits for these sheet alloys. Forming limits play an important role in metal forming processes. Forming limit diagrams, present the limit strains for various linear strain paths. In other hand, forming limit curve (FLC), illustrates localized formability for sheet metals under proportional loadings and are known as a powerful tool for trouble-shooting in sheet metal forming processes. In this study, mechanical properties of Ti-6Al-4V titanium sheets, AA7075-T6 and AA2024-T3 aluminum sheets are investigated through the uni-axial tensile test. Anisotropy coefficients as well as work-hardening exponent resulted from tensile test were used to theoretically prediction of limit strains. For the theoretical prediction of the forming limit curves, several constitutive models were implemented. Several Hill's yield criteria combined with Swift equation and empirical equation proposed by NADDRG were accomplished to predict the FLDs.

MSEC2011-50005

CONSTRAINED OPTIMIZATION OF SURFACE ROUGHNESS IN LONGITUDINAL TURNING VIA NOVEL MODIFIED HARMONY SEARCH

Reza Farshbaf Zinati — AmirKabir University of Technology

Mohammad Reza Razfar — AmirKabir University of Technology

The present research deals with a modified optimization algorithm of harmony search coupled with artificial neural networks (ANNs) to predict the optimal cutting condition. To this end, several experiments were carried out on AISI 1045 steel to attain required data for training of ANNs. Feed forward artificial neural network was utilized to create predictive models of surface roughness and cutting forces exploiting experimental data, and Modified Harmony Search algorithm (MHS) was used to find the constrained optimum of the surface roughness. Furthermore, Simple Harmony Search algorithm (SHS) and Genetic Algorithm (GA) were used for solving the same optimization problem to illustrate the capabilities of MHS algorithm. The obtained results demonstrate that MHS algorithm is more effective and authoritative in approaching the global solution than the SHS algorithm and GA.

MSEC2011-50007

COMPARISON OF PROCESS CAPABILITY INDEX AND SPC CONTROL LIMITS CALCULATIONS WHEN USING DIFFERENT INSPECTION TOOLS

Mohamed Gadalla — Alabama A&M University

Miroslaw Popielarczyk — Pratt & Whitney

A common practice in the manufacturing environment is to use different measuring tools for inspecting engineering products. These measuring tools ranges from hand held tools (manual) such as venire calipers, to manufactured inspection gages, and general purpose coordinate metrology based inspection tools such as: CMM machines. Although there are rules of thumb to select the measuring tool, less research has been done to evaluate the effect of this decision on the calculation of some important parameters and metrics used in the industrial community such as: process capability index Cpk, and SPC control limits. It was found that data collected from a coordinate metrology based tools tends to be clustered around the process mean, while it is more spread for the other inspection tools. This situation leads to higher values for process capability index calculations when the data is collected from a coordinate metrology tool. It also leads to variation in the calculations of SPC control limits, which may cause in-consistency, confusion, and may result in unnecessary false alarms.

MSEC2011-50014

FIVE-AXIS CNC TOOL GRINDING PART I: RAKE FACE GRINDING

Mahmoud Rababah — Concordia University

Zezhong Chen — Concordia University

Grinding the helical surfaces in end-mill cutters using two-axis CNC machines is well investigated in literature. However, the grinding wheels do not have explicit geometric representations and the produced helical angles differ from the designed values. Moreover, to the best knowledge of the authors, no reliable and robust algorithm exists to grind

generic shape cutters with constant normal rake angles. Thus, the first part of this work introduces a five-axis grinding process that keeps the normal rake angle constant along the rake face. The parameters that affect the shape of the tool flutes are also analyzed and studied in this part. These parameters are then optimized in the second part to obtain optimum wheel shapes grinding the tool flutes along optimum paths. Overall, the grinding process proposed grinds the tool flutes with close matching to the designed ones and replaces the complex wheel shapes commonly used by simple prismatic ones.

MSEC2011-50015

FIVE-AXIS CNC TOOL GRINDING PART II: FLUTE SURFACE GRINDING

Mahmoud Rababah — Concordia University

Zezhong Chen — Concordia University

The traditional cutting tools grinding reveals inexact tool flutes that altered the tool strength and affect the chip evacuation capabilities. Moreover, the normal rake angles are neither exact nor varying smoothly on the rake face along the cutting edge. Adopting the rake face grinding process described in part I, the wheel shape and path are optimized using GODLIKE scheme in order to grind the tool flutes with exact helical and normal rake angles while keeping close matching to the designed flutes. A tapered ball-end mill is considered in this study due to its extensive role in five-axis sculpture surfaces machining. With this approach proposed, a simple grinding wheel replaces the complex wheels commonly used, and the deviation between the designed and the generated flutes reveals less than 4 % of the tool minor radius. Beside all, a relationship between the radial and the normal rake angles is established.

MSEC2011-50018

INFLUENCE OF MACHINE TOOL COVERS ON FEED DRIVES

Petr Kolar — Czech Technical University in Prague

Jan Masek — Czech Technical University in Prague

Jiri Sveda — Czech Technical University in Prague

Jan Hudec — Czech Technical University in Prague

Machine tool covers are important parts of the machine. From the point of view of feed drives, a cover is an additional multi-body system that influences the dynamic properties of the feed drive and the positioning accuracy of the machine. The advantages of covers connected to the machine table with flexible elements are shown on simulation and experimental results. A mathematical model of the cover and its connection to the machine table is described. Optimization of the stiffness and damping ratio for the connection, using a model of the cover, is suggested. The optimal connection parameters cause decreasing of maximum reaction force acting from the cover to the feed drive. This phenomenon is presented on simulation example and also on the experiment results.

MSEC2011-50019

LEGACY MACHINE MONITORING USING POWER SIGNAL ANALYSIS

Amit Deshpande — TechSolve

Ron Pieper — TechSolve

A typical manufacturing job shop comprises of legacy machine tools, new (modern) machine tools, material handling devices, and peripheral manufacturing equipments. Automated monitoring of legacy machine tools has been a long-standing issue for the manufacturing industry primarily because of the computer numeric controller (CNC) closed architecture and limited external communication functionality. This paper describes a non-invasive methodology and development of a software application to monitor real-time machine status, energy usage, and other machining parameters for a legacy machine tool using power signal analysis. State machine algorithm is implemented to detect tool changes and part count. The system architecture, implementation, benefits, limitations, and future work needed for the legacy machine tool monitoring application is explained in detail.

MSEC2011-50025

A STUDY ON AMOUNT OF BIOMASS PELLETS USED IN DURBILITY TESTING

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Pengfei Zhang — Kansas State Univeristy

Zhijian Pei — Kansas State Univeristy

Xiaoxu Song — Kansas State Univeristy

Meng Zhang — Kansas State University

Timothy Deines — Kansas State Univeristy

ABSTRACT Biofuels are an alternative to petroleum-based liquid transportation fuels. Cellulosic biomass can be used as feedstocks for biofuel manufacturing. Low density of cellulosic feedstocks causes difficulties in handling them during transportation and storage, thus hindering large-scale and cost-effective manufacturing of cellulosic biofuels. Pelleting can increase the density of cellulosic feedstocks by compacting bulky biomass into pellets. Pellet durability, an important quality parameter, measures the ability of pellets to withstand impact and other destructive forces during transportation and handling. ASABE standard (S 269.4) specifies a procedure to determine pellet durability using 500

grams of pellets. However, it does not provide any justification of choosing this amount of pellets. This paper investigates the feasibility of using a smaller amount of pellets (50 grams) to determine pellet durability. Results show that 50 grams of pellets can generate comparable durability results as 500 grams of pellets.

MSEC2011-50026

INVESTIGATING TURNING OF HARD-TO-CUT MATERIAL USING SELF-PROPELLED ROTARY TOOLS

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This paper presents the findings of an experimental study on lathe turning operations on Hard-to-Cut Materials based on 55RC samples using Carbide inserts coated with Titanium Nitride fitted on a self-propelling rotary tool, and compares the results with simulated conventional tools with fixed inserts. Tool performance is assessed based on cutting force, surface quality of the machined workpiece, and tool wear. Findings indicate better tool life and overall performance of rotary tools due to the self-propelled motion of the inserts. The self-propelled motion of the inserts provides a self-cooling effect, improving tribological properties and lowering Thrust Force as a result of the decrease of contact time at the tool-work surface interface. Wear is observed to be evenly distributed with no evidence of diffusion-type wear. Finally, the machined surface quality is at par or better than one resulting from using a conventional fixed tool. The above characteristics translate into a more cost-efficient cutting operation.

MSEC2011-50029

RESEARCH AND DEMONSTRATIONS TO REALIZE INTEROPERABLE MANUFACTURING -- A STEP-NC APPROACH

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Yaoyao (Fiona) Zhao — National Institute of Standards and Technology

Frederick M. Proctor — National Institute of Standards and Technology

Sid Venkatesh — Boeing Company

David J. Odendahl — Boeing Company

Xun Xu — University of Auckland

STEP-NC is the result of a ten-year international effort to replace the RS274D (ISO 6983) G and M code standard with a modern associative language. The new standard connects CAD design data to CAM process data so that smart applications can understand both the design requirements for a part and the manufacturing solutions developed to make that part. STEP-NC builds on a previous ten-year effort to develop the STEP standard for CAD to CAD and CAD to CAM data exchange, and uses the modern geometric constructs in that standard to specify device independent tool paths, and CAM independent volume removal features. This paper reviews a series of demonstrations carried out to test and validate the STEP-NC standard. These demonstrations were an international collaboration between industry, academia and research agencies. Each demonstration focused on testing and extending the STEP-NC data model for a different application.

MSEC2011-50031

STUDY ON DISCRETE DIE STRETCH BENDING FOR STRIP AND L SECTION PROFILE

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Hao Zhang — Northwestern Polytechnical University

Weichao Wu — Northwestern Polytechnical University

ABSTRACT Conventional die for stretch bending forming needs much lead time and initial cost for manufacturing. In this paper, the reconfigurable stretch bending forming process was proposed and developed as an effective method to improve the production efficiency. The deformation of work-piece is quite different from that formed in conventional processes. The feasibility of this reconfigurable die for forming the strip and L cross section profile has been verified through FEM simulation and experiments. Its deformation characteristics, stress distribution and forming defects were studied. The polyurethane cushion, steel sheet cushion and element with different parameters have been conducted to inhibit the forming defects. Finally the relationships of discrete die stretch bending forming quality influenced by the cushion and element were obtained. The result indicates that the strip and L section profile can be formed with this new discrete die stretch bending process. Keywords: Stretch Bending, Discrete Die, Dimples, Section distortion.

MSEC2011-50035

STUDY OF CARBON NONATUBES ON WEAR PERFORMANCE OF ALUMINUM MATRIX COMPOSITES BY FRICTION STIR PROCESSING

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Carbon nanotubes (CNTs) reinforced Al matrix composites were prepared by friction stir processing (FSP). The effect of CNTs content on the wearing performance and hardness of Al matrix composites was studied. Results show that CNTs reinforced Al matrix composites by FSP are to create a good dispersion of the CNTs in the matrix and to achieve a good combination with the matrix. The interface of CNTs and pure aluminum matrix is smooth, no defects and is one kind of mechanical bonding interface. There are a large number of dislocations. CNTs can strengthen the matrix composites effectively and obviously improve the hardness of the composites. With increasing CNTs content, CNTs can also improve the wear performance of the matrix composites

MSEC2011-50038

EFFECT OF COILING TEMPERATURE OF HOT ROLLING ON THE MECHANICAL PROPERTIES OF A NB-MICROALLOYED STEEL SHEET

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Vahid Alizaadeh Otaaghvar — Islamic Azad University

Thermomechanical processing and controlled rolling of microalloyed steel sheets are affected by several factors. In this work, coiling temperature of hot rolling which is considered as one of the most effective parameters on the final mechanical properties of a hot rolled product has been studied. For this purpose, four different coiling temperatures of 550, 600, 650 and 700°C were chosen and then the microstructure and mechanical properties of products have been studied. It is observed that decreasing the coiling temperature causes increase of the strength and decrease of the total elongation. This is accompanied by more grain refinement of the microstructure, and the morphology is changed from polygonal ferrite to acicular one. Findings of this research provide suitable connection among coiling temperature, microstructural features and mechanical properties of hot rolled NB-microalloyed steel sheets.

MSEC2011-50040

THREE-DIMENSIONAL ENDMILL DYNAMICS: MODEL DEVELOPMENT AND EXPERIMENTAL VALIDATION

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Uttara Kumar — University of Florida

Burak Ozdoganlar — Carnegie Mellon University

Tony L. Schmitz, Ph.D. — University of Florida

In this paper the three-dimensional dynamic behavior of macro-scale milling tools is modeled using the spectral-Tchebychev technique while considering the actual fluted cross-sectional geometry and pretwisted shape of the tools. The bending and torsional behavior of three different fluted endmills is compared to finite element predictions and experimental results obtained using impact testing with free-free boundary conditions. The percent difference between experiment and the spectral-Tchebychev method predictions is shown to be 3% or less for all three tools while considering the first six bending modes and first two torsional modes. For the same modes, the spectral-Tchebychev and finite element model predictions agreed to better than 1%.

MSEC2011-50041

DYNAMIC FEATURE MONITORING TECHNIQUE APPLIED TO THIN FILM DEPOSITION PROCESSES IN AN INDUSTRIAL PECVD TOOL

Alexander Bleakie — The University of Texas at Austin

Dragan Djurdjanovic, Ph.D. — University of Texas

In semiconductor fabrication processes, reliable feature extraction and condition monitoring is critical to understanding equipment degradation and implementing the proper maintenance decisions. This paper presents an integrated feature extraction and equipment monitoring approach based on standard built-in sensors from a modern 300mm-technology industrial Plasma Enhanced Chemical Vapor Deposition (PECVD) tool. Linear Discriminant Analysis was utilized to determine the set of dynamic features that are the most sensitive to different tool conditions brought about by chamber cleaning. Gaussian Mixture Models of the dynamic feature distributions were used to statistically quantify changes of these features as the condition of the tool changed. Data was collected in the facilities of a well-known microelectronics manufacturer from a PECVD tool used for depositing various thin films on silicon wafers, which is one of the key steps in semiconductor manufacturing. Dynamic features coming from the radio frequency (RF) plasma power generator, matching capacitors, pedestal temperature, and chamber temperature sensors were shown to consistently have significant statistical changes as a consequence of repeated cleaning cycles, indicating physical connections to the chamber condition.

MSEC2011-50045

DESIGN AND FABRICATION OF AN AUTOMATIC NANOSCALE TOOL-TIP EXCHANGER FOR SCANNING PROBE MICROSCOPY

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Bijoyraj Sahu — University of Florida

Robert Riddle — University of Nevada – Reno

Kam K. Leang — University of Nevada – Reno

The scanning probe microscope (SPM), in particular the atomic force microscope (AFM), is widely used as a metrology tool at the nanoscale. Recently, the instrument has shown tremendous potential to perform various nanoscale fabrication processes (e.g. nanolithography, atomic deposition, nanomachining, etc.) with high resolution (< 10 nm). However, use of SPMs for fabrication have a low throughput and require frequent manual replacement of the SPM tips due to damage or wear. Manual switching of tips for multiple operations, is relatively time consuming. Thus these issues hinder the throughput, quality, reliability, and scalability of SPM as a practical tool for nanofabrication. To address these issues, this paper presents the design, analysis, and fabrication of a novel nano tool-tip exchanger that automatically loads and unloads SPM tool-tips. The ability to provide fully automated on-demand tool-tip exchange would enable SPM as a scalable tool for nanomanufacturing. In this work, an active SPM cantilever is designed with an electrothermally actuated microgripper capable of locating, loading, and unloading tool-tips automatically. The microgripper has been designed to provide adequate range of actuation, gripping force, stiffness, and dynamic response required for securely holding the tool-tip and for functioning within existing SPM-based systems. The design has been validated by finite element analysis. Experiments have been conducted to establish the micro-electro-mechanical systems (MEMS) fabrication processes for successful fabrication of the prototype.

MSEC2011-50048

EFFECTS OF ASPECT RATIO AND SIDE CONSTRAINT ON BUCKLING OF MULTI-WALL STRUCTURES AND TUBES

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Elizabeth Frink — Kansas State University

Kevin Lease — Kansas State University

Jack Xin — Kansas State University

Buckling of plates and tubes plays an important role in structural safety and energy absorption. Although buckling of plates and tubes has been studied theoretically and experimentally in the past, the effects of aspect ratio and side constraint on buckling of multi-wall structures and tubes has not been investigated systematically. In this work, finite element simulations have been carried out to investigate the buckling behavior of multi-wall structures and square tubes. A series of one- to three-panel walls and square tubes with various aspect ratios were simulated. The critical aspect ratios causing buckling mode transition were obtained and compared with theoretical predictions available in the literature. Effects of wall angle and side constraint on buckling behavior were investigated. The relevance of research findings to honeycomb-like structures was discussed.

MSEC2011-50049

APPLICATION OF TOPOLOGY OPTIMIZATION IN PRODUCT DESIGN AND MANUFACTURING

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Harry Tempelman — Hitachi Construction Truck Manufacturing Ltd.

David Kirby — Altair Engineering

This paper deals with the utilization of topology optimization in the design process. Topology optimization is considered the most challenging task in the structural design optimization problems because the general layout of the structure is not known; however, implementing it in the conceptual design stage has proven to reduce the cost and development time. In this paper, the design process is briefly discussed emphasizing the use of topology optimization in the conceptual design stage. Also, the mathematical formulation for topology optimization with material density contours is presented. Furthermore, two industrial case studies, related to off-road mining and construction trucks, are discussed where the use of topology optimization has proven to dramatically improve an existing design and significantly decrease the development time of a new design.

MSEC2011-50052

AN INVESTIGATION ON TOP SURFACE QUALITY FOR DIRECT METAL LASER FABRICATION

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Xu Chao — Institute of Machinery Manufacturing Technology, CAEP

Wang Yang — China Academics of Engineering Physics(CAEP)

SLS (Selective Laser Sintering) has been developing rapidly since its initial invention for non-metal materials by Texas University. Nowadays, Direct Metal Laser Fabrication (DMLF), as a variant of SLS technique, has been investigated intensively which is aimed at rapid manufacturing of end-use metal products with full functions. For describing the stability and properties of DMLF process, Top Surface Quality (TSQ) was put forward in this paper, which could be a unique and crucially important feature compared with traditional manufacturing methods. Through the systematic and detailed analysis of DMLF process using related theories of additive manufacturing technologies, it was revealed that TSQ was the key factor for controlling the stability of DMLF process and thus tailoring final properties of metallic parts. TSQ was defined as the surface morphology in macro and micro scopes in laser scanning area of unit layers during DMLF, and could be characterized by three key elements: flatness, compactness and cleanliness. Only good TSQ could ensure the stability of DMLF process and excellent performance of metal parts in theory. The flatness was the significant factor to assure the shaping during DMLF while the compactness and cleanliness are the decisive factors to assure the final properties of metal part for DMLF. As an example, the typical top surface defects and their contributing factors in DMLF for Cu-based metal powder mixtures were investigated thoroughly according to the proposed definition and requirements. Moreover, the specific controlling methods of TSQ were provided and discussed. Eventually, DMLF of three-dimensional Cu-based metal sample with complicate structure was successfully performed by taking some effective measures for adjusting TSQ parameters.

MSEC2011-50055

ULTRASONIC-VIBRATION-ASSISTED GRINDING OF BRITTLE MATERIALS: A MECHANISTIC MODEL FOR CUTTING FORCE

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Zhijian Pei — Kansas State Univeristy

Weilong Cong — Kansas State Univeristy

Clyde Treadwell — Sonic Mill

Dongming Guo — Dalian University of Technology

A mechanistic model for cutting force in ultrasonic-vibration-assisted grinding (UVAG) (also called rotary ultrasonic machining) of brittle materials is proposed for the first time. Fundamental assumptions include: (1) brittle fracture is the dominant mechanism of material removal, and (2) the removed volume by each diamond grain in one vibration cycle can be related to its indentation volume in the workpiece through a mechanistic parameter. Experiments with UVAG of silicon are conducted to determine the mechanistic parameter for silicon. With the developed model, influences of six input variables on cutting force are predicted. These predicted influences trends are also compared with those determined experimentally for several brittle materials.

MSEC2011-50056

FATIGUE BEHAVIOR, BRIDGING STRESSES, AND FATIGUE RELIABILITY IN SILICON NITRIDE CERAMICS

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Jamie J. Kruzic — Oregon State University

Silicon nitride ceramics doped with rare earth oxides exhibit excellent toughness and strength due to grain bridging. This contributes to increasing fracture and fatigue resistance curves (R-curves) dependent on crack size. Three Si3N4-RE ceramics were investigated containing MgO-Y2O3, Al2O3-Y2O3, and MgO-La2O3. Fatigue crack growth experiments were conducted on compact tension specimens in order to determine the fatigue threshold, ?Kth, for cracks with steady state bridging zones. Fatigue thresholds for the MgY and MgLa doped materials were found to be significantly higher than for the AlY doped Si3N4; however, when all the data were normalized by the bridging stress intensity factor they all overlapped considerably. To further understand the role of the bridging stresses, micro-Raman spectroscopy experiments were conducted on the MgY specimens to measure the bridging stress distribution. By measuring a small shift in the 862 cm-1 Raman peak the full bridging stress distribution was determined along the crack. The Raman results show a strong agreement with bridging stress distributions determined from fracture R-curves in the same Si3N4,

although the peak bridging stress is degraded by the fatigue loading. Using the combined fracture, fatigue, and Raman data the fatigue threshold R-curve has been calculated for this MgY oxide containing Si3N4 to allow fatigue reliability predictions. Experiments are currently being performed to verify those predictions.

MSEC2011-50057

ENVIRONMENTAL AND COST ASSESSMENT OF SEVERAL INJECTION MOLDED POWDER ELECTRONICS PACKAGING MATERIALS

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Malcolm Brown — Oregon State University

Sundar Atre — Oregon State University

Karl R. Haapala — Oregon State University

Electronics manufacturing technology has been advancing at an increasing rate for the past few decades and has forced related industries to do the same. One related industry involves the packaging technology used to enclose chips for power electronics. As demands of electronics manufacturers continue to increase in terms of cost, performance, and environmental impacts, so do demands on the packaging technologies involved. A variety of packaging materials have been used and proposed. The performance of each material varies in terms of ease of manufacturing, as well as its heat transfer properties. This study addresses performance, cost, and environmental impact measures to assist in selecting the most appropriate electronics packaging material. A performance study identified epoxy, aluminum nitride (AlN), and silicon carbide (SiC) to be the most viable options. Further analysis then found that epoxy outperforms the other options in terms of cost and environmental impact on a per-part basis, with AlN shown to be slightly better than SiC according to both metrics. Since it is known that AlN and SiC have superior material performance to epoxy packaging, further investigation is warranted to elucidate these relative differences, which will result in a more representative functional unit for comparative analysis.

MSEC2011-50059

DYNAMIC EVALUATION OF A NANOCOMPOSITE FORCE SENSOR

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Laine Mears, Ph.D., P.E. — Clemson University

Andrew Clark — SensorTech Corp.

This paper describes the dynamic characteristics of a newly-designed force sensor comprised of carbon nanoparticles embedded in a polyphenylene sulfide matrix and operating on the principle of contact resistance change with pressure. Sensor performance was investigated for frequencies ranging from 1 to 1,000 Hz using two testing setups: a load frame for low frequency characterization and a piezo-electric stack for describing higher-frequency behavior. Bode magnitude and phase response plots were developed and it was determined that the sensor under study can be modeled as a first order system up to 600 Hz. The -3 dB bandwidth was found to be 90 Hz and the sensor's time constant was determined to be 0.0018 seconds. A dynamic model of the sensor is constructed and compared against performance data. The sensor was found to have non-linear spring properties, allowing for two damping coefficients, one for each spring constant range, to be calculated. The damping coefficient was calculated to be 619 lb-s/in for loadings under 600 lbs and 1928 lb-s/in for loadings greater than 600 lbs. The sensor's time response was also found to be more similar in shape to the input loading waveform when it was compared to piezoelectric load transducers.

MSEC2011-50065

ENHANCEMENT OF SURFACE QUALITY AND STUDY ON MATERIAL REMOVAL MECHANISM IN MICRO ULTRASONIC MACHINING

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Swee Hock Yeo — School of Mech and Aerospace Eng

Surface integrity, mechanical deformation, and thermal deformation are among the crucial error generation factors in tool-based micromachining the influence of which should be minimized. As a micromachining process, micro ultrasonic machining (micro-USM) must satisfy the above considerations. In micro-USM, material is removed by fine and free abrasive particles inside a fluid; hence, there is no direct contact between micro-tool and the workpiece. Furthermore, no thermal damage is induced into the machined surface. Therefore, this process can satisfy the requirements of minimum mechanical and thermal deformation as a tool-based micromachining process. However, usually a rather course surface with subsurface microcracks is generated by USM processes. As such, study on surface characteristics and improvement of surface quality in micro-USM is considered necessary in order to introduce this process as a mature micromachining process. In this paper, the effect of various process parameters on surface quality in micro-USM is studied. The parameters include static load, vibration amplitude, abrasive particle size, and slurry concentration. Machining experiments were conducted using a self-developed micro-USM system with the method of workpiece vibration and using a precision static load measurement system with high sampling rate. An average surface roughness as small as 24 nm was achieved through the investigations on machined surface quality which has not been reported in micro-USM process using the workpiece vibration method. Moreover, the effect of process parameters on dominant removal mechanisms is investigated.

MSEC2011-50067

SOL-GEL SYNTHESIS AND MAGNETIC, OPTICAL AND IMPEDANCE BEHAVIOUR OF STRONTIUM FERRITE POWDER

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An attempt has been made to synthesize SrFeO3-? powder by sol-gel process involving oxalate formation, its digestion for 4h, drying at 150oC for 24h, and decomposition at 800oC for 10h. The resulting powder is shown to a) exhibit a single phase with a perovskite-type cubic structure and lattice parameter a = 3.862±0.002Å, b) contain irregular shape particles, and c) display optical absorption peaks corresponding to charge transfer from oxygen to iron (3.73 and 3.41eV), t2g to eg transition of Fe3+ (1.57eV), and crystal field (3d-3d) charge transfer of Fe3+ (1.25eV). Impedance over a wide frequency range of 20Hz-2MHz at 118-318K has contributions from two parallel 'RC' circuits belonging to bulk and grain boundaries with the later displaying significant space charge polarization. The relaxation time of polarization follows an Arrhenius behaviour (? =?o exp[Ea/kBT]) with ?o as ~10-8s and activation energy Ea as ~50meV. Further, the sample having magnetic character with transition temperature as 853K, coercivity (Hc) = 3748Oe and magnetization 0.09 ?B per iron atom (at 17kOe). The zero field cooled and field cooled magnetization versus temperature data in conjunction with constricted hysteresis loops near the origin suggest core-shell morphology for the particles, core being antiferromagnetic with net uncompensated moment and shell conforming to disordered disposition of spins.

MSEC2011-50068

DEVELOPMENT OF A MULTI-AXIS WEDM PROCESS

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A multi-axis WEDM technology is currently developed with an industrial consortium. To achieve this advanced application technology a CAM software and a machine prototype with an integrated two-axis round table was developed and first tests conducted. The assembly of the additional swing and rotational axis and the simultaneous steering with the machine axes enables the manufacturing of complex parts. But only in combination with the CAM software transforming complex shapes into NC programs for 6- and 7-axis manufacturing, the machining of complex geometries is feasible. At present, the technology is adapted to the manufacturing of medical parts from titanium alloys and CoCr alloys. First results of the machining of an involute gear will be presented.

MSEC2011-50069

ENERGY CONSUMPTION REDUCTION FOR SUSTAINABLE MANUFACTURING SYSTEMS CONSIDERING MACHINES WITH MULTIPLE-POWER STATES

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Due to rapid consumption of world's fossil fuel resources and impracticality of large-scale application and production of renewable energy, the significance of energy efficiency improvement of current available energy modes has been widely realized by both industry and academia. A great deal of research has been implemented to identify, model, estimate, and optimize energy efficiency of single-machine manufacturing system [1-5], but very little work has been done towards achieving the optimal energy efficiency for a typical manufacturing system with multiple machines. In this paper, we analyze the opportunity of energy saving on the system level and propose a new approach to improve energy efficiency for sustainable production systems considering the fact that more and more modern machines have multiple power states. Numerical case based on simulation model of an automotive assembly line is used to illustrate the effectiveness of the proposed approach.

MSEC2011-50070

MILLIMETER-SCALE THIN PART SELF-ASSEMBLY IN THE FLUIDIC PHASE AND ITS SENSITIVITY TO PART SCALING

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Fluidic self-assembly (FSA) is a promising alternative to conventional serial pick-and-place assembly. The pick-and-place mechanical assembly enables high yield. For small size parts, however, it becomes slow and difficult to control due to undesirable strong stiction forces. Therefore, for assembly with large numbers of small and thin parts, conventional pick-and-place becomes costly and FSA is preferred. Many research groups have studied FSA systems, which employ various driving forces such as gravity, surface tension, electrostatic or electromagnetic force and often require adhesives, liquid solder, shape matching structures or two different liquids. They, however, have lower yield compared to pick-and-place assembly due to their stochastic nature. In this paper, we introduce a novel FSA at air-water interface and demonstrate a high-yield FSA using specific surface Faraday waves to perform selective assembly from excess part supply to programmed sites. Surface functionalized silicon parts (1x1mm2, 100um thickness) assemble in preprogrammed hydrophilic locations on a substrate with self-alignment. To optimize the FSA system, we use two design factors and two agitation factors and select two-level full factorial design in fully randomized order to minimize unexpected bias. We optimized the process and design factors systematically using DOE (Design of Experiment) that leads to high yield (100%). This paper also presents an experimental and theoretical study of the FSA system. An analysis of the method is presented with an emphasis on the combined effect of substrate tilting angle and part size. For 1x1, 3x3 and 5x5mm2 parts with 100um thickness, the maximum substrate tilting angles are experimentally determined and the surface tension induced torques are calculated based on the developed model. For single angle assembly, the substrate tilting angle should be larger than a specific value to form line contact. From the assembly results and the developed model, the critical torque per unit area for assembly is calculated to be 0.066uN/m. The analysis indicates that there is a limit on the lateral dimension of the assemblable part size when we use a constant substrate tilting angle. Based on our analysis, we also propose a novel method that is capable of assembling parts of higher lateral dimensions using parametric changes in substrate tilting angle. Guided by our analysis we also alter the assembly mechanism to include parametric changes in substrate titling angle as a function of assembly time.

MSEC2011-50071

ON SOME ECO-INDICATORS OF CUTTING TOOLS

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This study deals with some eco-indicators of cutting tools. Eco-indicators of cutting tools are classified into three categories, namely, material-, process-, and geometry-related eco-indicators. Material-related eco-indicators consist of density, price, embodied energy, CO2 footprint, NOX, SOX, water usage, and recycle fraction of tool materials. Process-related eco-indicators consist of material removal rate, cutting velocity, feed rate, spindle speed, and coating. Geometry-related eco-indictors consist of special geometric features of cutting tool that make the tool's performance robust in terms of process-related eco-indicators. The general definitions and representations of these indicators are described. Giving examples of cutting tools made of carbide and HSS, it is shown that further research is needed to develop an ideal cutting tool that is equally preferable in terms of material-, process-, and geometry-related eco-indicators.

MSEC2011-50075

DETERMINATION OF BIAXIAL STRESS-STRAIN RELATIONSHIPS FOR ALUMINUM ALLOYS CONSIDERING THE ANISOTROPY

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Recently, offshore and ocean engineering have been dealing with novel materials that play a significant role in reducing the weight of structures used in the ship construction industry. 5XXX series of aluminum alloys are of the novel alloys are suitable for construction of ship hulls and the

topside structures of offshore platforms. Within different 5XXX aluminum alloys, AA5083 is of great importance which is extensively used in the ship construction industry. In the present study, formability of AA5083-H111 aluminum alloy is investigated in room temperature by using uni-axial tensile tests and hydraulic bulge tests. Tensile tests were performed to evaluate materials anisotropy in different directions with respect to rolling direction. Anisotropy coefficients were then used to correct flow stress curves obtained by balanced biaxial bulge tests. Moreover, flow stress curves obtained from both tests were separately introduced to an explicit commercial finite element code. Comparisons showed that numerical simulation done in this study stand in according with the experiments.

MSEC2011-50076

STUDY OF THE MECHANICS OF THE MICRO-GROOVE CUTTING PROCESS

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In an earlier paper, a high-speed micro-groove cutting process that makes use of a flexible single-point cutting tool was presented. In this paper, 3D finite element modeling of this cutting process is used to better understand process mechanics. The development of the model, including parameter estimation and validation, is described. Validation experiments show that on average the model predicts side burr height to within 2.8%, chip curl radius to within 4.1%, and chip thickness to within 25.4%. The model is used to examine chip formation, side burr formation, exit burr formation, and the potential for delamination of a workpiece consisting of a thin film on a substrate. Side burr formation is shown to primarily occur ahead of a tool and is caused by expansion of material compressed after starting to flow around a tool rather than becoming part of a chip. Exit burr formation is shown to occur when a thin membrane of material forms ahead of a tool and splits into two side segments and one bottom segment as the tool exits a workpiece. Lastly, examination of the stresses below a workpiece surface shows that film delamination can occur when the depth of a groove cut into a thin film is large relative to the film thickness.

MSEC2011-50080

SURVEY OF COURSES ON RENEWABLE ENERGY MANUFACTURING AT AMERICAN UNIVERSITIES

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Both U.S. and world economies have long depended on nonrenewable fossil energy sources (coal, oil, and natural gas). Supplies of fossil energy are expected to decline in the future and become more expensive. Meanwhile, their use contributes to the accumulation of greenhouse gas in the atmosphere. Therefore, an urgent need exists for renewable energy sources. In order to enhance the global competitiveness of the U.S. in renewable energy manufacturing, there is a dramatic need for a skilled workforce that has been trained in this field. A survey of more than 100 U.S. universities has been conducted for renewable energy related courses. It is found that manufacturing aspects of all forms of renewable energy are not emphasized, and there are no sophomore-level courses that cover manufacturing of all forms of renewable energy.

MMSEC2011-50089

METHODOLOGY FOR SOLVING THE ASSEMBLY SYSTEM RECONFIGURATION PLANNING PROBLEM

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The need to cost effectively introduce new generations of product families within ever decreasing time frames have led manufacturers to seek product development strategies with a multigenerational outlook. Co-evolution of product families and assembly systems is a methodology that leads to the simultaneous design of several generations of product families and reconfigurable assembly systems that optimize life cycle costs. Two strategies that are necessary for the implementation of the co-evolution of product families and assembly systems methodology are: (1) The concurrent design of product families and assembly systems and (2) Assembly system reconfiguration planning (ASRP). ASRP is used for the determination of the assembly system reconfiguration plans that minimize the cost of producing several generations of product families. More specifically, the objective of ASRP is to minimize the net present cost of producing successive generations of products. This paper introduces a method for finding optimum solutions to the ASRP problem. The solution methodology involves the generation of a staged network of assembly system plans for all the generations that the product family is expected to be produced. Each stage in the network represents a generation that the product family is produced, while each state within a

stage represents a potential assembly system configuration. A novel algorithm for generating the states (i.e. assembly system configurations) within each generation is also introduced. A dynamic program is used to find the cost minimizing path through the network. An example is used to demonstrate the implementation of the ASRP methodology.

MSEC2011-50094

DETERMINATION OF MINIMUM BLANKHOLDING PRESSURE FOR PRODUCING WRINKLE FREE PRODUCTS IN MULTISTAGE DEEP DRAWING

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Wrinkling in the flange region has been observed during redrawing operation by few researchers. In the present work an analysis methodology, based on a combination of upper bound and energy approaches, is proposed for the prediction of number of wrinkles and minimum blankholding pressure necessary to avoid wrinkling in redrawing operation. Thickness variation predicted by the upper bound formulation is used as input for the wrinkling analysis by assuming a suitable waveform based on geometrical and process conditions. The flange is constrained at both the ends, i.e. by the blank holder profile radius and at the die entry point (where the sheet enters into the die cavity). The waveform for present analysis is assumed such that it has zero displacement at both the ends (since it is constrained) and the maximum amplitude of the wave at some point in between those ends. The wrinkling predicted by the present methodology seems to be reasonably accurate considering the geometrical and process constraints of the redraw.

MSEC2011-50098

ENERGY MANAGEMENT IN MANUFACTURING SYSTEMS

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While in industry and academia, improving production efficiency, flexibility and responsiveness has been a mainstream trend, people ignore the energy consumption in their equation. Energy consumption plays a more and more important role in manufacturing environment. This is mainly driven by the escalating deterioration of the environment, overflowing waste sites and enforcement by governmental regulations. When the energy system becomes complicated and coupled with ongoing production, it is very difficult to hunt the “hidden treasure” which affects the overall benefit of a manufacturing system. This paper provides a systematic method for energy management in a production system. We start from dynamic production transient analysis and provide quantitative analysis for energy saving opportunity in a system. Furthermore, energy saving is integrated into production system which includes downtime and throughput to provide integrated energy management framework for a production system. A case study is conducted to demonstrate its potential on energy savings in a multi-stage manufacturing system.

MSEC2011-50099

STUDY OF MICROPHONE ARRAY FOR NOISE REDUCTION IN SOUND BASED MICRO-TOOL WEAR MONITORING

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An experienced technician can usually identify the cutting condition by hearing the sound generated during the cutting and the sound signal can be expected to detect the features closely related to the tool condition. However, the background noise always contaminates the signal obtained by microphone system during cutting and reduces the chance of applying the sound based micro tool condition monitoring system in industry. In order to reduce the noise effect and improve the system performance, a microphone array integrated with Wiener filter was designed and implemented in this study to enhance the noise reduction capability for monitoring system. The experimental results show that the microphone array integrated with Wiener filter provides a better solution than single microphone integrated with Wiener filter or the microphone array without the post filter design in reducing the broadband background noise.

MSEC2011-50100

DESIGN OF ROTARY ULTRASONIC VIBRATOR FOR FLAT GRINDING AND EFFECTS OF TIGHT NUT ON VIBRATION

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Parameters such as tight nut and fillet radius of ultrasonic amplitude transformer horn are usually ignored when designing the rotary ultrasonic machining (RUM) system. However, these neglected parameters will bring seriously impact. Through the finite element analysis (FEM) of the entire RUM system, the effects on position of nodal plane, amplitude and resonant frequency of RUM system caused by the varieties of tight nut are illustrated. The nodal plane is pushed down as the axial dimension of tight nut increasing, however, when it drops to a certain extent, the nodal plane moves up instead. The length increase of tight nut will also decrease the resonant frequency and amplitude sharply. This paper discusses the effects brought by variation of the transitional fillet in ultrasonic amplitude transformer horn. Analytical results showed that the transitional fillet has great influences on position of nodal plane, amplitude and resonant frequency when modal analyzing unconstrained ultrasonic amplitude transformer horn separately. However, modal analysis of the entire RUM system showed that the transitional fillet radius's variation will not lead to a significant change on above three characteristics of RUM system. Furthermore, this paper provided a theoretical formula of RUM system, which made the dimension calculation of each component much more easer. And according to these formulas, an ultrasonic vibrator for flat grinding was designed and modal analyzed, and the satisfactory analytical results confirmed that this set of formula had very strong practicability.

MSEC2011-50102

HOLISTIC APPROACH FOR A SIMULATION-BASED TWIST DRILL GEOMETRY OPTIMIZATION

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The optimization of solid carbide twist drills is a very difficult task because of the large number of conflicting design parameters. Former approaches only include limited design aspects. This article introduces a new holistic simulation-based method for multi-objective twist drill geometry optimization. By using a complete geometry model, numerical simulation models calculate all major properties of the drill. In detail structural stiffness and stability, torque and thrust force, coolant flow resistance, chip evacuation capability and chip flute manufacturability are calculated. Several multi-objective algorithms and evaluation methods are implemented. Hence an entire geometry optimization considering manufacturability and performance is possible.

MSEC2011-50105

RAPID-TOOLING OF BUNCHED ELECTRODE FOR EDM

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A bunched electrode for Electrical Discharge Machining (EDM) is formed by bunching numerous cell electrodes as a whole and allows better flushing to facilitate removal of more heat and debris produced during machining. This paper proposes a rapid tooling method for preparing bunched electrodes with desired end-face. A specially designed apparatus, which sits on an XY worktable of a CNC machine tool, is employed to hold the pre-bunched with flat end-face. By using a protrusion pin which is fixed on Z-axis, the heights of each cell electrode are protruded one after another according to a CNC program, which is generated by CAD/CAM software. The end-face of the bunched electrode approximates the ideal end-face of the designed 3D model by adjusting the Z positions of each cell electrode. By using this method the cost and time for electrode preparation are dramatically reduced as compared to that made by traditional cutting method. An investigation on 3D cavity machining of bunched electrode was conducted. The result gives a solid verification of the feasibility of using bunched electrode into roughing process of EDM.

MSEC2011-50107

ALTERNATIVE SHOP-FLOOR RE-LAYOUT DESIGN DUE TO DYNAMIC OPERATION CHANGES

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Highly turbulent environment of dynamic job-shop operations affects the shop floor layout problem as well as other areas. Due to frequently altering needs of layout, essential requirements such as adaptability and proactive responsiveness to the dynamic changes need to be considered in addition to the materials handling and machine relocation costs when a shop floor is reconfigured from one layout to the next. Targeting the autonomy and adaptability of dynamic and distributed job-shop assembly operations, this paper proposes to incorporate function block methodology to deal with the layout issues of the frequently changing environment.

MSEC2011-50109

PREPARATION OF POROUS METAL NICKEL BY JET ELECTRODEPOSITS

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The theory and related technology of porous metal nickel by using jet electro deposition (JED) are reviewed , and preparation of different porosities of the porous metal nickel samples was made by the developed plant. The surface morphology, microstructure ,grain size of the micro-cell structure of deposition were studied and analyzed by SEM, and the mechanical properties of the sample ,such as surface micro hardness and compressive property were also studied ,. The results are as follows:the process of porous nickel preparation with jet electrodeposition which mentioned in paper is capable of preparing porous metal with dendritic crystal structure as the subject porous structure. Ejection electrodeposition has great advantages in machining efficiency and cost compared with porous metal preparation process of traditional electrodeposition. The porous nickel metal sample prepared in respects of pore distribution and porosity are affected by electrodeposited porous dendritic crystal layers. The formula Bath A which has a relatively low concentration of nickel ions can make the preparation of uniform density porous structure of the dendrite more favorable. Current density is the key indicators of forming ideal branched crystal ,and which more than 60A/dm2 can make processing state access to good working state. With the increase in current density ,the dendrite formation of porous structure becomes more dense.The prepared sample's porosity is 48.7% by using jet scanning electrodeposition in current density of 80A/dm2.The surface micro hardness of the sample reaches HV 315. The compressive yield stress of porous Nickel is 11.35 MPa, which has a large number of plastic deformations of the absorption capacity. From original data of sample energy absorption rate and fitting curve, it is known that there comes great plastic deformation, which gives the sample better fine absorption ability and relatively greater energy absorption rate at a relatively low flow stress.

MSEC2011-50111

INVESTIGATION OF CORROSION PROCESSING FOR TI-6AL-4V IN HYDROFLUORIC-NITRIC ACID SYSTEM

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Corrosion processing is an effective way to solve difficult machining of titanium alloy. It can be applied for reducing weight, machining complex shape and fine structure. In this paper, the effects of the bath constituents and operation conditions on corrosion processing rate and surface quality for Ti-6Al-4V were investigated. Corrosion processing rate depends upon hydrofluoric acid concentration, the volume ratio of nitric acid to hydrofluoric acid, temperature. Nitric acid can promote the surface passivation and reduce surface roughness. The surfactant plays a dual role of surface finish improvement and acid fog suppression. During the period of processing, oxide film on the surface is dissolved initially, and there is the faster processing rate. Surface passivation occurs with the extension of time, decreasing processing rate. Finally corrosion processing rate tends to be stable when the growth of passive film and dissolution of the substrate achieve dynamic balance.

MSEC2011-50113

EXPERIMENTAL STUDY OF MICRO ABRASIVE TOOL MAKING BY ELECTROPLATING

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Accurate and precise micro abrasive tools are essential for the micromachining of highly complex features in a wide variety of engineering materials including metals and ceramics. With existing abrasive coating techniques such as sol-gel method, chemical vapor deposition, physical vapor deposition, and composite electroforming, it is difficult to control the aggregation tendency of abrasive grains. This work evaluates

the feasibility of implementing electroplating principles to fabricate a micro abrasive tool by co-deposition of nickel and micro diamond powder over a tungsten substrate. In this work, a tungsten rod of diameter 500 ?m was deposited with 2-4 ?m diamond abrasive grains using nickel as a binder. Scanning Electron Microscope (SEM) and energy-dispersive X-ray spectroscopy (EDX) studies reveal that more uniform coating is obtained with multilayer coating of micro diamond abrasive by electroplating. The coating process mechanism is discussed.

MSEC2011-50114

A COMPARATIVE STUDY OF CARBIDE TOOLS IN DRILLING OF CFRP AND CFRP-TI STACKS

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A comparative study was conducted to investigate how the titanium (Ti) plate on the carbon fiber reinforced plastic-titanium (CFRP-Ti) stacks affects tool wear and hole quality in drilling using micrograin tungsten carbide (WC) tools. The experiments were designed to first drill CFRP only for 20 holes then CFRP-Ti stacks for the next 20 holes and repeat. The drilling was done with tungsten carbide (WC) twist drills for two different speeds (high and low). The feed rate was kept the same for each test, but differs for each material drilled. A Scanning Electron Microscope (SEM), and a Confocal Laser Scanning Microscope (CLSM), was used for tool wear analysis. Hole size and profile, surface roughness, and Ti burrs were analyzed using a coordinate measuring system, profilometer, and an optical microscope with a digital measuring device. The experimental results indicate that the Ti drilling accelerated WC flank wear while CFRP drilling enhanced edge wear. Entry delamination, hole diameter errors, and surface roughness of the CFRP plate got worse during drilling of CFRP-Ti stacks, when compared with the results from CFRP only drilling. Damage to CFRP holes during CFRP-Ti stack drilling may be caused by Ti chips, Ti adhesion on the tool outer edge, and increased instability.

MSEC2011-50115

A PRELIMINARY STUDY ON MACHINABILITY OF POLYMETHYMETHACRYLATE(PMMA)/ MULTI-WALLED CARBON NANOTUBE(MWCNT) NANOCOMPOSITES IN FOCUSED ION BEAM MICROMACHINING

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This experimental study investigated the machinability of polymethylmethacrylate (PMMA)/multi-walled carbon nanotube (MWCNT) nanocomposites with 20wt% MWCNTs in focused ion beam (FIB) micromachining. PMMA/MWCNT nanocomposites were fabricated using a solution casting method, in which PMMA and MWCNTs were dispersed in a solvent by ultrasonication. Microscale rectangular pockets were created on the PMMA/MWCNT nanocomposites to study the material removal mechanism in FIB. Effects of FIB input current and the ion beam overlap parameter (overlap %) on the material removal rate and geometric accuracy were studied. It was observed that the material removal rate increases with increasing input current and decreasing overlap %. Soft lithography was used to translate the ion-milled pockets on PMMA/MWCNT nanocomposites into microscale posts on polydimethylsiloxane (PDMS) for the accurate measurement of the pocket geometries. Scanning electron microscope (SEM) was used to investigate the characteristics of the micromachined features, nanocomposite surfaces, and replicated PDMS patterns. Our results demonstrated an effective method to produce microscale patterns on MWCNT-based nanocomposites.

MSEC2011-50116

DRY MACHINING IN ROTARY ULTRASONIC MACHINING OF CARBON FIBER REINFORCED PLASTIC COMPOSITE: EFFECTS OF MACHINING VARIABLES

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Zhijian Pei — Kansas State Univeristy

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Dry machining (machining without direct contact between coolant fluid and cutting zone) is becoming increasingly more popular, due to the problems of coolant in machining. Carbon fiber reinforced plastic (CFRP) composite has a variety of applications, due to its superior properties. Drilling is an important machining process since it is involved in nearly all CFRP composite applications. Rotary ultrasonic machining (RUM) has been used to machine holes for brittle, ductile, and composite materials. However, all these experiments were conducted with helping of water or oil based coolant. This paper firstly study uses the cold air as coolant in rotary ultrasonic machining. This paper presents an experimental study of effects of machining variables (ultrasonic power, spindle speed, and feedrate) on outputs (cutting force, torque, surface roughness, and burning) in RUM of CFRP using vortex-tube generated cold air as coolant.

MSEC2011-50117

SIZE REDUCTION OF CELLULOSIC BIOMASS IN BIOFUEL MANUFACTURING: EFFECTS OF MILLING ORIENTATION ON SUGAR YIELD

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Cellulosic biofuels can reduce greenhouse gas emissions and the nation's dependence on foreign oil. In order to convert cellulosic biomass into biofuels, size reduction of biomass is a necessary step. Most related studies in the literature claimed that smaller particles produced higher sugar yields. However, some researchers reported that this claim was not always true. The literature does not have satisfactory explanations for the inconsistence. This paper presents an experimental study on size reduction of poplar wood using a metal cutting process (milling). The results provided one explanation for this inconsistence. It was found for the first time that milling orientation had a strong effect on poplar wood sugar yield. Although smaller poplar particles had a higher sugar yield when they were milled from the same orientation, this trend did not exist for particles milled from different orientations.

MSEC2011-50118

FINITE ELEMENT MODELING OF ORTHOGONAL CUTTING OF PYROLYTIC CARBON

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Engineered features on pyrolytic carbon (PyC) have been demonstrated as an approach to improve the flow hemodynamics of the cardiovascular implants. In addition, it also finds application in thermonuclear components. These micro/meso scale engineered features are required to be machined onto the PyC leaflet. However, being a layered anisotropic material and brittle in nature, its machining characteristics differ from plastically deformable isotropic materials. Consequently, this study is aimed at creating a finite element model to understand the mechanics of material removal in the plane of transverse isotropy (horizontally stacked laminae) of PyC. A layered model approach has been used to capture the interlaminar shearing and brittle fracture during machining. A cohesive element layer has been used between the chip layer and the machined surface layer. The chip layer and workpiece are connected through a cohesive layer. The model predicts cutting forces and the chip length for different cutting conditions. The orthogonal cutting model has been validated against experimental data for different cutting conditions for cutting and thrust forces. Parametric studies have also been performed to understand effect of machining parameters on machining responses. This model also predicts chip lengths which have also been compared with the actual chip morphology obtained from microgrooving experiments. The prediction errors for cutting force and chip length are within 20% and 33%, respectively.

MSEC2011-50119

STUDYING EFFECTS OF ARC DISCHARGE SURFACE TEXTURING ON STRESS DISTRIBUTION IN ADHESIVELY BONDED JOINTS BY USING FINITE ELEMENT MODELING

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This study investigates the potentiality of using atmospheric-pressure Direct Current (DC) plasma arc discharge as a surface treatment method of aluminum alloys in adhesively bonded joints in order to enhance adhesion. The surface morphology exposed to the arc for the current of 40 A (low intensity) and the plasma torch scanning speeds between 20 and 120 mm/s, exhibits a micro-scale surface roughness appropriate for adhesive bonding. The arc textured surfaces are characterized by using an optical profilometer. Additionally, the effect of modified surface on the stress distribution throughout the single-lap adhesively bonded joint in tension is explored by 2D FEM. The geometrical model for FE analysis of adhesively bonded structure is generated by including the surface texture coordinates obtained from the optical profilometer.

MSEC2011-50120

NUMERICAL AND EXPERIMENTAL STUDY ON WARM TENSION-ROTATION BENDING OF EXTRUDED AZ31 PROFILE

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Ming Cheng — Institute of Metal Research, Chinese Academy of Sciences

Magnesium alloy profiles have attracted more and more attention in automobile and aerospace industries. The rotary draw bending process is suitable to form profiles. A bending test machine is developed to conduct AZ31 profile bending experiment. A 3D elastic-plastic thermo-mechanical coupled finite element model is established and validated by experiment. The effects of process parameters on the geometric dimension of the profile were analyzed by using experimental and numerical methods. The results indicate that the pre-tension amount is the main parameter which influences the geometric dimension of the bent profile, then the forming temperature, following the bending angle. The dimensional variation of the middle-rib is relatively little, and the dimensional variations of the inside and the outside of the bent profile are large.

MSEC2011-50122

COMPARATIVE ANALYSIS OF THE PROCESS MECHANICS IN MICRO-ELECTRICAL DISCHARGE MACHINING (EDM) AND REVERSE MICRO-EDM

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The objective of this paper is to study the time-evolution of the process mechanics for micro-electrical discharge machining (MEDM) and reverse-micro-electrical discharge machining (R-MEDM), as a function of key system parameters, viz., voltage, capacitance, and threshold of the spark circuit. Full factorial experiments have been performed to quantify the aforementioned system parameters on the MEDM and R-MEDM processes. The process monitoring voltage and current signals, material erosion rate and the surface roughness values are the machining responses of interest. The voltage and current (V-I) signals reveal information about the material erosion rate and the extent of debris-interference associated with the corresponding process. Analysis of the V-I signals shows that R-MEDM is more stable than MEDM and can therefore be operated at aggressive conditions of capacitance and voltage. R-MEDM also results in higher material erosion rates but the resulting surface has a higher surface roughness value than that generated by MEDM. A debris deposition mechanism is proposed for R-MEDM that suggests debris entrapment and subsequent welding to the machined feature to be the reason for the increased surface roughness.

MSEC2011-50126

NEWEST DEVELOPMENTS ON THE MANUFACTURE OF HELICAL PROFILES BY HOT EXTRUSION

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The paper presents a new innovative direct extrusion process, Helical Profile Extrusion (HPE), which increases the flexibility of aluminum profile manufacturing processes. The application fields of such profiles can be seen in screw rotors for compressors and pumps. The investigations concentrate on experimental and numerical analyses by 3D-FEM simulations to analyze the influence of friction on the material flow in the extrusion die in order to find out the optimal parameters with reference to the twisting angle and contour accuracy. By mean of FEM the profile shape could be optimized by modifying the die design. The numerical results were validated by experiments. For these investigations a common aluminum alloy EN-AW6060, was used. The accuracy of the profile contour could be improved significantly. However the increasing of the twist angle is limited due to geometrical aspects.

MSEC2011-50128

INTELLIGENT METAL-FORMING SIMULATION

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In this paper, the basic concepts and requirements of intelligent metal-forming simulation are presented. A general-purpose metal-forming simulator AFDEX developed to meet the requirements is then discussed, with emphasis on its intelligence. The simulator is based on an adaptive and optimal mesh-generation technique and includes many intelligent, application-oriented special functions, which not only enhance solution accuracy but also minimize user intervention during a metal-forming simulation. Characteristics and typical applications of the simulator are described.

MSEC2011-50129

MICRO FEATURE ENHANCED SINTER BONDING OF METAL INJECTION MOLDED (MIM) PARTS TO SOLID SUBSTRATE

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In MIM, fine metal powders are mixed with a binder and injected into molds, similar to plastic injection molding. After molding, the binder is removed from the part, and the compact is sintered to almost full density. The obstacle to sinter bonding a MIM part to a conventional (solid) substrate lies in the sinter shrinkage of the MIM part, which can be up to 20%, meaning that the MIM part shrinks during sintering, while the conventional substrate maintains its dimensions. This behavior would typically inhibit bonding and/or cause cracking and deformation of the MIM part. A structure of micro features molded onto the surface of the MIM part allows for shrinkage while bonding to the substrate. The micro features tolerate certain plastic deformation to permit the shrinkage without causing cracks after the initial bonds are established. In a first series of tests, bond strengths of up to 80% of that of resistance welds have been achieved. This paper describes how the authors developed their proposed method of sinter bonding and how they accomplished effective sinter bonds between MIM parts and solid substrates.

MSEC2011-50130

MODELING OF SEMI-SOLID POWDER PROCESSING FOR A CLOSED DIE COMPACTION

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Semi-solid powder processing (SPP) is a promising technique in the fabrication of composite materials. Former work has experimentally shown that SPP was able to synthesize composite materials with reduced load and high efficiency. However, limited work was found in the modeling of the SPP. In this work, SPP was modeled with Shima-Oyane's model and compared with experimental data in a closed die compaction setup. The evolution and distribution of the density and stress were analyzed. The model prediction agreed with the experimentally measured values. As the compaction pressure increased, the density gradient in the axial compaction direction decreased, while the stress gradient increased.

MSEC2011-50131

DEVELOPMENT OF A NEW VIBRATOR FOR ELLIPTICAL VIBRATION TEXTURING

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Inspired by the idea of vibro-mechanical texturing, which adds a tertiary motion to the tool tip in the conventional turning process, and the elliptical vibration cutting process, which adds vibrations both in the cutting direction and feed direction, this paper proposes a new design for an ultrasonic vibrator for the elliptical vibration texturing process. The elliptical locus lies in the plane that is defined by the cutting and the radial directions. The device could be easily adapted for elliptical cutting applications by changing the orientation of the tool tip. The vibrator works in the resonant mode, with in-phase and anti-phase vibration modes at a nearly identical natural frequency. Simulations and experiments have been carried out to study and verify different vibration modes of the system. Different design parameters have been analyzed to control the elliptical trajectory of the tool tip. A set of preliminary experimental result of elliptical vibration texturing is also provided.

oxidation process. Thirdly, rapid cooling of laser remelting results into a grain refinement and a preferred oxidation of Al at the initial stage, leading to a reduction of oxidation rate.

MSEC2011-50132

DEVELOPMENT OF A CONDITION BASED MAINTENANCE PROGRAM FOR A CNC MACHINE: PART 1 – SIGNAL ACQUISITION, PROCESSING, AND NETWORK COMMUNICATION

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Laine Mears, Ph.D., P.E. — Clemson University

Condition based maintenance (CBM) of machine tools is an important maintenance strategy to invoke for a manufacturing company to run as lean as possible. CBM does this by indicating, in advance, the failure of the machine tool components or system, thus reducing the machine downtime. In this paper, the development of such a system is sought. A background review of the need and structure of such a system has been provided as well as the design considerations for the system are discussed. Having those considerations as the target requirements for a CBM system, discussion of a demonstrative system is presented, being implemented on an OKUMA LB 3000EX CNC lathe. Leveraging the Open Architecture Control (OAC) technology built into OKUMA CNC systems, the proposed system shall enhance machine monitoring by integrating the internal and external sensors aboard the machine tool. This work lays the foundation for the framework of a proposed CBM system. Coolant temperatures and spindle vibration signals are acquired and processed using a high speed data acquisition system. Towards the end of the paper, descriptions of how to best use this data and integrate it with the machine tool CNC system have been provided.

MSEC2011-50133

ALGORITHMS AND DATA STRUCTURES FOR FAST SURFACE QUALITY ESTIMATION IN MILLING

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New approaches for fast surface quality estimation in Milling are presented. Dimensional Error, Surface Roughness, and the 3D topological plots of the surfaces are generated. Calculation speed is improved by methods of structural organization and numerical optimizations. Structural organization enables program division into initialization and program-run segments for faster runs. Numerical optimizations are used to help further reduce the run time by reducing variable volume and avoiding unnecessary estimations. Experimental evaluation of the methods for Dimensional Error, Surface roughness and profiles are performed using three different cutting tool types (flat-end, ball-end and insert mills) in order to reveal strengths and weaknesses of the proposed approaches. Comparison of experimental and estimated surface profiles show good correlation. Typical surface profile estimation for one tool rotation takes between 0.04-4.1 seconds depending on the cut and whether or not the tool deflection is included in the algorithm. Surface quality estimation is done quickly enough to be promising for use in feedrate scheduling. Further improvement in the tool deflection model is expected to increase accuracy and further reduce the computational time.

MSEC2011-50135

EXPERIMENTAL STUDY OF HIGH-FREQUENCY VIBRATION ASSISTED MICRO/MESO-SCALE FORMING OF METALLIC MATERIALS

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Qingze Zou — Rutgers University

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Zichen Chen — Zhejiang University

Micro/meso-scale forming is a promising technology for mass production of miniature metallic parts. However, fabrication of micro/meso-scale features leads to challenges due to the friction increase at the interface and tool wear from highly localized stress. In this study, the use of high-frequency vibration for potential application in the technology of micro/meso-scale forming has been investigated. A versatile experimental setup based on a magnetostrictive (Terfenol-D) actuator was built. Vibration assisted micro/meso-scale upsetting, pin extrusion and cup extrusion were conducted to understand the effects of workpiece size, excitation frequency and the contact condition. Results showed a change in load reduction behavior that was dependent on the excitation frequency and contact condition. The load reduction can be explained by a combination of stress superposition and friction reduction. It was found that a higher excitation frequency and a less complicated die-specimen interface were more likely to result in a friction reduction by high-frequency vibration.

MSEC2011-50136

COST ESTIMATES OF CELLULOSIC ETHANOL MANUFACTURING: A LITERATURE REVIEW

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Cellulosic ethanol is one type of renewable energy, and can be used to replace petroleum based transportation fuels. The technologies of converting cellulosic biomass into ethanol are relatively mature. However, the manufacturing costs of cellulosic ethanol are too high to be competitive. Economic analyses of cellulosic ethanol manufacturing have appeared regularly to estimate manufacturing costs of cellulosic ethanol. But the estimated manufacturing costs of cellulosic ethanol have a wide range due to differences in used assumptions. It is very difficult to judge which one is most reliable among the markedly different cost estimates in the literature. This paper reviews the literature on cost estimates in manufacturing of cellulosic ethanol. Cost estimates of each manufacturing process are summarized. Cost components and their data sources are discussed. This review provides a foundation to develop a comprehensive cost model for cellulosic ethanol manufacturing.

MSEC2011-50139

FABRICATION OF CONFORMAL ULTRASOUND TRANSDUCER ARRAYS AND HORNS BASED ON MULTI-AXIS CNC ACCUMULATION

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Ultrasonic imaging is an important medical imaging technique. It uses ultrasound over 20K Hz to detect and visualize muscles, tendons, and many internal organs. Previous studies have shown that an improved acoustic performance can be achieved by conformal ultrasound transducer arrays and horns that can wrap conformably around curved surfaces. To address challenges in fabricating such curved ultrasound transducer arrays and horns, we investigate the possibility of using a newly developed additive manufacturing (AM) process named CNC accumulation. In such an AM process, an accumulation tool can have multi-axis motion, which is beneficial for building conformal ultrasound transducer arrays and horns on a curved surface. To address different resolution requirements, we illustrate the use of multiple accumulation tools that can have different curing sizes and power in the fabrication of a single component. The tool path planning methods for any given cylindrical and spherical surfaces have been discussed. Based on the developed prototype system, various test cases have been performed. The experimental results have illustrated the capability of the process and its potential use in the fabrication of conformal ultrasound transducer arrays and horns. The current limitations and future development have also been discussed.

MSEC2011-50140

STUDY ON NUMERICAL CONTROL ELECTROCHEMICAL MACHINING WITH INNER-SPRAYING SPHERICAL CATHODE

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Numerical control electrochemical machining (NC-ECM) is one of the most important developments in electrochemical machining. In order to put this technology into the precision machining of complex surface, the preliminary experimental study of NC-ECM with inner-spraying spherical cathode was

presented in this paper. To carry out the study, the 5-axis electrochemical equipment was developed, and a kind of inner-spraying spherical cathode was design according to the process of machining complex surface. First, the NC-ECM with inner-spraying spherical cathode was simply described. Then, the method for calculating the material removal depth in machining surface was given. Finally, the experiments of machining surface were carried out. In the experiments, the working voltage, the initial inter-electrode gap, the cathode feed rate were chosen as the technological parameters, and the material removal depth per stroke was chosen as the technological indicator. The experiments data showed that the calculated material removal depth per stroke is well consistent with the actual value of the machining process. It is indicated that the method for calculating the material removal depth meets the accuracy of the engineering calculations and can be used as the reference for choosing the technological parameters in NC-ECM with spherical cathode.

MSEC2011-50142

EFFECTS OF PRE-STRAIN AND ANNEALING ON POST-ANNEAL MECHANICAL PROPERTIES AND FORMING LIMITS OF AA5182-O

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The effects of different pre-strain levels, paths and subsequent annealing on the post-anneal mechanical properties of AA5182-O were investigated by tensile testing, R-value testing and the development of strain-based forming limit diagrams (FLDs). Aluminum panels were pre-strained in uniaxial, plane strain and equibiaxial tension to several equivalent strain levels, annealed at 350°C for short (10 seconds) and long (20 minutes) durations, and then tested for post-anneal mechanical properties, including tensile properties, anisotropy and forming limits. Digital image correlation was used in the FLD development. The important factors affecting the post-anneal properties were identified via analysis of variance (ANOVA). The expanded forming limit curve demonstrates the advantage of annealing in extending the formability of strained materials.

MSEC2011-50143

EFFECT OF MACHINING PARAMETERS ON SURFACE ROUGHNESS IN VIBRATION-ASSISTED GRINDING

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Dry machining is considered as a green manufacturing process because the use of cutting fluids has concerns about environmental contamination and health hazards. However, in grinding, the use of cutting fluids is a common strategy to improve the cutting performance and the product surface finish due to the transportation of heat away from the cutting zone. Vibration-assisted machining is a novel technology which is an efficient technique for high quality surface finish in dry cutting. The purpose of this paper is to investigate the feasibility of vibration-assisted grinding of SKD61 steels, where the amplitude about 1 micron with a frequency about 10 KHz is applied. This study compares the machined surface finish in vibration-assisted grinding to that in conventional machining based on experimental measurements. The effects of the grinding and vibrating conditions on the ground surface finish are studied. A near mirror surface (Ra = 0.05 micron) is achieved at the vibration frequency of 11.4 KHz in this paper. It is also found that the best surface finish in vibration-assisted grinding is affected both by the feed and the vibration frequencies. The experimental results show that proper combination of grinding and vibration parameters should be carefully chosen to prevent instability in grinding.

MSEC2011-50144

MULTI-OBJECTIVE OPTIMIZATION FOR THE MICRO-MILLING PROCESS WITH ADAPTIVE DATA MODELING

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Victor Zaloom — Lamar University

This paper presents a multi-objective optimization study for the micro-milling process with adaptive data modeling based on the process simulation. A micro-milling machining process model was developed and verified through our previous study. Based on the model, a set of simulation data was generated from a factorial design. The data was converted into a surrogate model with adaptive data modeling method.

The model has three input variables: axial depth of cut, feed rate and spindle speed. It has two conflictive objectives: minimization of surface location error (which affects surface accuracy) and minimization of total tooling cost. The surrogate model is used in a multi-objective optimization study to obtain the Pareto optimal sets of machining parameters. The visual display of the non-dominated solution frontier allows an engineer to select a preferred machining parameter in order to get a lowest cost solution given the requirement from tolerance and accuracy. The contribution of this study is to provide a streamlined methodology to identify the preferred best machining parameters for micro-milling.

MSEC2011-50145

MICROSTRUCTURE CHARACTERISTICS AND HIGH-TEMPERATURE OXIDATION BEHAVIOR OF PLASMA-SPRAYED AND LASER-REMELTED MCRALY COATINGS ON TIAL INTERMETALLICS

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In order to further improve the high-temperature oxidation resistance of TiAl intermetallic alloys, MCrAlY coatings were fabricated by plasma spraying and plasma spraying-laser remelting technologies. The microstructures of the as-sprayed and laser-remelted MCrAlY coatings were studied. In addation, the oxidation behaviors at 850 Degrees Celsius for three samples were investigated. One sample is the matrix of TiAl intermetallic alloys, the other one is precessed by plasma-spraying MCrAlYcoatings, and the third one is processed by plasma-spraying and laser-remelting MCrAlY coatings. It was revealed that the oxidation resistance of TiAl intermetallics is weak due to lack of protection of Al_2O_3 film formed on the surface. The plasma-sprayed MCrAlY coatings have better oxidation resistance than the TiAl intermetallics although the plasma-sprayed MCrAlY coatings with high density of porosity and a typical layered structure. It is demonstrated that the most of holes can be eliminated by laser remelting, leading to the the best oxidation resistance of the third sample with the laser-remelted coatings. The high oxidation resistance of the laser-remelted is mainly attributed to three aspects: firstly, an Al enriched zone on the coating surface is formed during laser remelting, which is transformed a protective Al_2O_3 film during oxidation process. Secondly, laser remelting eliminates most of the defects in plasma-sprayed coatings and enhances its density, thus decreases the channel of oxidation diffusion in high temperature

MSEC2011-50146

SIZING EXTREME ENVIRONMENTAL CONDITION INFLUENCES ON THE MULTIPHASE POLYMERIC COMPOSITES' CTE

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The coefficient of thermal expansion (CTE) of multiphase polymeric composite materials represents an important role in the process of engineered materials design, especially while approaching thermal management issues. Tailoring and designing material combinations in order to develop a composite structure to prove stability over a wide range of temperatures, from cryogenic to high values, to withstand extreme environmental conditions is the dream and the purpose of any engineering team involved in such study/ research area. The paper aims to approach and to present the variations of the CTE with extreme environmental conditions (e.g. cryogenic, desert and hygroscopic conditioning) for particular combinations of particle-fibers multiphase polymeric composite materials. Influencing factors will be underlined to accompany the experimental research.

MSEC2011-50148

FINITE ELEMENT ANALYSIS OF CENTRAL BURSTING DEFECTS OCCURRING IN COLD FORWARD EXTRUSION

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An improved approach to simulating the formation of central bursting defects is presented in this paper. The rigid-plastic finite element method and a modified McClintock damage model are employed. An improved node-splitting technique with degenerate element cleaning is proposed. The technique is applied to several cold forward extrusion processes to reveal the effects of reduction of area, die conical angle, and friction on the formation of central bursting defects. A comparison with experimental results and predictions found in the literature shows that the present analysis provides more realistic predictions of the shape of a central bursting defect (i.e., an obtuse V-shape, which is typical).

MSEC2011-50149

DIAMOND DISC PAD CONDITIONING IN CHEMICAL MECHANICAL PLANARIZATION (CMP): A MATHEMATICAL MODEL TO PREDICT PAD SURFACE SHAPE

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Chemical mechanical planarization (CMP) is widely used to planarize semiconductor wafers and smooth the wafer surface. In CMP, a diamond disc conditioner is used to condition (or dress) a polishing pad to restore the pad performance. In this paper, a surface element method is proposed to develop a mathematic model to predict the pad surface shape resulted from diamond disc conditioning. The developed model is then validated by published experimental data. Results show that the model is effective to simulate the diamond disc conditioning and predict the pad surface shape.

MSEC2011-50151

TUBE PRESS HARDENING FOR LIGHT WEIGHT DESIGN

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Press hardening is an innovative technology being applied to meet the growing demands for both lightweight and crash performance qualities. To further increase the lightweight potential, closed profiles are being used. As a result, a method has been developed at the Fraunhofer Institute for Machine Tools and Forming Technology IWU which allows the integration of press hardening of tubes and closed profiles into the media-based forming process. Using this press hardening technology, the original material strength of 500 MPa can be increased to between 1200 and 1900 MPa, depending on the chosen material. The engineering of tube press hardening is more complex than other forming processes, specifically the time dependence in combination with heat management makes it difficult. Therefore the use of FEA is indispensible when dealing with aspects such as heat treatment, the forming process itself, the cooling caused by the gaseous forming media and the general heat management of the tooling. To control and improve the process and therefore the part quality and process reliability, all these factors and their dependencies has to be taken into account. In addition to 22MnB5 other manganese-boron alloyed steels and different heating strategies have been tested. Based on these experiments the process capability was successfully proven and technological limits were obtained. Actual investigations are focused on realizing tailored properties thus creating areas with varied strength and ductility in a single part.

MSEC2011-50152

STANDARDIZATION OF CMM FITTING ALGORITHMS AND DEVELOPMENT OF INSPECTION MAPS FOR USE IN STATISTICAL PROCESS CONTROL

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The choice of fitting algorithm in CMM metrology has often been based on mathematical convenience rather than the fundamental GD&T principles dictated by the ASME Y14.5 standard. Algorithms based on the least squares technique are mostly used for GD&T inspection and this wrong choice of fitting algorithm results in errors that are often overlooked and leads to deficiency in the inspection process. The efforts by organizations such as NIST and NPL and many other researchers to evaluate commercial CMM software were concerned with the mathematical correctness of the algorithms and developing efficient and intelligent methods to overcome the inherent difficulties associated with the mathematics of these algorithms. None of these works evaluate the ramifications of the choice of a particular fitting algorithm for a particular tolerance type. To illustrate the errors that can arise out of a wrong choice of fitting algorithm, a case study was done on a simple prismatic part with intentional variations and the algorithms that were employed in the software were reverse engineered. Based on the results of the experiments, a standardization of fitting algorithms is proposed in light of the definition provided in the standard and an interpretation of manual inspection methods. The standardized fitting algorithms developed for substitute feature fitting are then used to develop Inspection maps (i-Maps) for size, orientation and form tolerances that apply to planar feature types. A methodology for Statistical Process Control (SPC) using these i-Maps is developed by fitting the i-Maps for a batch of parts into the parent Tolerance Maps (T-Maps).Different methods of computing the i-Maps for a batch are explored such as the mean, standard deviations, computing the convex hull and doing a principal component analysis of the distribution of the individual parts. The control limits for the process and the SPC and process capability metrics are computed from inspection samples and the resulting i-Maps. Thus, a framework for statistical control of the manufacturing process is developed.

MSEC2011-50153

A NEW METHOD FOR DETERMINATION OF THE PRE-FORM SHAPES AND THEIR CORESSPONDING PRESSURES IN TUBE-HYFROFORMING PROCESS OF SUS 304 IN A SQUARE DIE

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The pre-form design in hydroforming process plays a key role in improving product quality, such as defect-free property and proper final product. This approach, however, leads not only to the increase of significant tool cost but also to the extended down-time of the production equipment. It is thus necessary to reduce time and man power through an effective method of pre-form design. In this paper, the equi-potential lines designed in the electric field are introduced to find an appropriate pre-form shape. The equi-potential lines generated between two conductors of different voltages show similar trends for minimum work paths between the undeformed shape and the deformed shape. Based on this similarity, the equi-potential lines obtained by arrangement of the initial and final shapes are utilized for the design of the pre-form, and then the finite element simulations are done for finding the forming pressure of each pre-form shape.Finally,the pre-form and its corresponding forming pressure with other parameters are used for training an artificial neural network. This trained neural network can be used for estimating the proper pre-form shape and forming pressure for a SUS304 tube inside an square die or other configurations of die (Geometrical shape) and tube (Diameter and thickness).

MSEC2011-50154

MODEL BASED PREDICTION AND CONTROL OF MACHINING DEFLECTION ERROR IN TURNING SLENDER BARS

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Model based control of machining processes is aimed at improving the performance of CNC systems by using the knowledge of machining process to reduce cost, improving machining accuracy and improving overall productivity. In this paper, real time control of the machining process to maintain dimensional quality when turning a slender bar is addressed. The goal is to actively control the machining feed rate to maintain constant and predicable deflection through a combined force-stiffness model integrated to the process controller. A brief review is presented on manufacturing process models, process monitoring, and model based control strategies such as Model Predictive Control (MPC). The main objective of this paper is to outline a method for deploying such models to process control. To demonstrate this, model of the deflection of the workpiece under tool cutting forces is developed. Unknown process parameters have been calculated using series of FEA simulations and verified with basic experimental data. A simple but effective control strategy has been formulated and simulated. In the initial results, the diameter of bar is maintained within 1.04% error with controller as opposed to up to 4% error without controller. Ultimately, the goal is to deploy such control strategies in the industrial control system. With the continual development in physical understanding of machining processes and affordable computing technology (both software and hardware) coupled with Open Architecture Control (OAC) applied to CNC machine tools, such approaches are now computationally feasible. This will be an enabling factor to deploy model based control in an industrial environment. The last section discusses the proposed hardware architecture to achieve this. The paper concludes with a brief plan for the future work and a summary.

MSEC2011-50155

APPLICATION OF SANDWICH BASED DESIGNS ON MAIN STRUCTURAL PARTS OF MACHINE TOOLS

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New, higher and challenging properties of new high speed machines and high performance machines bring many questions connected to main machine tool structures' design and properties. Parameters like static stiffness, eigenfrequencies, modal damping and mass of parts may be identified as very important and all these properties need to be improved. The most important material properties in the field of machine tools are presented. A case study based on modification of a real horizontal machining centre is introduced. The modification consists in implementation of a sandwich design concept on a main structural part of machine tool. Sandwich concept that is widely known and used in aerospace and generally in transportation industry has practically not been used in machine tool design. Significant mass reduction was reached by manufacturing of hybrid column with aluminum foam cores while static stiffness has not been lowered.

MSEC2011-50156

FINITE ELEMENT PREDICTIONS FOR A COLD SHEET METAL FORMING PROCESS USING TETRAHEDRAL MINI-ELEMENTS

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In this paper, finite element prediction of a cold sheet metal forming process is investigated using solid elements. A three-dimensional rigid-plastic finite element method with conventional linear tetrahedral MINI-elements [1, 2] is employed. This technique has traditionally been used for bulk metal forming simulations. Both single- and double-layer finite element mesh systems are studied, with particular attention to their effect on the deformed shape of the workpiece and thickness variation. The procedure is applied to the well-known problem of the NUMISHEET93 international benchmark. The resulting predictions are compared with experimental observations found in the literature, and good agreement is noted.

MSEC2011-50157

THE USE OF HYBRID SYSTEM OF CLASSIFICATION FOR THE RETRIEVAL AND MODIFICATION OF MECHANICALLY ORIENTED PRODUCTS

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With people becoming more individualistic in their choices they make in personalizing the goods and services they use, as resulted in major development that has been recorded in the customization world. This individualism has resulted in the increase in demand of customized products in many industries especially in the footwear, kitchen and computer industries. However, little has been done when it comes to mechanically oriented products and little flexibility has been given to the consumers in the co-creation of customized products. The Hybrid system of classification is one way to satisfy the customers' need for the products that are mechanically oriented in nature thereby meeting their desire needs. This paper presents a framework in which an Hybrid system of classification is used to integrates Customers into the design process by defining, configuring, matching, or modifying an individual product that is mechanically oriented in nature and grouping the products into classes and sub-classes using a wide range of product parameters, products configuration which make it possible to add and/or change functionalities of a core product, a coding system for mechanical designs which is applicable to each product in the hierarchy, the use of a database for the products information. And the retrieval system to retrieve a similar product code from the database if the initial customer configuration data does not yield a feasible product code through the application of Analytic Hierarchy Process which helps in determining the combination weights from subjective judgments regarding the importance of the Product Attributes and finally modifying the existing similar product to suit the customers desire.

MSEC2011-50158

FINITE ELEMENT MODELING OF THE WORKPIECE THERMAL DISTORTION IN MQL DEEP-HOLE DRILLING

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This paper develops a three dimensional (3-D) finite element modeling (FEM) to predict the workpiece thermal distortion in minimum quantity lubrication (MQL) deep-hole drilling. Drilling-induced heat fluxes on the drilled hole bottom surface (HBS) and hole wall surface (HWS) are first determined by the inverse heat transfer method. The proposed 3-D heat carrier model consisting of shell elements to carry the HWS heat flux and solid elements to carry the HBS heat flux conducts the heat to the workpiece to mimic drilling process. A coupled thermal-elastic analysis is used to calculate the workpiece thermal distortion at each time step based on the temperature distribution. The heat carrier model is validated by comparing the temperature profiles at selected points with those from an existing 2-D axisymmetric advection model. The capability for modeling distortion in the case of drilling multiple deep-holes is also demonstrated.

MSEC2011-50160

MODULAR AND RECONFIGURABLE 3D MICRO-OPTICAL BENCHES : CONCEPT, VALIDATION, AND CHARACTERIZATION

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In this paper we present an approach to design MOEMS based on Reconfigurable Free Space Micro-Optical Benches (RFS-MOB). The proposed concept enables to design modular and reconfigurable MOEMS by using a generic structure of silicon holders and non defined position in the substrate. Various micro-optical elements, e.g. microlenses or micromirrors, can be integrated within holders. Their assembly is achieved with an active microgripper, after high precision alignement within guiding rails of silicon substrate. Flexible parts are used to fixe a final position. The concept is validated by successful assembly of holders. A characterization method of assembled holders is proposed and provides an accuracy better than +/- 0.04° for an angle measurement.

MSEC2011-50161

RESEARCH ON DRY EDM PROCESSING PERFORMANCE WITH TWO KINDS OF PULSE GENERATOR MODES

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Dry EDM (Electrical discharge machining in gas) is an innovative electrical discharge machining (EDM) method. The machining performances of dry EDM vary from that of the liquid medium due to the different physical properties of gases and liquids. The generator, a key component in an EDM machine tool, supplies electrical energy to ionize the dielectric, therefore generator mode plays important roles in EDM performance. In this work, experiments were conducted to study the machining performances of dry EDM with two generator modes: the iso-frequencial mode and the iso-pulse mode. Experimental results show that the material removal rate (MRR) and surface roughness (SR) value using the iso-frequencial mode are higher than that of the iso-pulse mode in dry EDM and reasons for the experimental phenomena were analyzed. Under the iso-pulse mode, MRR and SR present an approximately linear increase with an increase in the pulse width increase. The iso-frequencial mode could be used in the rough machining gauge and the iso-pulse mode might be used in finish machining. It is concluded that a high frequency and narrow pulse generator with a high opening voltage might be suitable for dry EDM under a certain conditions.

MSEC2011-50163

ENERGY CONSUMPTION IN DISCRETE PART PRODUCTION

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It is widely recognized that industrial production inevitably results in an environmental impact. Energy consumption during production is responsible for a part of this impact, but is often not provided in cradle-to-gate life cycles. Transparent description of the transformation of materials, parts, and chemicals into products is described herein as a means to improve the environmental profile of products and manufacturing machine. This paper focuses on manufacturing energy and chemicals/materials required at the machine level and provides a methodology to quantify the energy consumed and mass loss for simple products in a manufacturing setting. That energy data are then used to validate the new approach proposed by (Overcash et.al, 2009a, and 2009b) for drilling unit processes. The approach uses manufacturing unit processes as the basis for evaluating environmental impacts at the manufacturing phase of a product's life cycle. Examining manufacturing processes at the machine level creates an important improvement in transparency which aids review and improvement analyses.

MSEC2011-50165

REAL TIME FRICTION ERROR COMPENSATION IN TUBE HYDROFORMING PROCESS CONTROL

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Tube Hydroforming (THF) is a metal-forming process that uses a pressurized fluid in place of a hard tool to plastically deform a given tube into a desired shape. In addition to the internal pressure, the tube material is fed axially toward the die cavity. One of the challenges in THF is the nonlinear and varying friction conditions at the tube-tool interface, which make it difficult to establish accurate loading paths (pressure vs feed) for THF. A THF process control model that can compensate for the loading path deviation due to frictional errors in

tube hydroforming is proposed. In the proposed model, an algorithm and a software platform have been developed such that the sensed forming load from a THF machine is mapped to a database containing a set of loading paths that correspond to different friction conditions for a specific part. A real-time friction error compensation is then carried out by readjusting the loading path as the THF process progresses. This scheme reduces part failures that would normally occur due to variability in friction conditions. The implementation and experimental verification of the proposed model is discussed.

MSEC2011-50166

THERMOSENSITIVE / PHOTOCROSSLINKABLE HYDROGEL FOR SOFT TISSUE SCAFFOLD PRINTING

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Qingwei Zhang — Drexel University

A new type of hydrogel for solid free-form fabrication (SFF) and rapid prototyping (RP) that obtains the qualities of a photocrosslinkable and thermosensitive hydrogel would benefit the tissue engineering field. For a material to best suit SFF and RP, it must: 1) be a low-viscous solution before being printed, 2) involve easily joined on-substrate mixing to form a homogenous gel, 3) have a short solution to gel transition time, 4) be a mechanically strong gel, and 5) have an irreversible gelation processes. A biodegradable, biocompatable thermosensitive triblock copolymer, poly(ethylene glycol-b-(DLlactic acid-co-glycolic acid)-b-ethylene glycol) (PEG-PLGA-PEG), additionally crosslinked with photocrosslinkable Irgacure 2959 allows for quick transition from solution to gel with a post-processing step utilizing UV light would add additional crosslinks to the gel structure resulting in an irreversible hydrogel. A material that gels instantaneously from a non-viscous solution to a 3-dimentional building gel could be used in multiple different types of SFF methods already developed. Since the material is biocompatible and able to be used in numerous types of printers, it can be used to replicate many different types of tissues. In this paper, the mechanism of gelation is proposed, and the material relationship to the initial viscosity is investigated.

MSEC2011-50168

ANALYSIS OF THE SIMULTANEOUS CNC TURNING AND BORING OPERATION VIA MULTISENSOR MONITORING

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The introduction of multi-axis CNC machining has reduced machining time and increased production rates. However, optimizing simultaneous operations to produce quality parts and prolong tool life still possesses a challenge to engineers due to the mutual interactions of two tools removing material and the amount of factors and noise in a production environment. Since there are multiple factors and the sources of error are unknown, we use a statistical approach to obtain and organize information. A design of experiment study was implemented across twelve sensor responses to optimize the spindle speed, feed rate, inner diameter (ID) depth of cut and outer diameter (OD) depth of cut for simultaneous turning and boring roughing operations. The optimal machining conditions were obtained by a response optimizer from Minitab 16 statistical software. The optimized settings result in 13% reduced cutting and 10% reduced total power consumption for a 3% increase of average power. Future studies will cross correlate different responses to reduce the number of sensors in developing a robust adaptive controller for chatter detection and tool condition monitoring.

MSEC2011-50169

INVESTIGATING THE EFFECT OF MINIATURIZATION ON THE MICROTENSILE PROPERTIES OF BRASS (CUZN30)

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As everyday equipment becomes smaller and smaller, it is of increasing importance that the manufacturing processes used for metals are capable of producing parts of appropriate sizes. Currently, manufacturing processes assume macromaterial properties can be applied for microscale production, but is

this a valid assumption? This paper investigates the accuracy of applying macroscale tensile properties in microscale applications. In order to test the soundness of this supposition, tensile tests were performed on both macroscale and microscale brass specimens, and the resulting calculated material properties, strain hardening exponent (n) and strength coefficient (K), were compared. Specimens were heat treated to various temperatures before tensile tests were performed, and the strength coefficient and strain hardening exponents of micro and macro tensile specimens were compared. Additionally, it is investigated whether average grain size correlates to material properties. The results showed that in general it is not accurate to apply macroscale tensile properties to microscale applications. However, at mesocale grain sizes, (12-20 microns), the strain hardening exponent values were similar for both macro and microscale specimens.

MSEC2011-50170

INVESTIGATION ON THE EFFECT OF SIC NANOPARTICLES ON CUTTING FORCES FOR MICRO-MILLING MAGNESIUM MATRIX COMPOSITES

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Magnesium Metal Matrix Composites (Mg-MMCs) with nano-sized reinforcements exhibit better mechanical properties comparing to pure Magnesium (Mg) and its alloys. However, it is challenging to improve the machinability of this kind of composites. An analytical cutting force model for the micro-milling process was developed and validated to analyze the micro-machinability of the SiC nanoparticles reinforced Mg-MMCs. This model is different from the previous ones because it encompasses the behaviors of the reinforcement nanoparticles in the three cutting regimes, i.e., shearing, ploughing and elastic recovery. The volume fraction of particles and particle size are considered as two significant factors affecting the cutting forces in this model. The effects of the reinforcement nanoparticles on cutting forces were studied through modeling and experimental validation. The simulated cutting forces show a good agreement with the experimental data. Moreover, it is indicated that the amplitude and profile of cutting forces vary with the reinforcement particle's volume fraction. This mainly arises from the strengthening effect of SiC nanoparticles.

MSEC2011-50171

TOWARDS MASS-SCALE MICRO-ASSEMBLY SYSTEMS USING MAGNETOTACTIC BACTERIA

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Magnetotactic bacteria (MTB) can be used in a coordinated fashion to assemble micro-objects in an orderly manner. To perform micro-assembly tasks, magnetotaxis-based control is used where a directional magnetic field is generated to induce a torque on an embedded chain of membrane-based magnetic nanoparticles (MNP) named magnetosomes. Such chain acts like a nano-compass or a nano-steering system embedded in each bacterium. Such magnetotaxis-based control is then used to orient the MTB in such a way that the laminar flow created by their flagella bundles provides a displacement force on the micro-objects being assembled. Since the force is generated by the bacteria, relatively large micro-objects can be moved with no requirement for electrical energy except for a relatively small value required for inducing a directional torque on the chain of magnetosomes in the cells. Because the energy required to generate the directional torque is independent on the population of MTB being involved but the displacement force can be scaled up with the use of a larger swarm while the total workspace would typically be at microscale dimensions, the energy required for the coils configuration around such workspace and responsible for generating the directional torque can be reduced further to a very low level and hence, makes the implementation of mass-scale bacterial micro-assembly systems, a viable approach. Based on these findings, we propose a corresponding mass-scale system based on many workspaces, each relying on a swarm of MTB to perform micro-assembly tasks in parallel.

MSEC2011-50172

SENSITIVITY ANALYSIS ON INVENTORY CLASSIFICATION METHODS FOR OILFIELD EQUIPMENT INDUSTRY

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This paper presents a case study for inventory management for an oilfield equipment company. The management encounters the problem of deciding which parts to manufacture in-house and which ones to subcontract. A decision support system (DSS) is developed which ranks component parts by integrating multi-criteria classification methods considering both quantitative (e.g., cost and demand) and qualitative (e.g., importance) factors. The focus on

this research is to perform a sensitivity analysis on weight assignment for each criterion. This information is important in applications of inventory management since industries may not be able to manufacture all the necessary parts on time. Real world data from an oilfield equipment industry are used where inventory control problems have arisen because the company does not have the capacity to manufacture all the required parts to satisfy customer orders.

MSEC2011-50173

MONOTONIC AND CYCLIC CHARACTERIZATION OF FIVE DIFFERENT CASTING PROCESSES ON A COMMON MAGNESIUM ALLOY

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The monotonic and cyclic behavior of five different casting processes for AZ91 magnesium alloy is evaluated through microstructure characterization and mechanical testing. A passenger car control arm was cast by squeeze cast, low pressure permanent mold, low pressure permanent mold-electricmagnetic-pump, T-mag, and ablation processes. Samples were cut from twelve locations of the control arm for microstructure characterization. The grain size, porosity fraction, and porosity size were measured via optical microscopy. Different types and sizes of defects were present in each type of casting processes. The mechanical behavior characterization included monotonic tension, and fully-reversed fatigue tests. Sources of fatigue crack initiation were quantified using scanning electron microscopy. For both monotonic and cyclic loading conditions, poor mechanical performance was directly linked to the presence of large pores, oxide films, and/or pore shrinkage clusters.

MSEC2011-50174

ENERGY CONSUMPTION REDUCTION IN SERIAL PRODUCTION LINES VIA OPTIMAL STARTUP SCHEDULE

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Research efforts for energy consumption reduction in manufacturing systems have been centered at technology and process innovation. These projects, however, often involve major capital investment of new equipment and material. In this paper, we explore energy saving opportunities through improvement in factory floor operations. Specifically, in the framework of Bernoulli serial lines, we consider production systems with stripping operations. In such systems, the in-process buffers have to be depleted at the end of each shift to avoid quality deterioration during off-shift periods. Transient analysis of the systems are carried out and formulas to calculate the performance measures are derived. In addition, we investigate the effect of machine startup schedule on the system performances and develop optimal startup schedule which, as shown in the paper, can lead to significant improvement in energy utilization efficiency.

MSEC2011-50175

AN ANALYSIS OF THE WEAR OF TUNGSTEN CARBIDE AND POLYCRYSTALLINE DIAMOND INSERTS TURNING TI-6AL-4V

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Dry turning experiments on Ti-6Al-4V were conducted using two grades (finer and coarser) of carbides and polycrystalline diamond (PCD) inserts to study tool wear. Despite of minor compositional difference between two carbide grades, both grades contain 6% Co. Crater wear and flank wear were measured using Confocal Laser Scanning Microscopy (CLSM). Three dimensional rake surface topographies were reconstructed from the CLSM data and wear profiles were extracted. Finite Element Analysis (FEA) was conducted to study the effects of cutting conditions and thermal properties on rake face temperature. Flank wear on the carbide tools indicated that the inserts with the finer grain size exhibited smaller flank wear than the insert of the coarser grain size. This was attributed to reduced abrasive wear in the finer grained inserts as a result of a higher hardness. The carbide grade with a coaser grain size had an enhanced ability to resist crater wear, likely from lower rake face temperatures and the differences in the compositions. It is known that fine-grain carbides have a higher thermal conductivity resulting from increased grain contiguity. FEA was used to study the temperature difference between the two grain-sizes and the effect of thermal conductivity on temperature gradients. Tool wear of the PCD inserts was also studied. The PCD tools showed significant adhesive wear at the 200sfm cutting speed, transitioning to crater wear at 400sfm. With a high thermal conductivity, it is possible that rake face temperatures were low enough to alter the wear mechanism. FEA supports this hypothesis, as the maximum rake face temperature for the PCD inserts were only around 900?C at 200sfm.

MSEC2011-50176

A NEW FLEXIBLE AND MULTI-PURPOSE SYSTEM DESIGN FOR 3-DIMENSIONAL PRINTING

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David M. Wootton — Cooper Union

Jack G. Zhou — Drexel University

A new type of Solid freeform fabrication (SFF) machine based on Automatically Programmed Tools (APT) language has been developed to construct hydrogel scaffolds and porous structures. The system comprises three servo motors, three motor drives, three appropriate optical linear encoders, digital/analogue input and output interfaces, air pressure control system, UV light, hot plate, and nozzle with dispensing controller. In this study, the system was connected into a PC to act as a high-performance servo controller for monitoring the control of a three axis setup with X-Y-Z moving arms. The printing procedures were repeated layer-by-layer to form a 3D structure. A biocompatible and thermosensitive material, PEG-PLGA-PEG triblock copolymer, has been printed by this new three-dimensional direct printing machine and the experimental results are discussed with respect to potential applications. Our novel SFF printing system has some advantages over other commercial SFF machines including: 1. Changeable printing nozzles for materials with different viscosities. 2. Re-constructible system setup for different printing purposes. 3. Capability for heterogeneous printing. 4. User-friendly software development 5. Economic system design. The study of the hardware and software and their integration are described and its new heterogeneous printing algorithm is discussed for multiple purpose uses. The integrated software has been developed to combine all components of the control system together and is easy to adapt to different applications.

MSEC2011-50177

SHEET ORIENTATION EFFECTS ON THE FORMABILITY LIMITS OF THE AZ31B MAGNESIUM ALLOY AT SPF CONDITIONS

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The formability curves of the AZ31B magnesium alloy were constructed by following a novel approach that best resembles the conditions of actual Superplastic Forming (SPF) operations. Sheet samples were formed at 400 ºC and a constant strain rate of 1x10-3 s-1, by free pneumatic bulging into a set of progressive elliptical die inserts. By doing so, the material in each of the formed domes was forced to undergo biaxial stretching at a distinct strain ratio, which is simply controlled by the geometry (aspect ratio) of the selected die insert. Material deformation was quantified using circle grid analysis (CGA), and the recorded planar strains were used to construct the forming limit diagram (FLD) of the material. The aforementioned was carried out with the sheet oriented either along or across the direction of major strains, in order to establish the relationship between the material's rolling direction and the corresponding limiting strains. Great deviations between the two sets of formability curves are realised, hence a compound forming limit diagram is constructed as an improved way for characterising the material behaviour. The presented pneumatic stretching approach is shown to produce accurate friction-independent formability diagrams, with clear distinction between the safe and unsafe deformation zones, even though the developed diagrams are confined to the biaxial strain region (right side quadrant of an FLD). Moreover, the approach proves to be a viable means for providing formability maps under conditions where traditional mechanical stretching techniques (Nakazima and Marciniak tests) are limited.

MSEC2011-50178

A QUANTITATIVE STUDY OF ILLUMINATION TECHNIQUES FOR MACHINE VISION BASED INSPECTION

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In this paper, three basic lighting geometries are compared quantitatively in an inspection task that checks for the presence of J-clips on an aluminum carrier. Two independent LabVIEW® machine vision algorithms were used to evaluate backlight, bright field and dark field illumination on their ability to minimize variations within a pass (clip present) or fail (clip absent) sample set, as well as maximize the separation between sample sets. Results showed that there were clear differences in performance with the different lighting geometries, with over a 30% change in performance. Although it is widely acknowledged that the choice of lighting is not a trivial exercise for machine vision systems, this paper provides a case study of the quantitative performance of different lighting geometries.

MSEC2011-50179

RAPID PROTOTYPING OF FULL SCALE HOUSE STRUCTURES

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This paper reports on the machining of a construction material (aerated concrete) with a rapid prototyping device, Shapemaker III, which is based on waterjet technology. Preliminary machining tests were carried out to investigate machining conditions (speed and pressure) of separation cuts. Cutting speeds for the waterjet were investigated for two aerated concrete construction materials; autoclaved aerated concrete (AAC) in two strengths (348 and 580 psi compressive strength) and a non-autoclaved, fiber reinforced aerated concrete (FRAC) with a 450 psi compressive strength. Cutting samples were prepared in four thicknesses (0.5, 1, 2, and 3 inches) and cut at two pressures (40 and 60 ksi). The 0.5 and 1 inch specimens were cut with good surface finish at over 600 in/min at 40 ksi. The 2 and 3 inch specimens could be cut at 320 and 80 in/min at 40 ksi, respectively. The experimental data was used in the fabrication of rapid prototyping houses with a pure waterjet machine. As results, full scale houses were fabricated with FRAC and Styrofoam. Additionally, a sub-mold of an outdoor fireplace was manufactured with Styrofoam for casting of customized aerated concrete blocks.

MSEC2011-50180

PULSED LASER MICRO POLISHING: AN ANALYTICAL METHOD FOR PREDICTING SURFACE FINISH

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This project is focused on developing physics based models to predict the outcome of pulsed laser micro polishing (PLμP). Perry et al. [1-3] have modeled PLμP as oscillations of capillary waves with damping resulting from the forces of surface tension and viscosity. They have proposed a critical spatial frequency, fcr, above which a significant reduction in the amplitude of the spatial Fourier components is expected. The current work extends the concept of critical spatial frequency to the prediction of the spatial frequency content and average surface roughness after polishing, given the features of the original surface, the material properties, and laser parameters used for PLμP. The proposed prediction methodology was tested using PLμP results for Nickel, Ti6Al4V, and stainless steel 316L with initial average surface roughnesses from 70 nm to 190 nm. The predicted average surface roughnesses were within 10% to 15% of the values measured on the polished surfaces. The results show that the critical frequency continues to be a useful predictor of polishing results in the spatial frequency domain. The laser processing parameters, as represented by the critical frequency and the initial surface texture therefore can be used to predict the final surface roughness before actually implementing PLμP.

MSEC2011-50183

COLD DRAWING OF MAGNESIUM ALLOY TUBES FOR MEDICAL

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Magnesium alloy is the lightest in practical metals, and it is used for a housing of small home?appliance products and automobile parts. It is also expected to be a new material for stent, because of its possibility of systemic absorption. It is known that cold-plastic working of magnesium alloy is very difficult. In this study, fabrication of a magnesium-alloy medical tube by cold drawing was attempted. Fineness, thinness, adequate strength and high-quality surface are required for the medical tube. Firstly, plug drawing was carried out, because it was thought to be one of the methods for satisfying the requirements. But, after all it was found to be impossible to apply this method, because magnesium alloy is too brittle for plug drawing. Secondly, soft-metal mandrel drawing was tried. Drawing was possible, but it was difficult to extract the mandrel, because there was a possibility that the tube might break due to its high drawing stress. So newly-devised fluid mandrel drawing was carried out. As a result, it was found that the fabrication of medical tube by fluid mandrel drawing was possible. It is easy to extract mandrel after drawing, as the mandrel is fluid. And it is possible to prevent tube break during drawing, because drawing stress is lower than that of soft-metal mandrel drawing.

MSEC2011-50197

THE PERIODICAL FLUCTUATION RESIDUAL STRESS IN HARD TURNED SURFACE

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To evaluate the residual stress distribution along cutting direction in hard turning process, an explicit dynamic thermo-mechanical orthogonal Finite Element Model (FEM) is developed to consider the correlation between residual stress distribution and chip morphology and plough effect by cutting edge. The FEM adopts Johnson-Cook (J-C) model to describe work material property, the critical equivalent plastic strain criterion to simulate chip separation behavior, and the revised coulomb's law to capture the friction pattern between the tool and chip interface. The FEM is validated by comparing the predicted and experimental chip morphology and residual stress distribution. The residual stress distribution in hard machined surface along cutting direction is accurately captured by using sharp and honed cutting edge tools. The residual stresses by sharp tool demonstrate a periodical characteristic, the fluctuation amplitudes are determined in the surface and subsurface along the cutting direction, and the fluctuation frequency corresponds to that of the saw-tooth chip. However, the residual stresses by honed cutting edge tool demonstrate an indistinct periodic characteristic, the fluctuation frequency in surface and subsurface is larger than that of the saw-tooth chip. Saw-tooth chip formation process by sharp tool is identified to analyze the residual stress scatter periodic mechanism, which associates with the fluctuation of cutting force and temperature. The plough process by honed cutting edge tool is identified to explain the equilibrium effect on the amplitude and frequency of residual stress scatter in hard turned surface and subsurface. The periodical fluctuation characteristics of residual stress in hard turned surface and subsurface is revealed and verified by determining its amplitude and frequency corresponding to that of the saw-tooth chip. The analysis will enhance the fatigue life prediction accuracy by incorporating the effect of residual stresses periodical fluctuation on the crack initiation and propagation life in hard turned surface and subsurface.

MSEC2011-50198

METHODS TO RATIONALIZE THE GENERATION OF PARAMETER TECHNOLOGIES IN SINKING EDM

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The demands on parameter technologies in Sinking EDM are very high. In each processing step, a certain surface roughness has to be achieved in very precise manner. At the same time removal rate (productivity) and relative wear (costs) have to achieve advantageous values. The generation of these parameter technologies is time-consuming and expensive, since many influencing factors affect the target figures. The procedural methods in practice are often unsystematic and ineffective. The technological possibilities of machine and process configuration are very often not used. This publication deals with methods designed to effectively optimize the target figures. At the same time, effort and time spent for generating parameter technologies are reduced. Continuous parameter technologies are used for the generation of discrete parameter technologies. Two different types of continuous mappings are compared: Nonlinear regression functions and artificial neural networks (ANN). Model accuracy and the handling properties of these variants are evaluated in this context. A variety of methods for assessing the adequacy of mappings are discussed. A new, problem-oriented experimental design method for EDM-processes is also described, focusing on two aspects: a reduction of the experimental effort and the achievement of a sufficient accuracy of the continuous mappings at the same time. In order to achieve these characteristics, different scale methods and transformation methods are discussed, as well. As a result, a problem-adapted CAP-software solution is presented. Nonlinear regression functions as well as ANNs for the continuous parameter technologies can be generated, visualized and evaluated within this software. In a next step, software functions are implemented, allowing the technologist to derive optimal pulse parameter series for processing. The application of the presented methods is first of all useful for manufacturers of EDM die sinking machines.

MSEC2011-50199

FABRICATION OF SUPPORTS FOR SOLID OXIDE FUEL CELLS BY POWDER INJECTION MOLDING

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In this paper the processing steps for producing SOFC (Solid Oxide Fuel Cell) supports by means of PIM (Powder Injection Molding) technique were investigated. Injection molding parameters in this study were divided into pressure-related (injection pressure and packing pressure), temperature-related (nozzle temperature and mold temperature), and time-related (injection rate and holding time) parameters. Keeping the other parameters (pressure-related, temperature-related and time-related parameters) constant at an optimized value, the effects of each of the molding parameters above were investigated. The results show that the short shot, warpage, weld line and void are the most common defects in molded parts. According to the results the short shot could be seen in low values of injection pressure, injection rate, nozzle and mold temperature. Also, warpage could be seen in high values of mold temperature, injection and packing pressure. Poor weld line was another defect that could be seen in low values of injection pressure, injection rate, nozzle and mold temperature. Also the void was one of the most common defects that could be seen in high values of injection rate and nozzle temperatures. Finally, using optimized molding parameters, the molded parts underwent debinding and sintering processes. Based on the results of thermal shock tests and the porosity measurements of the sintered parts, these molded parts possessed relatively desirable characteristics.

MSEC2011-50202

PROPERTIES DEVELOPMENT OF IF STEEL SHEETS DURING CONSTRAINED GROOVE PRESSING TECHNIQUE

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The severe plastic deformation method known as constrained groove pressing was used to produce ultrafine-grained microstructure in IF steel sheets. The principle of CGP is that a material is subjected to the repetitive shear deformation under the plane strain deformation condition by utilizing alternate pressing with the asymmetrically grooved die and flat die constrained tightly by the cylinder wall. Each complete groove pressing pass is arranged from four step pressing operations. Considering the geometry of die, in each complete pass, the amount of strain imposed on the specimen is 1.16. In present research, IF sheets were subjected to a total strain of 4.64. The mechanical properties were studied as a function of the number of passes. Results showed that by increasing the number of passes, specimen's hardness and ultimate strength stress increases. Also a loss of ductility was observed in all processed sheets. The microstructural evolution was characterized using Scanning Electron Microscopy (SEM) and it was observed that the grains were significantly refined after 16 steps pressing for IF steel sheets. Details of the deformation characteristics found in the investigation are discussed in this paper.

MSEC2011-50204

MULTIDISCIPLINARY DESIGN OPTIMIZATION OF A HYBRID COMPOSITE WIND TURBINE BLADE

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In recent years, the demand for renewable energy sources is rapidly growing to reduce the emission of greenhouse gases. The energy production using wind turbine is one of the promising solutions to generate electricity from a reusable source. As the demand for production of "green" energy increases, the demand for developing "green" technology

to build large scale wind turbines also increases. These large scale wind turbines require optimum design of very long length performance blades to sweep larger areas and generate power efficiently. The hybrid composites, which are combination of different composite materials, can yield combined performance and properties of composite materials. An accurate analysis will allow to identify specific combinations of separate composite materials to be used to form an laminated structure known as a hybrid laminate composite structure (HLCS). Precise design and incorporation of the HLCS in wind turbine blades could improve efficiency of the system and reduce manufacturing costs. This research work will yield effective methods and processes for the multidisciplinary design optimization (MDO) of the hybrid laminated composite based wind turbine blade structures. A baseline analysis is conducted and a MDO of a large scale hybrid composite wind turbine blade is developed in this research. Multiple objectives in the design optimization process include: maximize length of blade, minimize weight and manufacturing cost. A wind turbine blade is divided into regions and the orientation, thickness, material and number of hybrid composite layup for each region are considered as design variables. Applied loads due to extreme wind conditions for rotor rotation and rotor stop conditions are considered for finite element analysis (FEA) to evaluate the structural strength. The structural stiffness is designed and illustrated so that the natural frequency of the blade does not coincidence with the excitation frequency of the wind turbine. A process of obtaining an optimum hybrid composite laminate layup and an optimum length of wind turbine blade is developed. MO-SHERPA method is used in the MDO process and HEEDS optimization software is used to manage the optimization process. A series of processes were setup using CATIA for geometric modeling, FEMAP for pre and post processing, NASTRAN for structural analysis, SEER-Mfg for manufacturing cost estimation and Excel for data management.

MSEC2011-50205

EFFECT OF FILM FORMATION METHOD AND ANNEALING ON CRYSTALLINITY OF POLY(L-LACTIC ACID) FILMS

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Poly(L-lactic acid) (PLLA) has been shown to have potential medical usage such as in drug delivery because it can degrade into bioabsorbable products in physiological environments, and its degradation is affected by crystallinity. In this paper, the effect of film formation method and annealing on the crystallinity of PLLA are investigated. The films are made through solvent casting and spin coating methods, and subsequent annealing is conducted. The resulting crystalline morphology, structure, conformation, and intermolecular interaction are examined using optical microscopy, X-ray diffraction, and Fourier transform infrared spectroscopy. It is observed that solvent casting produces category 1 spherulites while annealed spin coated films leads to spherulites of category 2. Distinct lamellar structures and intermolecular interactions in the two kinds of films have been shown. The results enable better understanding of the crystallinity in PLLA, which is essential for its drug delivery application.

MSEC2011-50206

PARAMETRIC INVESTIGATION ON THE HYBRID PROCESSING OF JET ELECTROCHEMICAL MACHINING AND LASER BEAM MACHINING

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A hybrid processing of jet electrochemical machining and laser beam machining(JECM-LBM) can effectively reduces recast and spatter to improve the quality of laser beam machining. The effect of different process parameters on the quality of small holes is investigated in this paper. Laser pulse energy(LE), repetition rate(RR), applied voltage(VA), duration ratio(DR) and inter electrode gap(IEG) are selected as independent process variables. Residual recast rate(RRR) and via hole taper have been used for the quality of hole. The experiments were performed with 1Cr18Ni9Ti Stainless material sample. The central composite design(CCD) technique based on response surface methodology(RSM) was employed to plan the experiments and achieve optimum responses parameters. An analysis of variance(ANOVA) performed to test the significance of models. The experimental results showed that the LE, VA and IEG have the most significant on RRR, VA and IEG have the most significant on taper. In addition, the errors of RRR and taper between predicted and experimental results are 7% and 8% respectively.

MSEC2011-50207

MECHANICAL PROPERTIES OF SOME PLANT FIBRES COMPARED WITH GLASS FIBRE

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The tensile strength, specific tensile strength, breaking force, tenacity and percent elongation of some fibres extracted from eight fibrous plants found in Northern Nigeria were determined with a view to ascertaining their suitability for the replacement of glass fibre in plastic composites. The fibrous plants were Sisal (Agave Sisalana) (ASB), Lalloh (Corchorus Triden L.) (CCR), Dargaza (Grewia Mollis Juss) (GRW), Kenaf (Hibiscus Cannabinus L.) (HCB), Goruba (Hyphaene Thebaica)(HYP), Sukuwa (Sida Acuta) (SDA), Karlgo (Piliostigma Thoningii) (PTA) and Shikuri Tuggah (Urena Lobata) (ULB). Their properties were compared with E-Glass. The results show that whereas the highest tensile strength of the plant fibre (ASB) was about one-third that of the glass fibre, the highest specific tensile strength of the plant fibre (HCB) was about 5 times that of the glass fibre. The percent elongation of the plant fibres except HYB and SDA were at least 5.6 times that of the glass fibre. Three of the plant fibres, (HCB, ASB and ULB) were observed to be possible replacements for the classic glass fibre.

MSEC2011-50208

PREDICTING THE HIGH SPEED CUTTING PROCESS OF TITANIUM ALLOY BY FINITE ELEMENT METHOD

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To predict the cutting forces and cutting temperatures accurately in high speed dry cutting Ti-6Al-4V alloy, a Finite Element (FE) model is established based on ABAQUS. The tool-chip-work friction coefficients are calculated analytically using the measured cutting forces and chip morphology parameter obtained by conducting the orthogonal (2-D) machining tests. It reveals that the friction coefficients between tool-work are 3~7 times larger than that between tool-chip, and the friction coefficients of tool-chip-work vary with feed rates. The analysis provides a better reference for the tool-work-chip friction coefficients than that given by literature empirically regardless of machining conditions. The FE model is capable of effectively simulating the high speed dry cutting process of Ti-6Al-4V alloy based on the modified Johnson-Cook model and tool-work-chip friction coefficients obtained analytically. The FE model is further validated in terms of predicted forces and the chip morphology. The predicted cutting force, thrust force and resultant force by the FE model agree well with the experimentally measured forces. The errors in terms of the predicted average value of chip pitch and the distance between chip valley and chip peak are smaller. The FE model further predicts the cutting temperature and residual stresses during high speed dry cutting of Ti-6Al-4V alloy. The maximum tool temperatures exist along the round tool edge, and the residual stress profiles along the distance from machined surface are hook-shaped regardless of machining conditions.

MSEC2011-50209

FLOW STRESS EXPERIMENTAL DETERMINATION FOR WARM-FORMING PROCESS

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Warm forming is a manufacturing process in which a workpiece is formed into a desired shape at a temperature range between room temperature and material recrystallization temperature. Flow stress is expressed as a function of the strain, strain rate, and temperature. Based on such information, engineers can predict deformation behavior of material in the process. The majority of existing studies on flow stress mainly focus on the deformation and microstructure of alloys at temperature higher than their recrystallization temperatures or at room temperature. Not much works have been presented on flow stress at warm-forming temperatures. This study aimed to determine the flow stress of stainless steel AISI 316L and titanium TA2 using specially modified equipment. Comparing with the conventional method, the equipment developed for uniaxial compression tests has be verified to be an economical and feasible solution to accurately obtain flow stress data at warm-forming temperatures. With average strain rates of 0.01, 0.1, and 1 /s, the stainless steel was tested at degree 600, 650, 700, 750, and 800 °C and the titanium was tested at 500, 550, 600, 650, and 700 °C. Both materials softened at increasing temperatures. The overall flow stress of stainless steel was approximately 40 % more sensitive to the temperature compared to that of titanium. In order to increase the efficiency of forming process, it was suggested that the stainless steel should be formed at a higher warm-forming temperature, i.e. 800 °C. These findings are a practical reference that enables the industry to evaluate various process conditions in warm-forming without going through expensive and time consuming tests.

MSEC2011-50211

MACHINE ANOMALY DETECTION AND DIAGNOSIS INCORPORATING OPERATIONAL DATA APPLIED TO FEED AXIS HEALTH MONITORING

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Solutions for machinery anomaly detection and diagnosis are typically designed on an ad hoc, custom basis, and previous studies have shown limited success in automating or generalizing these solutions. Reusing and maintaining the analysis software, especially when the machine usage pattern or operating condition changes, remains a challenge. This paper outlines a strategy to make use of operational data obtained from the machine's controller and signals obtained from external sensors to provide an accurate analysis within each operating condition. Operational data collected from the controller is used both for labeling datasets into different operating conditions and for analysis. Principal component analysis (PCA) is adopted to identify critical sensors that can provide useful information. Self-organizing map (SOM)-based anomaly detection and diagnosis methods are used to automatically convert data to easily understandable machine health information for operators. Experimental trials conducted on a feed-axis test-bed demonstrated the effectiveness of incorporating operational data for anomaly detection and diagnosis.

MSEC2011-50212

INVESTIGATION OF STRAIN GRADIENTS AND MAGNITUDES DURING MICROBENDING

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Brad Kinsey — University of New Hampshire

Sheet metal forming of parts with microscale dimensions is gaining importance due to the current trend towards miniaturization, especially in the electronics industry. In microforming, although the process dimensions are scaled down, the polycrystalline material stays the same (e.g., the grain size remains constant). When the specimen feature size approaches the grain size, the properties of individual grains begin to affect the overall deformation behavior. This results in inhomogeneous deformation and increased data scatter of the process parameters. In this research, the influence of the specimen size and the grain size on the distribution of plastic deformation through the thickness during a 3-point microbending process is investigated via digital image correlation. Results showed that with miniaturization, a decrease in the strain gradient existed which matched previous research with respect to micro-hardness measurement.

MSEC2011-50213

EFFECT OF ELEMENT TYPE ON FAILURE PREDICTION USING A STRESS-BASED FORMING LIMIT CURVE

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Strain-based forming limit diagrams (FLDs) are the traditional tool used to characterize the formability of materials for sheet metal forming processes. However, this failure criterion exhibits a significant strain path dependence. Alternatively, a stress-based FLD have been proposed and shown to be less sensitive to the deformation path. This stress-based failure criterion can be readily implemented in numerical simulations to predict concerns. However, for reliable numerical modeling, the sensitivity of the models to the selection of discretization parameters, in particular, the element type, must be assessed. In this paper, Marciniak tests have been numerically simulated to investigate failure prediction using three different element types (shell, solid and solid-shell). Seven different specimen geometries were modeled in order to vary the loading paths. The results show that despite differences in stress calculation assumptions, shell, solid-shell and solid elements do not provide differences in failure prediction when a stress-based failure criterion is used.

MSEC2011-50215

AN EXPERIMENTAL COMPARISON OF TWO PELELTING METHODS FOR CELLULOSIC ETHANOL MANUFACUTRING

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Ethanol produced from cellulosic biomass is an alternative to petroleum-based transportation fuels. However, manufacturing costs of cellulosic ethanol are too high to be competitive. Low density of cellulosic feedstocks increases their handling and transportation costs, contributing to high overall costs of cellulosic ethanol manufacturing. Pelleting can increase density of cellulosic feedstocks, reduce transportation and storage costs, and make cellulosic ethanol production more competitive. UV-A (ultrasonic vibration-assisted) pelleting

is a new pelleting method (available only in lab scale now). Preliminary research showed that UV-A pelleting could significantly increase pellet density and pellet durability but it has never been compared with other pelleting methods (e.g., using an extruder, a briquetting press or a ring-die pelleting). The objectives of this research are to compare UV-A pelleting with ring-die pelleting in terms of pellet density, pellet durability, energy consumptions of pelleting. The results will be useful to find a better pelleting method for cellulosic ethanol manufacturing.

MSEC2011-50216

THEORETICAL MODELING OF CUTTING TEMPERATURE DISTRIBUTION BY CONSIDERING THE MATERIAL THERMAL PROPERTIES AS FUNCTIONS OF TEMPERATURE

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To depict the temperature distribution in the tool and chip, a modified theoretical model by considering material thermal properties as temperature dependent is developed to predict temperature elevation due to the shear and friction at the tool-chip interface. Work's thermal properties of thermal conductivity and specific heat are modified and considered as functions of temperature. The semi-infinite method is utilized in the model, in which the back of the chip and the shear band are assumed as adiabatic. Temperature distribution in the tool and chip is determined simultaneously by shear and friction. An image heat source is set plane-symmetric to each original heat source. The effects of original heat source and image heat source are superimposed to calculate the final temperature elevation in the tool and chip. To determine the ratio of total heat transferred into the chip and the tool, it assums that the temperatures in the tool and the chip reach balance along the tool-chip interface in the stable cutting state. The model is developed and validated with peak temperature from previous literature. Results indicate that the temperature deviation is less than 10% when thermal properties are considered termperature dependent, which is more accurate than that by considering the thermal properties as constants. The patterns of temperature distribution in the tool and chip are further analyzed by the model.

MSEC2011-50218

ESTIMATION OF MILLING TOOL TEMPERATURE CONSIDERING COOLANT AND WEAR

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This paper presents a novel technique to estimate the temperature distribution of a milling tool during machining. In this study, heat generation during the machining process is estimated using cutting forces. We consider the heat to be time-dependent heat flux into the tool. In the proposed model, we discretize each rake face on a mill into several elements; each experiences time-dependent heat flux. Second, we approximate the time-dependent heat flux as several constant heat input starts at different time. Finally, we sum the temperature rise from each heat flux to obtain the overall temperature change. A similar concept is applied on the flank surface, where the flank wear area is modeled as an additional heat generation zone. Experimental results are presented to validate the developed model.

MSEC2011-50219

NUMERICAL MODELING OF TRANSPORT AND DENDRITIC GROWTH IN LASER CONDUCTION WELDING OF 304 STAINLESS STEEL

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A multi-scale model is developed to investigate the heat/mass transport and dendrite growth in laser spot conduction welding. A macro-scale transient model of heat transport and fluid flow is built to study the evolution of temperature and velocity field of the molten pool. The molten pool geometry and other solidification parameters are calculated, and the predicted pool geometry matches well with experimental result. On the micro-scale level, the dendritic growth of 304 stainless steel is simulated by a novel model that has coupled the Cellular Automata (CA) and Phase Field (PF) methods. The epitaxial growth is accurately identified by defining both the grain density and dendrite arm density at the fusion line. By applying the macro-scale thermal history onto the micro-scale calculation domain, the microstructure evolution of the entire molten pool is simulated. The predicted microstructure achieves a good quantitative agreement with the experimental results.

MSEC2011-50220

DISLOCATION DENSITY-BASED GRAIN REFINEMENT MODELING OF ORTHOGONAL CUTTING OF COMMERCIALLY PURE TITANIUM

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Recently, machining has been exploited as a means for producing ultra-fine grained (UFG) and nanocrystalline microstructures for various metal materials, such as aluminum alloys, copper, stainless steel, titanium and nickel-based super alloys, etc. However, no predictive, analytical or numerical work has ever been presented to quantitatively predict the change of grain sizes during machining. In this paper, a dislocation density-based viscoplastic model is adapted for modeling the grain size refinement mechanism during machining by means of a finite element based numerical framework. A novel Coupled Eulerian-Lagrangian (CEL) finite element model embedded with the dislocation density subroutine is developed to model the severe plastic deformation and grain refinement during a steady-state cutting process. The orthogonal cutting tests of a commercially pure titanium (CP Ti) material are simulated in order to assess the validity of the numerical solution through comparison with experiments. The dislocation density-based material model is calibrated to reproduce the observed material constitutive mechanical behavior of CP Ti under various strains, strain rates and temperatures in the cutting process. It is shown that the developed model captures the essential features of the material mechanical behavior and predicts a grain size of 100-160 nm in the chips of CP Ti at a cutting speed of 10 mm/s.

MSEC2011-50222

MICROVIA FORMATION FOR MULTI-LAYER PWB BY LASER DIRECT DRILLING: IMPROVEMENT OF HOLE QUALITY BY SILICA FILLERS IN BUILD-UP LAYER

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Microvia formation technology using lasers has become the dominant method for drilling microvia called blind via-holes (BVHs) in printed wiring boards (PWBs). Laser direct drilling (LDD), drilling directly outer copper foil by laser, has attracted attention as a novel method. In particular, when copper and resin with different processing thresholds are drilled at the same time, an overhang defect occurs on the drilled hole. However, the overhang generation mechanism has not been clarified. Therefore, we investigated it by detailed observation of the drilled-hole section. Moreover, we estimated the overhang length using the finite element method (FEM). Influences of surface treatment of outer copper foil and thermal properties of the build-up layer were evaluated experimentally and analytically. Consequently, we carried out an experiment with a prototype PWB with silica filler added in the build-up layer. Using the prototype PWBs, the overhang was reduced as shown in FEM analysis results.

MSEC2011-50226

HYBRID MANUFACTURING OF DEEP HOLES WITH SMALL DIAMETERS

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Bore holes with a high length-to-diameter (l/D)-ratio and small diameters are needed in various industries. Examples are the downsizing of components for medical and biomedical products or for fuel injection in automotive industry because of the increase of injection pressure. For the production of deep holes with very small diameters an adapted process design is necessary, especially when the conditions at the begin of the deep hole drilling process are unfavorable. In these applications, a hybrid process consisting of a laser pilot-drilling and a single-lip deep hole drilling can shorten the process chain in machining components with non-planar surfaces, or can reduce tool wear in machining case-hardened materials. In this research, the combination of laser and single-lip drilling processes for the machining of workpieces with non-planar surfaces was realized and investigated for the very first time.

MMSEC2011-50228

OPTIMAL SENSOR LOCATION TO ESTIMATE TEMPERATURE DISTRIBUTION IN AN INJECTION MOULD

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The objective of this research is to identify optimal sensor locations to estimate temperature distribution in an injection mould using finite-element analysis. Potential locations (referred to as target nodes) are grouped based on the similarity of their thermal response using a proposed temperature-ratio clustering method. A sensitivity analysis of the temperature distribution for these groups of target nodes identifies the sensor location for each cluster that exhibits the highest sensitivity to variable inputs. Using identified sensor locations with a neural network model, the accuracy in estimation of temperature response is evaluated.

MSEC2011-50229

EFFECT ON FLOW STRESS OF A RAPID PHASE TRANSITION IN AISI 1045 STEEL

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New experimental data on AISI 1045 steel from the NIST pulse-heated Kolsky Bar Laboratory are presented. The material is shown to exhibit a nonequilibrium phase transformation at high strain rate. An interesting feature of these data is that the material has a stiffer response to compressive loading when it has been preheated to a testing temperature that is below the eutectoid temperature using pulse-heating than it does when it has been preheated using a slower heating method. On the other hand, when the material has been pulse-heated to a temperature that exceeds the eutectoid temperature prior to compressive loading on the Kolsky bar, it is shown to exhibit a significant loss of strength. A consequence of this behavior is that fixed-parameter constitutive models, such as the well-known Johnson-Cook model, cannot be used to describe this constitutive response behavior. An argument is made that the phase transition does not occur during high-speed machining operations, and suggestions are made as to how to modify the Johnson-Cook model of Jaspers and Dauzenberg for this material in order to obtain improved temperature predictions in finite-element simulations of high-speed machining processes.

MSEC2011-50230

MICROWAVE TORREFACTION OF CORN STOVER AND TECH-ECONOMIC ANALYSIS

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Microwave torrefaction of corn stover with particle size of 4 mm was investigated and the effects of reaction temperature and time on the yields of volatile, bio-oil and torrefied biomass were determined. The response surface analysis of the central composite design (CCD) showed that the yields of volatile, bio-oil and torrefied biomass were significantly affected by the reaction temperature and time. Three linear models were developed to predict the yields of conversion products as a function of temperature and time. A first order reaction kinetics was also developed to model the corn stover torrefaction. pH values of torrefaction bio-oils ranged from 2.3 to 2.76 which were similar to those of bio-oils from biomass pyrolysis. GC/MS analysis for torrefaction bio-oils showed that the organic acid was about 2.16% to 12.00%. The torrefaction bio-oils also contain valuable chemical compounds such as phenols, furan derivatives and aliphatic hydrocarbons determined by a GC/MS. There are no aromatic compounds and polycyclic aromatic hydrocarbons (PAHs) detected in the torrefaction bio-oils. The torrefaction biogas was mainly consisted of CH4, C2H6, C3H8, which was about 56 wt% of the total bio-gas. The biogas can be used for chemical synthesis or electricity generation. The heating values of torrefied biomass were from 18.64-22.22 MJ/Kg depending on the process conditions. The heating values of torrefied biomass were significantly greater than those of raw biomass and similar to those of coals. The energy yields of torrefied biomass from 87.03- 97.87% implied that most energy was retained in the torrefied biomass. Economic analysis indicated that the biomass microwave torrefaction plant located in a farm is profitable.

MSEC2011-50232

CONSIDERATION OF MANUFACTURING PROCESSES AND THE SUPPLY CHAIN IN PRODUCT DESIGN

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As efforts continue to incorporate environmental sustainability into product design, struggles persist to concurrently consider the environmental impacts resulting from transportation planning and supply chain network design. In fact, the transportation sector is the second largest contributor to direct greenhouse gas (GHG) emissions in the United States, following electricity generation. To address these concerns and consider environmental issues more holistically during the development of products, Design for X (X: manufacturing, environment, etc.) methods, such as environmentally benign manufacturing (EBM) and life cycle assessment (LCA) continue to be advanced through research. In spite of improving environmental performance through design, supply chain related impacts are not well understood and can be impacted by decisions made during product design. Thus, the aim of this research is to explore how changes to the design of a product affect manufacturing supply chain configurations and, in turn, influence product environmental sustainability. The environmental impacts for producing several three-ring binder design variations are predicted by assuming a given set of suppliers that provide materials and components to the

manufacturer. Supply chain transportation impacts are also accounted for in the analysis. Transportation impacts are found to be minor compared to materials and manufacturing impacts.

MSEC2011-50233

PLANT LAYOUT OPTIMIZATION CONSIDERING THE EFFECT OF MAINTENANCE

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With increasing production costs and constraints, demand has increased for manufacturers to minimize maintenance cost and product transport time. We address some aspects of this problem by examining how to choose the optimal layout of stations (machines or buffers) in a production facility based on how the station layout affects the maintenance and product transport times. Specifically, we consider how the location of the stations relative to the maintenance facility affects the overall maintenance time as well as how the location of the final station affects the product transport time. Hence, we can address maintenance cost during the design-phase of a production facility. By employing discrete-design optimization techniques, we generate and evaluate various station layouts to choose an optimal layout which satisfies all geometric and adjacency constraints. We focus on a single, serial production line including a set of n stations.

MSEC2011-50234

SIZE EFFECTS IN CUTTING WITH A DIAMOND-COATED TOOL

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In machining using a diamond-coated tool, the tool geometry and process parameters have compound effects on the thermal and mechanical states in the tools. For example, decreasing the edge radius tends to increase deposition-induced residual stresses at the tool edge interface. Moreover, changing the uncut chip thickness to a small-value range, comparable or smaller than the edge radius, will involve the so-called size effect. In this study, a developed 2D cutting simulation that incorporates deposition residual stresses was applied to evaluate the size effect, at different cutting speeds, on the tool stresses, tool temperatures, specific cutting energy as well as the interface stresses around a cutting edge. The size effect on the radial normal stress is more noticeable at a low speed. In particular, a large uncut chip thickness has a substantially lower stress. On the other hand, the size effect on the circumferential normal stress is more noticeable at a high speed. At a small uncut chip thickness, the stress is largely compressive.

MSEC2011-50235

THEORETICAL AND NUMERICAL ANALYSIS OF INCREMENTAL SHEET FORMING BY USING HIGH PRESSURE WATER JET

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Incremental sheet forming using water jet (ISF-WJ) is a new sheet metal forming process proposed in recent years. Few reports can be found on this process and some basic questions are unanswered, i.e., the water jet pressure required for plastic forming and the accuracy of this forming process. In this paper, an analytical model was developed to evaluate the size effect in the ISF-WJ process with respect to some key parameters, such as sheet thickness, part dimension, jet size and jet pressure. Three commonly used engineering sheet materials (aluminum, stainless steel and titanium) are studied in the analysis and the formability of water jet on these materials was evaluated. In addition, comparisons are made between the ISF-WJ and conventional ISF process with rigid tool based on finite element simulations. The result suggests that the dimensional accuracy of ISF-WJ may be controlled by a supporting back plate and ISF-WJ shows a better distribution of strain and thickness reduction than ISF process. It also provides a good reference for future ISF-WJ equipment design and development.

MSEC2011-50238

PREDICTION ON DIE STRUCTURE PERFORMANCE DURING ADVANCED HIGH-STRENGTH STEEL SHEET METAL STAMPING WITH NON-RIGID TOOLING DEFINITION

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Die structure behavior and its stability are playing more important roles in stamping of advanced high-strength steel (AHSS) sheet metals since the die structure has to maintain steady forming conditions when larger forming load is generated and applied on the die components. Before the workshop try-out, the virtual testing tool is necessary to assure the stamping die design safety. In this paper, a reliable and

efficient method to forecast the die structure performance using an updated load mapping algorithm was proposed to verify the stamping die structure design. Furthermore, an improved method for sheet metal forming modeling with non-rigid tooling definition was also presented to enhance the prediction accuracy. In order to validate the proposed method, a step-shaped-bottom cup drawing die was developed and a data collection system was also adopted to measure the strain/stress evolution at specified locations and to reveal the phenomenon of tooling deflection during the AHSS sheet metal drawing process. The comparison between experimental results and prediction demonstrated very good correlation, and the revised method is more accurate and efficient and is expected to be used to verify the industrial AHSS stamping die designs and support the further research on die structure optimization.

SEC2011-50240

INDIRECT APPROACH TO ULTRASONIC SUPERPOSITION IN MICRO-EDM

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Micro Electro Discharge Machining is a well known process for machining microstructures with highest precision in hard and brittle or tough materials. The deeper the structures and therefore higher the aspect ratio, the more difficult it is to remove the ablated particles from the discharge zone and keep the process in stable condition. Flushing can be aided by vibration of either tool or workpiece. Thus, applying ultrasonic vibration to micro EDM has proven to enhance the process significantly. The vibration is most efficiently induced via the tool or workpiece directly to the discharge zone. However, to achieve an ultrasonic vibration of the tool or workpiece, a complex vibration system that operates in resonant mode is needed. Any crucial change of the vibrating parts results in a demanding and therefore expensive adjustment of the vibrating system. With this setup, the application of ultrasonic vibration is only profitable for large scale serial production. In this work a different approach of ultrasonic superposition to the EDM is proposed. A highly focused ultrasonic vibration is induced into the dielectric in a way to directly influence the discharge zone. This indirect ultrasonic superposition can be easily applied since it is independent of the tool or workpiece geometry. Experiments are carried out to examine the effects of the indirect ultrasonic superposition on the EDM process. First results show the possibility of enhancing micro-EDM by this approach.

MSEC2011-50244

EXPERIMENTAL AND NUMERICAL MODELING ANALYSIS OF MICRO-MILLING OF HARDENED H13 TOOL STEEL

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Yung Shin — Purdue University

This study is focused on experimental evaluation and numerical modeling of micro-milling of hardened H13 tool steels. Multiple tool wear tests are performed in a micro side cutting condition with 100 μm diameter endmills. The machined surface integrity, part dimension control, size effect and tool wear progression in micromachining of hardened tool steels are experimentally investigated. A strain gradient plasticity model is developed for micromachining of hardened H13 tool steel. Novel 2D FE models are developed in software ABAQUS to simulate the continuous chip formation with varying chip thickness in complete micro-milling cycles under two configurations: micro slotting and micro side cutting. The steady-state cutting temperature is investigated by a heat transfer analysis of multi micro-milling cycles. The FE model with the material strain gradient plasticity is validated by comparing the model predictions of the specific cutting forces with the measured data. The FE model results are discussed in chip formation, stress, temperature, and velocity fields to great details. It is shown that the developed FE model is capable of modeling a continuous chip formation in a complete micro-milling cycle, including the size effect. It is also shown that built-up edge in micromachining can be predicted with the FE model.

MSEC2011-50245

RESEARCH ON CARRYING CAPACITY OF HYDROSTATIC SLIDEWAY ON HEAVY-DUTY GANTRY CNC MACHINE

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Abstract: Hydrostatic slideway is a key part in the heavy-duty gantry CNC machine, which supports the total weight of the gantry and moves smoothly along the table. Therefore, the oil film between sliding rails plays an important role on the carrying capacity and precision of machine. In this paper, the oil film in no friction is simulated with three-dimensional CFD. The carrying capacity of heavy hydrostatic slideway, pressure and velocity characteristic of the flow field are analyzed. The simulation result is verified through comparing with the experimental data obtained from the heavy-duty

gantry machine. For the requirement of engineering, the oil film carrying capacity was analyzed with simplified theoretical method. The precision of the simplified method is evaluated and the effectiveness is verified with the experimental data. The simplified calculation method was provided for designing oil pad on heavy-duty gantry CNC machine hydrostatic slideway.

MSEC2011-50246

EVALUATION OF A REVERSE OSCILLATORY FLOW MICROREACTOR DESIGN FOR THE SYNTHESIS OF UNIFORMLY-SIZED NANOPARTICLES

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Brian K. Paul — Oregon State University

Computational fluid dynamics is used to refine the operating parameters of a Reverse Oscillatory Flow (ROF) microreaction system for the synthesis of uniformly-sized nanoparticles. The ROF mixing system uses highly advective flow regions to achieve high quality mixing over short mixing lengths. The mixing system is further enhanced by sinusoidal inlet flow conditions which create plugs having reduced diffusional lengths. Flow conditions leading to plug creation were found to be chiefly responsible for shorter mixing times. Residence time distributions (of simulated inert particles) were found to decrease with increasing pump displacement. It is expected that these conditions will lead to smaller particle size distributions. Mixing quality and residence time distribution are not captured well by Reynolds or Strouhal numbers; however the maximum inlet Reynolds number does correlate well with mixing time trends. Implications for flow conditions are discussed.

MSEC2011-50247

AN INVESTIGATION INTO MACHINABILITY OF SINTERED NANOCRYSTALLINE HYDROXYAPATITE

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Close physical properties with human bone make sintered hydroxyapatite (HAP) a suitable bioceramic material for hard tissue replacement. When being used as implant devices in the human body, the HAP bioceramic needs to be machined to the closest possible configuration with minimal surface roughness. This study investigates the machinability of a newly developed, fully dense nanocrystalline hydroxyapatite (nHAP) bioceramic in turning operations. Efforts are focused on the effects of various machining conditions on surface integrity. Surface roughness is measured using a surface profilometer and the machined surface is observed using a scanning electron microscope (SEM). Chip morphology and tool wear are examined using an optical microscope. Cutting forces are measured using a three-component dynamometer. Based on the experimental results, it is found that the nHAP bioceramic is not very difficult to machine because the tool wear and cutting forces are small. However, the big challenge is how to obtain a smooth and strong surface without chipping or fracturing the material. Two machining strategies are proposed for improving the surface integrity of the sintered nHAP bioceramic in the future.

MSEC2011-50248

A STUDY ON MACHINING AND ENVIRONMENTAL CHARACTERISTICS OF MICRO-DRILLING PROCESS USING NANOFLUID MINIMUM QUANTITY LUBRICATION

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Sang Won Lee — Sungkyunkwan University

This paper presents two basic experimental studies of a micro-drilling process with nanofluid minimum quantity lubrication (MQL) in terms of machining and environmental characteristics. By using a miniaturized desktop machine tool system, a series of micro drilling experiments were conducted in the cases of dry, compressed air and nanofluid MQL. The experimental results imply that nanofluid MQL significantly reduces the adhesion of chips when compared with the cases of dry and compressed air micro-drilling. As a result, it is observed that the magnitudes of average drilling torque and thrust force are decreased and the tool life of micro drills is extended in the case of nanofluid MQL micro-drilling process. In addition, the empirical study on environmental characteristics of MQL micro-drilling process is conducted by measuring MQL oil mist with the oil sampling method. The results show that remaining MQL oil mist is tiny enough not to have a detrimental effect on human health.

MSEC2011-50249

THE EFFECT OF NANOPARTICLES ON PROCESSING AND PROPERTIES OF ALUMINUM NITRIDE BY POWDER INJECTION MOLDING

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Timothy McCabe — Kinetics

Sundar Atre — ONAMI

Aluminum nitride (AlN) exhibits many functional properties that are relevant to applications in electronics, aerospace, defense and automotive industries. However, the successful translation of these properties into final applications lies in the net-shaping of ceramics into fully dense microstructures. Increasing the packing density of the starting powders is one effective route to achieve high sintered density and dimensional precision. The present paper presents an in-depth study on the effects of nanoparticle addition on the powder injection molding process (PIM) of AlN powder-polymer mixtures. In particular, bimodal mixtures of nanoscale and sub-micrometer particles were found to have significantly increased powder packing characteristics (solids loading) in the powder-polymer mixtures. The influence of nanoparticle addition on the multi-step PIM process was examined. The above results provide new perspectives which could impact a wide range of materials, powder processing techniques and applications.

MSEC2011-50250

THERMO-MECHANICAL INVESTIGATIONS OF THE ELECTROPLASTIC EFFECT

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Recent development of Electrically-Assisted Manufacturing processes proved the advantages of using the electric current, mainly related with the decrease in the mechanical forming load and improvement in the formability when electrically-assisted forming of metals. The reduction of forming load was formulated previously assuming that a part of the electrical energy input is dissipated into heat, thus producing thermal softening of the material, while the remaining component directly aids the plastic deformation. The fraction of electrical energy applied that assists the deformation process compared to the total amount of electrical energy is given by the electroplastic effect coefficient. The objective of the current research is to investigate the complex effect of the electricity applied during deformation, and to establish a methodology for quantifying the electroplastic effect coefficient. Temperature behavior is observed for varying levels of deformation and previous cold work. Results are used to refine the understanding of the electroplastic effect coefficient, and a new relationship, in the form of a power law, is derived. This model is validated under independent experiments in Grade 2 (commercially pure) and Grade 5 (Ti-6Al-4V) titanium.

MSEC2011-50254

LOADING PATH DESIGN OF TUBULAR HYDROFORMING PROCESS FOR COMPLICATED SHAPED MG ALLOY COMPONENTS

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This paper aims to present an optimization process for three different types of loading paths studied in the numerical simulation of tube hydroforming of diamond-shaped sheet products. These three different types of loading paths werestudied in a numerical simulation of tube hydroforming of diamond-shaped products. The loading paths by which the best final shapes were obtained in the simulation were adopted in actual processing operation. A series of experiments were conducted within the temperature range of 270±10oC. Constitutive behavior was assumed to be elasto-plastic, and the material parameters used in the simulation were obtained from corresponding literature. The designed loading ratios were incorporated into the model to obtain the corresponding hydroforming results. The simulation results are used in the experimental verification and the products were compared with the simulation results. The experimental results showed a good agreement with the predicted numerical results, indicating that FEM simulation is an effective tool in optimizing processing procedures.

MSEC2011-50256

ORTHOGONAL CUTTING STUDY OF THE MICRO-CUTTING THIN WORKPIECE

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With a broader intention of producing thin sheet embossing molds, results from investigations in orthogonal cutting of thin workpieces are presented here. Challenges in machining thin workpieces are many: residual stress effects, fixturing challenges, and substrate effects. Aluminum alloy Al6061-T6 workpiece fixture using an adhesive is orthogonally cut with a single crystal diamond tool. We study trends in cutting forces, understand to what level of thickness we can machine the

workpiece down to and in what the form the adhesive fails. Two types of workpiese-adhesive anomalies were noticed. One is the detachment of the thin workpiece by peel-off and the other one is where the workpiece did not get detached but the final width of the workpiece was non-uniform. We then use a validated finite element machining model to understand the stresses in the workpiece when it is thick and when machined to thin condition, effect of the adhesive itself and also the effect of adhesive thickness. Simulations show that the stress induced by the cutting process at the bottom of the workpiece is higher for the thinner workpiece (40 micrometers) compare to a thicker workpiece (400 micrometers) especially at the tool entrance region for adhesive thicknesses of 30 micrometers and 100 micrometers. Hence a thinner workpiece is more susceptible to failure by adhesive peeling.

MSEC2011-50257

INFLUENCE OF CONTINUOUS DIRECT CURRENT ON THE MICRO TUBE HYDROFORMING PROCESS.

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Jaime Camelio — Virginia Tech

Research of the micro tube hydroforming (MTHF) process is being investigated for potential medical and fuel cell applications. This is largely due to the fact that at the macro scale the tube hydroforming (THF) process, like most metal forming processes has realized many advantages. Unfortunately, large forces and high pressures are required to form the parts so there is a large potential to create failed or defective parts. Electrically Assisted Manufacturing (EAM) and Electrically Assisted Forming (EAF) are processes that apply an electrical current to metal forming operations. The intent of both EAM and EAF is to use this applied electrical current to lower the metals required deformation energy and increase the metal's formability. These tests have allowed the metals to be formed further than conventional methods without sacrificing strength or ductility. Currently, various metal forming processes have been investigated at the macro scale. These tests also used a variety of materials and have provided encouraging results. However, to date, there has not been any research conducted that documents the effects of applying Electrically Assisted Manufacturing (EAM) techniques to either the tube hydroforming process (THF) or the micro tube hydroforming process (MTHF). This study shows the effects of applying a continuous direct current to the MTHF process.

MSEC2011-50258

CHARACTERIZATION OF TENSILE AND COMPRESSIVE BEHAVIOR OF MICROSCALE SHEET METALS USING A TRANSPARENT MICRO-WEDGE DEVICE

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Rui Zhou — Northwestern University

Morgan McHugh — Northwestern University

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The cyclic and compressive mechanical behavior of ultra-thin sheet metals was experimentally investigated. A novel transparent wedge device was designed and fabricated to prevent the buckling of thin sheets under compressive loads, while also allowing full field strain measurements of the specimen using digital imaging methods. Thin brass and stainless steel sheet metal specimens were tested using the micro-wedge device. Experimental results show that the device can be used to delay the onset of early buckling modes of a thin sheet under compression, which is critical in examining the compressive and cyclic mechanical behavior of sheet metals.

MSEC2011-50259

DEVELOPMENT OF HA-PLGA SCAFFOLD ENCAPSULATING INTACT BMP-2 USING SOLID FREEFORM FABRICATION TECHNOLOGY

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Tissue engineering is an interdisciplinary field for the restore and repair of tissues or organs. Cells, scaffold and biomolecules are recognized as three main components of tissue engineering. Solid freeform fabrication (SFF) technology is required to fabricate three-dimensional (3D) porous scaffolds to provide 3D environment for cellular activity. The SFF technology is especially advantageous to obtain fully interconnected porous scaffold. Bone morphogenic protein-2 (BMP-2), one of the important biomolecule, is widely applied to bone tissue engineering for enhancement of bone regeneration activity. However, methods for direct incorporation of intact BMP-2 within 3D scaffolds are rarely

introduced. In this work, 3D porous scaffolds with poly(lactic-co-glycolic acid) chemically grafted hyaluronic acid (HA-PLGA), in which intact BMP-2 was directly encapsulated, were successfully fabricated using SFF technology. BMP-2 was previously protected by poly(ethylene glycol) (PEG) and the BMP-2/PEG complex was incorporated within HA-PLGA using organic solvent. Prepared HA-PLGA/PEG/BMP-2 mixture was dissolved in chloroform and deposited via multi-head deposition system (MHDS), one type of SFF technology, to fabricate a scaffold for tissue engineering. Additional air blower system and suction were installed in MHDS for solvent based fabrication method. In-vitro BMP-2 release was studied and sustained release of intact BMP-2 for 28 days was observed. After confirmation of higher proliferation on pre-osteoblasts, relatively higher differentiation effect of HA-PLGA/PEG/BMP-2 scaffold was validated by measuring high expression levels of bone specific markers such as alkaline phosphatase (ALP) and osteocalcin (OC). We found that our solvent based fabrication method is non-toxic for cellular activity and thus, HA-PLGA/PEG/BMP-2 scaffold was effective for bone regeneration.

MSEC2011-50260

COMPARATIVE ASSESSMENT OF THE LASER INDUCED PLASMA MICRO-MACHINING (LIP-MM) AND THE MICRO-EDM PROCESSES

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Kornel F. Ehmann — Northwestern University

The paper introduces the LIP-MM process and compares its micro-machining capabilities with micro-EDM in the machining of micro-channels. While, micro-EDM is a well-established micro-manufacturing process and has been at the center of research for the last 15 years, the LIP-MM is a newly developed micro-machining process. Although both processes utilize plasma to perform micro-machining, differences in their plasma generation mechanism and hence differences in their plasma characteristics lead to differences in their micro-machining capabilities. For comparative assessment of their micro-machining capabilities, micro-channels were machined by the two processes at similar pulse energy levels, while other process parameters were maintained at their optimal values, depending on the respective experimental setups used. The comparative assessment was based on the geometric characteristics of the micro-channels, material removal rate (MRR), productivity in the machining of micro-channels, effect of tool wear, and the range of machinable materials for the two processes. Keywords: micro-EDM, Laser, Plasma, Micro-machining.

MSEC2011-50262

IMPROVEMENT OF GEOMETRIC ACCURACY IN INCREMENTAL FORMING USING A SQUEEZING TOOLPATH STRATEGY WITH TWO FORMING TOOLS

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Single Point Incremental Forming (SPIF) is plagued by an unavoidable and unintended bending in the region of the sheet between the current tool position and the fixture, which leads to significant geometric inaccuracies. Double Sided Incremental Forming (DSIF) uses two tools, one on each side of the sheet to form the sheet into the desired shape. This work explores the capabilities of DSIF in terms of improving the geometric accuracy as compared to SPIF by using a novel toolpath strategy in which the sheet is locally squeezed between the two tools. Experiments and simulations are performed to show that this strategy can improve the geometric accuracy of the component significantly. An examination of the forming forces indicates that after a certain amount of deformation using this strategy a loss of contact occurs between the bottom tool and the sheet. The effects of this on the geometric accuracy are discussed as well.

MSEC2011-50263

DIELECTRIC AND PIEZOELECTRIC CERAMICS FOR HIGH TEMPERATURE APPLICATIONS

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Perovskite materials have been widely embedded in many consumer and industrial electronics, both for capacitor applications, in the case of dielectric materials, and for actuator, transducer, sensor applications, in the case of piezoelectric materials. Functional devices used in high temperature environments such as deep oil well instrumentation, geothermal exploration, and devices for aerospace applications require the persistence of materials' properties at high temperatures. In this paper, high potential capacitor and piezoelectric ceramics for high temperature applications are presented. High-K 0.8BaTiO3 – 0.2Bi(Zn1/2Ti1/2)O3 solid solutions have been shown to have superior properties for high temperature capacitors. Temperature dependence studies of dielectric properties have

shown that the composition with Ba vacancies exhibit a high relative permittivity (> 1150) and a low dielectric loss (< 0.05) that persists up to a temperature of 460 °C. This composition also shows a high resistivity in excess of 7.0 x 1010 ohm-cm and remains unchanged up to a temperature of 270 °C as well as a large RC time constant (RC > 20 s). In the case of high temperature piezoelectric ceramics, solid solutions of PbTiO3 – BiScO3 – Bi(M1/2Ti1/2)O3 ternary systems were studied, where M is Mg, and Zn. The ratio of BiScO3 to Bi(M1/2Ti1/2)O3 was kept at 1:1, while the concentration of PbTiO3 was varied. X-ray diffraction patterns showed that tetragonal symmetry was observed in compositions, which contain a high concentration of PbTiO3 (> 60 mol%). Evidence of morphotropic phase boundary (MPB) was observed with compositions containing PbTiO3 in range of 52 – 56 mol%. At 70 mol% PbTiO3 compositions, high Curie temperatures (TC) of 490 °C and 533 °C were observed for compositions containing Mg and Zn, respectively.

MSEC2011-50267

A BIO-INSPIRED FRAMEWORK FOR A SELF-HEALING ASSEMBLY SYSTEM

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Statistical process monitoring and control has been popularized throughout the manufacturing industry as well as various other industries interested in improving product quality and reducing costs. Advances in this field have focused primarily on more efficient ways for diagnosing faults, reducing variation, developing robust design techniques, and increasing sensor capabilities. System level advances are largely dependent on the introduction of new techniques in the listed areas. A unique system level quality control approach is introduced in this paper as a means to integrate rapidly advancing computing technology and analysis methods in manufacturing systems. Inspired by biological systems, the developed framework utilizes immunological principles as a means of developing self-healing algorithms and techniques for manufacturing assembly systems. The principles and techniques attained through this bio-mimicking approach will be used for autonomous monitoring, detection, diagnosis, prognosis, and control of station and system level faults, contrary to traditional systems that largely rely on final product measurements and expert analysis to eliminate process faults.

MSEC2011-50273

AN INVESTIGATION ON DEFORMATION-BASED MICRO SURFACE TEXTURING

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Micro surface textures have various applications ranging from friction/wear reduction to the prevention of bacteria growth. Deformation-based micro surface texturing has the potential of economically creating micro surface textures over large surface areas. To this end, a novel desktop micro surface texturing system is proposed and developed for efficiently and economically fabricating micro channels on the surface of thin sheet materials for micro fluidic and friction/wear reduction applications. Both experimental and numerical studies were employed to analyze the problems related to the flatness of the textured sheet, the uniformity of the channel depths and pile-ups built up during the micro surface texturing process. The results demonstrate a clear relationship between the relative velocity of the upper and lower rolls and the flatness of the textured sheet and the final profile of the micro channels.

MSEC2011-50274

BIOHYDROGEN PRODUCTION FROM GLYCEROL IN MICROBIAL ELECTROLYSIS CELLS AND PROSPECTS FOR ENERGY RECOVERY FROM BIODIESEL WASTES

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The manufacture of biodiesel generates 10 wt% of glycerol as a byproduct. Currently, the majority of this waste glycerol is treated in wastewater treatment plants or incinerated. In this study, single chamber, membrane-free microbial electrolysis cells (MECs) was evaluated to produce hydrogen from pure glycerol and waste glycerol. At an applied voltage of 0.6 V, a maximum current density of 7.5 ± 0.4 A/m2 (238.6 ± 12.7 A/m3) was observed, the highest reported current density for a microbial electrochemical system operating on glycerol. Maximum current densities on 0.5% waste glycerin were 0.1-0.2 A/m2, much lower than those on pure glycerol, possibly due to the high salt and soap concentration in the waste glycerol. The maximum hydrogen yield on 50 mM glycerol was 1.8 ± 0.1 mol hydrogen/mol glycerol at a hydrogen production rate of 1.3 ± 0.1 m3/day/m3. The presence of methanol in the waste glycerin reduced hydrogen yield by nearly 30%. The energy efficiency on 0.5% of waste glycerol reached 200% at an applied voltage of 0.6 V. Conversion of all of the waste glycerol currently generated annually in global biodiesel

manufacture to hydrogen using optimized MEC technology could generate ~180 million kg of H2, representing a value of nearly $540 million, or the amount of H2 required for the production of 4.8 billion kg of green diesel. This study indicates that the generation of useful products (such as hydrogen) from waste glycerol will greatly increase the viability of the growing biodiesel industry.

MSEC2011-50275

GEOMETRIC MODELING AND ANALYSIS OF SINGLE POINT CUTTING TOOLS WITH GENERIC PROFILE

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The presented work models the geometry of Single Point Cutting Tools (SPCTs) with generic profile. Presently few standard shapes of SPCTs defined in terms of projective geometry are being employed while there is a need to design free-form tools to efficiently machine free-form surfaces with few passes and chosen range of cutting angles. To be able to produce SPCT face and flanks with generic shapes through grinding, a comprehensive geometric model of the tool in terms of the varying grinding angles and the ground depths is required which helps design the tool with arbitrarily chosen tool angles. The surface modeling begins with the creation of a tool blank model followed by transformation of unbounded planes to get the cutting tool surfaces. The intersection of these surfaces with the blank gives the complete model of the tool. Having created the geometric model in two generations of generalization, the paper presents the methodology to obtain the conventional tool angles from the generic model. An illustration of the model has been provided showing variation of tool angles along the cutting edge with changing grinding parameters. When the geometric model is not to be related to the grinding parameters, the SPCT can be modeled as a composite NURBS surface which has been presented towards the end of the work.

MSEC2011-50268

NANOSCALE SURFACE MODIFICATIONS BY MAGNETIC FIELD-ASSISTED FINISHING

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A magnetic field-assisted finishing (MAF) process has been developed to reduce the sidewall surface roughness of the 5–20 micron wide curvilinear pores of microelectromechanical systems micropore X-ray optics. Although the feasibility of this process has been demonstrated on these optics, a clear understanding of the MAF process material removal mechanisms has not been attained. To discover these mechanisms, the MAF process is applied to a flat workpiece, allowing for direct observation and tracking of changes to distinctive surface features before and after MAF. Atomic force microscopy, field-emission scanning electron microscopy, and energy-dispersive X-ray spectroscopy are used to analyze the surface morphology and composition with respect to polishing time. These observations suggest that the MAF process removes surface material, improving surface roughness (to 0.1 nm Rq on silicon) without significantly changing the shape of existing surface features. Moreover, the MAF process appears to remove material by mechanical means.

MSEC2011-50270

MOLECULAR DYNAMICS SIMULATION OF AFM-BASED NANOMACHINING PROCESSES

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Recently, atomic force microscopy (AFM) has been widely used for nanomachining and fabrication of micro/nanodevices. This paper describes the development and validation of computational models for AFM-based nanomachining (nanoindentation and nanoscratching). The Molecular Dynamics (MD) technique is used to model and simulate mechanical indentation and scratching at the nanoscale in the case of gold and silicon. The simulation allows for the prediction of indentation forces and the friction force at the interface between an indenter and a substrate. The effects of tip curvature and speed on indentation force and friction coefficient are investigated. The material deformation and indentation geometry are extracted based on the final locations of atoms, which are displaced by the rigid tool. In addition to modeling, an AFM was used to conduct actual

indentation at the nanoscale, and provide measurements to validate the predictions from the MD simulation. The AFM provides resolution on nanometer (lateral) and angstrom (vertical) scales. A three-sided pyramid indenter (with a radius of curvature ~ 50 nm) is raster scanned on top of the surface and in contact with it. It can be observed from the MD simulation results that the indentation force increases as the depth of indentation increases, but decreases as the scratching speed increases.On the other hand, the friction coefficient is found to be independent of scratching speed.

MSEC2011-50271

SUSTAINABILITY IN NANOMANUFACTURING: STATUS AND VISION FOR THE FUTURE

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Nanomaterials and nanomanufacturing is one of the fast growing and interesting fields in recent research and industries, and gaining huge interest around the world. As the nanomaterials has a higher physical and mechanical properties compared to their metal counterparts, it is expected that significant amount (15-20%) of nanomaterials will be put into use in less than five years periods almost in all fields of manufacturing. As the nanomaterial manufacturing is new, it is essential to establish an optimal method so as to reduce wastages and to increase the ratio of output to input materials used. It's important to use the minimal energy, water and other raw materials. Thus, this review will more concentrate on the sustainability of inputs, need to improve or optimize the production methods or sustainable manufacturing and green gas production and its global effects. Suitability of both top-down and bottom-up processing for nanoparticles will be addressed. Need of life cycle analysis to understand feasibility of recyclable at the end of the life with least possible wastage and reduced energy. Current research on environmental benefits and risk of potential toxicity and health effects of nanoproducts will be discussed.

MSEC2011-50276

CDS NANOPARTICLE SYNTHESIS USING OSCILLATORY FLOW MIXING

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Microchannel mixers enable faster mixing times compared with batch stir mixing leading to the promise of higher throughput, better yields and less solvent usage for the solution-phase reactive precipitation of inorganic nanoparticles. However, reliance on diffusive transport for subsecond mixing requires channel dimensions in the tens of micrometers. These channel dimensions make diffusive micromixers vulnerable to clogging. In this paper, an oscillatory flow mixing strategy is explored to increase the contact area between reagents within larger microchannels. Forward and reverse oscillatory signals are designed to pump reactants through a 450 μm high serpentine microchannel to increase advection within the flow. Computational fluid dynamics simulations are performed to provide insight into flow behavior and nanoparticle morphology. Quantification of mixing performance is proposed using mixing quality and particle residence time metrics. Experimental validation is pursued through the reactive precipitation of CdS quantum dots using a reverse oscillatory mixing setup. Transmission electron microscopy provides insights into the particle size distribution and particle crystallinity.

MSEC2011-50278

ON THE VOLUMETRIC ASSESSMENT OF TOOL WEAR IN MACHINING INSERTS WITH COMPLEX GEOMETRIES: NEED, METHODOLOGY & VALIDATION

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The objective of this paper is to qualitatively assess the inadequacies of the current manner of tool wear quantification and consequently to suggest/develop a more comprehensive approach to machining tool wear characterization. Traditional parameters used for tool wear representation such as flank and crater wear are no longer self-sufficient to satisfactorily represent the wear of the complex geometric profiles of more recent cutting tools. These complexities in tool geometries are all the more pronounced when catering to difficult-to-machine materials such as titanium and its alloys. Hence, alternatives to traditional tool wear assessment parameters are briefly explored and a suitable one is selected, that will

help understand the very nature of the evolving wear profile itself from a three dimensional standpoint. The assessment methodology is further developed and standardized and suggestions for future use and development provided. The measurement system is evaluated using a gauge repeatability and reproducibility (R&R) study as well. The method is deployed for assessing tool wear during the machining of Ti-6Al-4V at selected process conditions for validation purposes. Further, concepts such as the M-ratio and its derivatives are developed to quantify the efficiency of the cutting tool during each pass as a function of time at a theoretically constant material removal rate (MRR).

MSEC2011-50279

TEMPERATURE FIELD CORRELATION WITH SURFACE INTEGRITY IN HARD MILLING

Hardik Singh — The University of Alabama

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Experimental and FEA study is conducted to get an insight into critical mechanisms of temperature, deformation, stress generation and variations with cutting speed and tool wear in hard milling AISI H13 steel (50±1 HRC). The critical issues like energy consumption during milling and the resulting surface integrity of the machined component depend on the tool and workpiece interaction. An insight into tool and workpiece interaction is needed in order to design a better milling process for required surface integrity. 2D finite element simulation of orthogonal cutting model is performed to investigate the variations of temperatures and residual stresses at different cutting speeds and tool wears. Hard milling experiments are conducted to correlate with the simulation results. The fact that in hard milling, the temperature does not penetrate deep into the workpiece and there is no clear evidence of heat affected zone such as white layer is demonstrated. With the finite element simulations and experiments, the capability of hard milling process to achieve better surface integrity on the machined surface is explored.

MSEC2011-50280

PROCESS MECHANICS IN DEEP ROLLING OF MAGNESIUM-CALCIUM (MGCA) BIOMATERIAL

M. Salahshoor — The University of Alabama

Y.B. Guo — University of Alabama

Magnesium-Calcium (MgCa) alloys have received considerable attention recently in medical device manufacturing industry specially in making biodegradable bone implants. Deep rolling (DR) is as a promising manufacturing technique to adjust surface characteristics of implants with the ultimate goal of being able to adjust corrosion rates of MgCa implants. Contact mechanics between rolling ball and the workpiece is essential to understand the DR process. Contact mechanics is further complicated by the normal force reduction due to hydraulic pressure loss at the tip of DR tool, and the penetration depth reduction due to elastic recovery. The measured normal force, in this study, shows maximum 23% reduction compared to theoretical value. The normal force drop is not uniform and increases with increasing applied pressure. A 2D axisymmetric, semi-infinite FEM model is developed and validated to predict the amount of elastic recovery after deep rolling. The dynamic mechanical behavior of the material is simulated using the internal state variable (ISV) plasticity model and implemented in FEM code using a user material subroutine. The simulated dent geometry agrees with the measured ones in terms of profile and depth. Simulation results suggest 8% elastic recovery on average.

MSEC2011-50281

CUTTING MECHANICS OF HIGH SPEED DRY MACHINING OF MAGNESIUM-CALCIUM BIOMEDICAL ALLOY USING INTERNAL STATE VARIABLE PLASTICITY MODEL

M. Salahshoor — The University of Alabama

Y.B. Guo — University of Alabama

Magnesium-Calcium (MgCa) alloys have become attractive orthopedic biomaterials due to their biodegradability, biocompatibility, and congruent mechanical properties with bone tissues. However, process mechanics of machining biomedical MgCa alloys is poorly understood. Mechanical properties of the biomedical magnesium alloy at high strain rates and large strains are determined by using the split-Hopkinson pressure bar testing method. Internal state variable (ISV) plasticity model is implemented to understand the dynamic material behavior under cutting conditions. A finite element simulation model has been developed to study the chip formation during high speed dry cutting of MgCa0.8 (wt %) alloy. Continuous chip formation predicted by the FE simulation is verified by high speed dry face milling of MgCa0.8 using polycrystalline diamond (PCD) inserts. Chip ignition is known as the most hazardous aspect of machining Mg alloys. The predicted temperature distributions may well explain the reason for machining safety of high-speed dry cutting of MgCa0.8 alloy.

MSEC2011-50282

SURFACE INTEGRITY AND FATIGUE STRENGTH OF HARD MILLIED SURFACES

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Y.B. Guo — University of Alabama

M. Barkey — The University of Alabama

C. Guo — United Technologies Research Center

Zhanqiang Liu — Shandong University

Tool flank wear during hard milling adversely affects surface integrity and, therefore, fatigue strength of machined components. Surface integrity and machining accuracy deteriorate when tool wear progresses. In this paper, surface integrity and its impact on endurance limit of AISI H13 tool steel (50 ± 1 HRC) by milling using PVD coated tools are studied. The evolutions of surface integrity including surface roughness, microhardness and microstructure were characterized at three levels of tool flank wear (VB = 0, 0.1mm, 0.2mm). At each level of tool flank wear, the effects of cutting speed, feed, and radial depth-of-cut on surface integrity were investigated respectively. Fatigue endurance limits of the machined surfaces at different reliability levels were calculated and correlated with the experimentally determined fatigue life. The good surface finish and significant strain-hardening on the machined surfaces enhance endurance limit, which enables machined components have a fatigue life over one million cycles.

MMSEC2011-50283

A VERTEX TRANSLATION ALGORITHM FOR ADAPTIVE MODIFICATION OF STL FILE IN LAYERED MANUFACTURING

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Modern Rapid Prototyping (RP)/Rapid Manufacturing (RM) machines use a Stereolithography (STL) file to manufacture parts. However, the conversion of the part CAD file to STL results in the distortion of the part geometry, particularly if the part consists of freeform curved surfaces. Existing algorithms and software tend to reduce this distortion globally, which typically increases the size and memory requirements of the STL file. This paper presents a new approach for reducing the CAD to STL translation error locally, using chordal error as the criteria. The algorithm presented here compares the STL file to the design surface of the part, expressed as a NURBS surface, and computes the chordal error for multiple points on the STL facets. The point within each STL facet having the largest chordal error is modified to coincide with its corresponding point on the design surface. This replaces the original facet of the STL file with three new facets with significantly lower chordal error than that of the original facet. This Vertex Translation Algorithm (VTA), reduces the chordal error in areas with high curvature and areas having tighter profile tolerance specifications. The algorithm provides the user the flexibility to selectively modify the STL file according to the tolerance requirements. The algorithm has been validated with the help of a test case.

MSEC2011-50284

FORMABILITY AND SURFACE FINISH STUDIES IN SINGLE POINT INCREMENTAL FORMING

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Incremental sheet metal forming (ISMF) has demonstrated its great potential to form complex three-dimensional parts without using a component specific tooling. The die-less nature in incremental forming provides a competitive alternative for economically and effectively fabricating low-volume functional sheet parts. However, ISMF has limitations with respect to maximum formable wall angle, geometrical accuracy and surface finish of the component. In the present work, an experimental study is carried out to study the effect of incremental sheet metal forming process variables on maximum formable angle and surface finish. Box-Behnken method is used to design the experiments for formability study and full factorial method is used for surface finish study. Analysis of experimental results indicates that formability in incremental forming decreases with increase in tool diameter. Formable angle first increases and then decreases with incremental depth and it is also observed that the variation in the formable angle is not significant in the range of incremental depths considered to produce good surface finishes during the present study. A simple analysis model is used to estimate the stress values during incremental sheet metal forming assuming that the deformation occurs predominantly under plane strain condition. A stress based criterion is used along with the above mentioned analysis to predict the formability in ISMF and its predictions are in very good agreement with the experimental results. Surface roughness decreases with increase in tool diameter for all incremental depths. Surface roughness increases first with increase in incremental depth up to certain angle and then decreases. Surface roughness value decreases with increase in wall angle.

MSEC2011-50285

NUMERICAL MODELING OF MINIMUM UNCUT CHIP THICKNESS FOR MICROMACHINING WITH DIFFERENT RAKE ANGLE

Zhenyu Shi — Shandong University

Zhanqiang Liu — Shandong University

In micromachining, when the undeformed chip thickness becomes comparable to the edge radius of the cutting tool, the effective rake angle becomes to be negative and has significant effect on the determination of the minimum uncut chip thickness. The determination of the minimum uncut chip thickness is essential in micro machining in order to achieve desired surface integrity and accuracy. In this paper, an Arbitrary Lagrangian Eulerian (ALE)-based numerical modeling is proposed to determine the minimum uncut chip thickness for Copper by changing the cutting tool's nominal rake angle. According to the relationship between the minimum uncut chip thickness and the effective rake angle, a mathematical model that reflects the relationship between the effective rake angle and the nominal rake angle is established.

MSEC2011-50287

CONSTANT CURRENT DENSITY COMPRESSION BEHAVIOR OF 304 STAINLESS STEEL AND TI-6AL-4V DURING ELECTRICALLY-ASSISTED FORMING

Joshua Jones — Clemson University

Laine Mears, Ph.D., P.E. — Clemson University

A metal forming technique which has more recently come of interest as an alternative to processes that use elevated temperatures at some stage during manufacturing is Electrically-Assisted Forming (EAF). EAF is a processing technique which applies electrical current through the workpiece concurrently while the material is being formed. At present, this method has only been studied on an experimental level in laboratory settings, and the heuristic results show increased fracture strain, reduced flow stress, and reduced springback; the enhanced process capability is beyond the range that would be expected from pure resistive heating alone. Thus far, when applying the electrical current through the workpiece during deformation, the current magnitude flowing through the workpiece has remained constant. Hence, for a compression loading, the current flux or density decreases as a result of an increasing specimen area. This work examines the effect of a non-constant current density (NCCD) and a constant current density (CCD) on the deformation behavior of 304 Stainless Steel and Ti-6Al-4V during uniaxial compression testing. Additionally, the application of a CCD is used to modify existing empirically-based EAF flow stress models for these materials. From this testing, it is shown that a CCD during forming can significantly reduce the flow stress of the material as compared to the NCCD tests. The reductions in the flow stress were increased at higher strains by approximately 30% and 15% for the 304 Stainless Steel and Ti-6Al-4V, respectively. More importantly, these flow stress curves are better representative of how the material responds to an applied electrical current as the specimen shape change is removed from the results. Also, the NCCD tests were approximated using an existing empirically-based EAF flow stress model and the CCD tests concluded that a new flow stress predictor model be introduced.

MSEC2011-50288

INVERSE HALL-PETCH EFFECT IN ATOMISTIC MACHINING OF POLYCRYSTALLINE COPPER STRUCTURES

Jing Shi — North Dakota State University

Xiaoping Yang — Cummins Inc.

Yachao Wang — North Dakota State University

In this study, a preliminary investigation about the grain size effect in machining of polycrystalline copper structures at atomistic scale is carried out using molecular dynamics simulation. Four copper structures with different grain sizes are chosen for simulation. The four structures consist of 16, 64, 128, and 256 grains, and the corresponding equivalent grain sizes are 13.6, 8.6, 6.8, and 5.4 nm, respectively. The results show that significant smaller forces are required to machine the copper workpiece in both the tangential and thrust directions as the grain size decreases. The magnitude of equivalent stress distribution also becomes smaller with the decrease of grain size. It disagrees with the commonly accepted strengthening effect (i.e., the Hall-Petch relation) for polycrystalline materials as a result of grain size reduction. This phenomenon can be explained by the inverse Hall-Petch relation proposed in literature in recent years. According to the new relation, the polycrystalline material strength decreases as the grain size decreases within a threshold value. This can be further attributed to the fact that the dominant deformation mode is changed from dislocation movement to other mechanisms such as grain boundary sliding with very fine nano-structured polycrystalline.

MSEC2011-50294

CONTROLLED NANOCRYSTALLIZATION OF NITI SHAPE MEMORY ALLOY BY LASER SHOCK PEENING

Chang Ye — Purdue University

Gary Cheng — Purdue University

In this paper, partial amorphization of NiTi alloys by laser shock peening (LSP) is reported. The microstructure of NiTi after LSP was characterized by transmission electron microscopy (TEM). The amorphization mechanism was discussed in light of the high strain rate deformation characteristics of LSP. With subsequent controlled annealing after LSP, nanostructure with different grain size distribution was achieved.

MSEC2011-50295

SURFACE TEXTURING OF METALS BY CATHODE SPOTS OF ATMOSPHERIC ARC

Rouzbeh Sarrafi — Research Center for Advanced Manufacturing

Mehdi Asgharifar — Southern Methodist University

Radovan Kovacevic — Southern Methodist University

This paper investigates the application of atmospheric arc (the same arc that is used for welding) for surface texturing of aluminum alloy in micro scale. This research shows that micro-texturing of metallic surfaces is feasible with an arc-based, inexpensive, environment-friendly method. In this paper, fundamental phenomena occurring during surface texturing process using cathode spots of arc are introduced. The surface texturing process is experimentally studied using surface microscopy and high-speed real-time monitoring by a machine-vision system. The advantages of the process and the potential applications of the presented surface treatment technique are discussed.

MSEC2011-50296

NANOSCALE SIZE DEPENDENCE ON METALLIC PARTICLES: CASE STUDY OF TITANIUM NANOPARTICLES ON PULSED LASER SINTERTING OF HYDROXYAPATITE/TITANIUM NANOPARTICLES

Yi Zhang — Purdue University

Gary Cheng — Purdue University

Nanoscale size effects on pulsed laser coating of hydroxyapatite/titanium nanoparticles on metal substrate is discussed in this article. Laser coating method has recently been developed to coat bioceramics material on Ti-6Al-4V substrate. Laser-coated bioceramics implants have several advantages due to the use of nanosized materials: strong interfacial bonding strength, good biocompatibility and potentially longer lifetime cycle. These advantages benefit from intrinsic properties of nanoparticles. Size effects on melting point, heat capacity, thermal and electrical conductivities have been discussed. Multiphysics model is built to reveal the mechanism of laser coating process. Two sub-modules are included in the model: electromagnetic module to represent the laser-nanoparticle interactions and heat transfer module to simulate the heat conduction. Both simulation and experimental results showed that nanoTi, functioning as nanoheaters, effectively enhances the laser coating sinterability. For large nanoTi (>100 nm), sinterability enhancement mainly attributes to the stronger laser-particle interactions due to higher plasmon resonance; for small nanoparticles (<100 nm), not only stronger laser-nanoparticle interactions, reduction on melting point also contributes to sinterability enhancement.

MSEC2011-50297

MEASUREMENT OF TRANSIENT TOOL INTERNAL TEMPERATURE FIELDS DURING HARD TURNING BY EMBEDDED THIN FILM SENSORS

Dirk Werschmoeller — University of Wisconsin-Madison

Xiaochun Li, Ph.D. — University of Wisconsin - Madison

Kornel F. Ehmann — Northwestern University

This paper presents a novel approach for obtaining thermomechanical data from the close vicinity (i.e., 10s of micrometers) of the tool-workpiece interface while machining hardened steel. Arrays of micro thin film thermocouples with junction size 5 μm x 5 μm were fabricated by standard microfabrication methods and have been successfully embedded into polycrystalline cubic boron nitride (PCBN) using a diffusion bonding technique. Scanning electron microscopy (SEM) and energy dispersive X-ray spectroscopy (EDS) were performed to examine material interactions at the bonding interface and to determine optimal bonding parameters. Static and dynamic sensor performances have been extensively evaluated. The sensors exhibit excellent linearity up to 1300 °C, fast rise time of 150 ns, and possess good sensitivity. The PCBN inserts instrumented with embedded thin film C-type thermocouples were successfully applied to measure internal tool temperatures as close as 70 μm to the cutting edge while machining hardened steel workpieces at industrially relevant cutting parameters. Acquired temperature data followed theoretical trends very well. Correlations between temperature and cutting parameters have been established. The embedded micro thin film sensor array provided unprecedented temporal and spatial

resolution as well as high accuracy for micro-scale transient tool-internal temperature field measurements. Tool internal temperature maps were generated from acquired data. In the frequency domain, obtained thermal data indicated the onset of regenerative machining chatter earlier and more effective than conventional force measurement by dynamometer.

MSEC2011-50300

A REVIEW OF RECENT RESEARCH IN SUSTAINABLE MANUFACTURING

Karl R. Haapala — Oregon State University

Fu Zhao — Purdue University

Jaime Camelio — Virginia Tech

John W. Sutherland — Division of Ecological and Environmental Engineering

Steven J. Skerlos — University of Michigan

David Dornfeld — UC Berkeley

I. S. Jawahir — University of Kentucky

Hong-Chao Zhang — Texas Tech University

Andres Clarens — University of Virginia, Civil and Environmental Engineering

Sustainable manufacturing has been defined by the U.S. Department of Commerce as the creation of manufactured products using processes that minimize negative environmental impacts, conserve energy and natural resources, are safe for employees, communities, and consumers, and are economically sound. Thus, it requires simultaneous consideration of economic, environmental, and social implications associated with production and delivery of goods. Research in sustainable manufacturing is an important activity that informs product development from a life cycle perspective. At the process level, sustainable manufacturing research addresses issues related to planning, analysis and improvement, and the development of processes. At a systems level, sustainable manufacturing research addresses challenges relating to supply chain design, facility design and operations, and production planning. Though economically vital, manufacturing processes and systems have retained the negative image of being inefficient, polluting, and dangerous. Through strategic activities focused on sustainable processes and systems, industrial and academic engineering researchers are re-imagining manufacturing as a source of innovation to meet society's future needs. Recent research into concepts, methods, and tools for sustainable manufacturing are highlighted at the systems level, and explored more deeply as they relate to discrete manufacturing process development and analysis. Despite recent developments in decision making, and process- and systems-level research, many challenges and opportunities remain. Several of these in manufacturing research, development, implementation, and education are highlighted.

MSEC2011-50301

LASER SHOCK BASED CONTROLLED FORMING OF SILVER NANOWIRES

Ji Li — Purdue University

Yiliang Liao — Purdue University

Gary Cheng — Purdue University

One-dimensional nanomaterials have attracted a great deal of research interest in the past few decades due to their unique mechanical, electrical and optical properties. Changing the shape of nanowires is a big challenge, but remains key for realistic applications of nanowires. Here we report a general technique to flexibly form nanowires into different shapes by making use of laser shock pressure. Controllable deformation is induced into nanowires in a similar manner as traditional metal forming. Shaping of silver nanowires is demonstrated, during which the Ag nanowires exhibit very good ductility (strain to failure is larger than 1). The microstructure observation indicates that the main deformation mechanism in Ag nanowires under dynamic loading is controlled by twinning and stacking fault formation. Dislocation motion and pile-up is still operative but less important. Our method provides a simple, unique, and one-step approach in massive forming and machining nanowires.

MSEC2011-50302

CAPILLARY FORCE INDUCED ELASTIC DEFORMATION ON ZNS NANOBEAMS

Xinnan Wang — NDSU

Xiaodong Li — University of South Carolina

In this study, synthesized Wurtzite-structured ZnS nanobelts was investigated using high resolution transmission electron microscope, atomic force microscope, and scanning electron microscope for structural and morphology analyses. Results show that ZnS nanobelts are tens of microns in length, mostly ~40×50 nm2 in width and thickness. The nanobelts grow along direction [001] and are dislocation free. The distance spacing for (001) plane is 3.19Å. The capillary force was found strong enough to deform the ZnS nanobeam down to the substrate. Theoretical analysis on small strain elastic deformation was conducted. It was found that as the maximum beam deflection increases, beam elastic energy increases; in the meantime, the surface energy decreases. The net increase in elastic beam energy is less than the net decrease in the surface energy, resulting in total energy decrease. In addition, as the volume of liquid increases, for a certain maximum beam deflection, the total energy increases, this is result of the increase of the surface energy. Furthermore, for a specific nanobeam to be deflected to the underlying surface, the amount of liquid can be calculated.

MSEC2011-50304

DEVELOPMENT OF SCALABLE NANOMANUFACTURING FOR PHOTOVOLTAICS USING MICROREACTOR-ASSISTED NANOMATERIAL DEPOSITIONTM PROCESSES

Chih-Hung Chang — Oregon State University

Microreactor-Assisted Nanomaterial DepositionTM process combines the merits of microreaction technology and solution phase synthesis of nanomaterials. This technique uses continuous flow microreactors for the synthesis and deposition of nanomaterials. In synthesis, microreactor technology offers large surface-area-to-volume ratios within microchannel structures to accelerate heat and mass transport. This accelerated transport allows for rapid changes in reaction temperatures and concentrations leading to more uniform heating and mixing in the deposition process. The possibility of synthesizing nanomaterials in the required volumes at the point-of-application eliminates the need to store and transport potentially hazardous materials, while providing new opportunities for tailoring novel nanostructures and nanoshaped features. MANDTM processes control the heat transfer, mass transfer and reaction kinetics using well defined microstructures of the active unit reactor cell that can be replicated to produce higher chemical production volumes. This important feature opens a promising avenue in developing scalable nanomanufacturing. In this talk, I will discuss our progress in using microreactors to dispense reactant streams directly onto moving or stationary substrates to yield nanostructured thin films for photovoltaics. Results-to-date demonstrate the possibility to control the reacting flux including small intermediate-reaction molecules, macromolecules, nanoclusters, nanoparticles, and structured assembly of nanoparticles directly after synthesis.

MSEC2011-50305

THE NANO-WORLD AS A MANUFACTURING PLAYGROUND: THE VISION OF NANOMANUFACTURING AT NSF

Charalabos C. Doumanidis — National Science Foundation

Our recent analytical explorations and insights into the nanoworld have afforded us with new opportunities and challenges in synthesis and manufacture of useful devices and systems, to carry unprecedented functionalities all the way to our macroworld. This lecture overviews the philosophy and background of the presenter's research group in thermo-mechanical materials processing and manufacturing (fusion welding, material deposition, multi-layer coating, rapid prototyping, etc.) modeling and control by scanned distributed-parameter, dynamic adaptive techniques. It also elaborates on his current design and nanomanufacturing investigations in probabilistic branching tree-structured materials, such as: Nanocomposite layered foils by ultrasonic joining; Carbon-fiber polymer composites with nanoparticulates; Nano-heater sources by reactive material multi-layers; Ultrasonic and laser powder consolidation, net-shaping and metrology; Nanomaterial templating in anodized aluminum oxides; Fiber electrospinning for tissue engineering scaffolds and pharmaceutical vectors; and targeted drug delivery via magnetic micelle nanocapsules. The presentation also projects new research directions in multiscale design and manufacture of random fractal architectures; Extreme engineering of terrestrial and space structures; and Biomanufacturing of biomolecular machinery with the live cell as production plant. Research activities are coupled with related educational curricula, laboratory facility design and innovation activities, as well as outreach and administration initiatives through the Nanomanufacturing Program of the National Science Foundation.

MSEC2011-50306

INKJET PRINTED CONDUCTIVE SILVER FILMS FROM CHEMICAL REACTION

Ying-Chih Liao — National Taiwan University

Zhen-Kai Kao — National Taiwan University

Ying-Han Hung — National Taiwan University

Hao-Ming Hsiao — National Taiwan University

An inkjet printing device with two ink channels was used to deposit silver thin lines. Two aqueous solutions, diamminesilver solution and formaldehyde solution, were separately ejected, mixed, and reacted on glass slides. Computational fluid dynamic simulations were first used to evaluate the inkjet device setup and mixing efficiency for the so-called silver mirror reaction. The printed silver lines had 100 micron or less in width. Surface profilometry was used to measure the thicknesses and smoothness of printed silver lines. Without sintering, the electrical conductivity of the resulting silver lines was around 20% of bulk silver, and can be much higher if sintered. Results of XRD and EDS showed our printed films purely comprised face-centered cubic (FCC) silver metal. Scanning electron microscopy (SEM) images of printed silver lines showed that these thin lines contain spherical nanoparticle grains of 50 to 80 nanometers in diameter. This inkjet printing method could be used for various applications, such as embedded printed circuit boards, micro electro mechanical systems (MEMS), and radio frequency identification (RFID) tags.

MSEC2011-50307

MODELING AND SIMULATION OF PAD SURFACE SHAPE DUE TO DIAMOND DISC CONDITIONING IN CHEMICAL MECHANICAL PLANARIZATION (CMP)

Zhichao Li — North Carolina Agricultural & Technical State University

Emmanuel Baisie — North Carolina Agricultural & Technical State University

X.H. Zhang — Seagate Technology

Chemical mechanical planarization (CMP) remains as the state of the art to planarize semiconductor wafers and smooth the wafer surface. In CMP, a diamond disc conditioner is used to condition (or dress) a polishing pad to restore the pad planarity and surface roughness. In this study, a surface element method is proposed to develop a mathematic model to predict the pad surface shape resulted from diamond disc conditioning. The model first determines sectional pad wear and then cumulative pad wear. Simulation results show that the model is effective to simulate the diamond disc conditioning process and predict the pad surface shape.

MSEC2011-50308

INTERFACE ENGINEERED DIAMOND COATINGS FOR DRY MACHINING

Humberto Gomez — USF - Me. Dept., ENB 118

Delcie Durham — USF - Me. Dept., ENB 118

Ping Lu — The University of Alabama

Xingcheng Xiao — General Motors R&D Center

Michael Lukitsch — General Motors R&D Center

Kevin Chou — The University of Alabama

Ashok Kumar — USF - Me. Dept., ENB 118

Several studies have been propose to improve the adhesion of diamond films on cemented carbide tool materials, however a systematic study in identifying the role of the factors that affect the final diamond adhesion and the resulting machining performance of the tool under real manufacturing conditions is still unexplored. In this study, adherent diamond on WC-Co (6%) turning inserts was deposited under different surface pretreatments including chemical etchings and CrN/Cr interlayer to overcome the adhesion issues associate with the detrimental effect of cobalt and to reconstruct the surface. After characterizing the surface before and after the diamond deposition, Rockwell hardness tests were performed on the surface to measure the resulting film delamination and fracture patterns. Finally, dry machining performance tests for all diamond coated turning inserts were performed on an aluminum alloy A390 H3. Correlations between the initial Rockwell indentation and tool life were established.

MSEC2011-50309

LIFE CYCLE MANAGEMENT OF ABRASIVE TOOLS AND EFFECTS ON SUSTAINABLE GRINDING

Barbara Linke — University of California, Berkeley

The world-wide trend to environmental awareness is accompanied by a rising need for manufacturing technologies that spare energy and resources. The sustainability of products and processes becomes more and more a main competitive edge. However, the very essential aspect of abrasive tool design and its impact on process eco-efficiency have not been examined in a holistic view yet. Therefore this work evaluates the whole tool life from manufacturing to use phase and end-of-life. Abrasive tools have a huge variety in specifications, manufacturing steps and ingredients. Therefore a framework has to be set up to evaluate tool manufacturing with a thorough investigation of main and auxiliary ingredients, emissions, waste and energy. Tool design affects the abrasive machining process in terms of productivity, workpiece quality and tool life. Relevant mechanisms of impact are discussed, evaluated and included into a suitable holistic life cycle management of abrasive tools. Not only the improvement of the single abrasive process, but moreover the process chain and leveraging effects on product performance are considered. Different scenarios for the end-of-life of abrasive tools conclude the life cycle management. Abrasive tools are not only complex products, but moreover important enablers for green manufacturing.

MSEC2011-50310

DEVELOPMENT OF AN AUTOMATED TOOL-TIP EXCHANGER FOR TIP-BASED NANOMANUFACTURING

Curtis Taylor — University of Florida

Bijoyraj Sahu — University of Florida

Robert Riddle — University of Nevada – Reno

Kam K. Leang — University of Nevada – Reno

The scanning probe microscope (SPM), in particular the atomic force microscope (AFM), has recently demonstrated tremendous potential to perform various nanoscale fabrication processes (e.g. nanolithography, atomic deposition, nanomachining, etc.) with high resolution (< 10 nm). However, use of SPMs for fabrication have a low throughput and require frequent manual replacement of the SPM tips due to damage or wear. Manual switching of tips for multiple operations, is relatively time consuming. Thus, these issues hinder the throughput, quality, reliability, and scalability of SPM as a practical tool for nanofabrication. To address these issues, this poster presents the design, analysis, and fabrication of a novel nano tool-tip exchanger that automatically loads and unloads SPM tool-tips. The ability to provide fully automated

ondemand tool-tip exchange would enable SPM as a scalable tool for nanomanufacturing. In this work, an active SPM cantilever is designed with an electrothermally actuated microgripper capable of locating, loading, and unloading tool-tips automatically. The microgripper has been designed to provide adequate range of actuation, gripping force, stiffness, and dynamic response required for securely holding the tool-tip and for functioning within existing SPM-based systems. The design has been validated by finite element analysis. Experiments have been conducted to establish the micro-electromechanical systems (MEMS) fabrication processes for successful fabrication of the prototype.

MSEC2011-50311

INVESTIGATION OF DEFORMATION PATH DURING MICRO-TUBE FLARING

Chetan Nikhare — University of New Hampshire

Brad Kinsey — University of New Hampshire

Weichao Wu — Northwestern Polytechnical University

Jian Cao — Northwestern University

Tube flaring process has been traditionally used to expand one end of the tube without changing its cross-sectional area. This simple process typically forms the product on a single deformation path which could lead to less formability and early failure. However in the present work two different cross-sectional flaring punches were used to flare the tube. In the one-step process, a single elliptical punch was used, whereas in the two-step process, a more circular punch followed by the elliptical punch was used. The deformation path in both the cases was analyzed and the geometrical punch and specimen effect on changing the deformation path was observed. It is found that with changing the deformation path more formability can be achieved which delays the failure.

MSEC2011-50312

NOVEL HYBRID MATERIAL CRASH STRUCTURE FOR FRONT RAIL

Chetan Nikhare — University of New Hampshire

Peter Hodgson — Deakin University, Institute for Technology Research and Innovation

Crash analysis is one of the critical areas in which vehicle industries are demanding the highest accuracy in the design of the crash structures. The knowledge of elastic and plastic behaviour of the crash structures and their interaction with the human body during crash is still not fully developed. One of the attractive materials in recent production of automotive parts are Advanced High Strength Steels (AHSS), which offer higher strength for improved energy absorption and further opportunity to reduce weight through the use of thin walled structures for vehicle fuel efficiency. However, the complexity of the crash event can lead to a complex structure and more understanding is required. This poster investigates the interaction of a heat treated strip with different properties within the base material of AHSS and analyzed the crash response during front crash in order to evaluate their potential use in vehicle design for crashworthiness. A simple square beam with the strip material integrated with the base material was used. The crash behavior, force-displacement response and the energy absorption characteristics of the different front rail structures were studied numerically.

MSEC2011-50313

DROP-ON-DEMAND-BASED FABRICATION OF ALGINATE MICROSPHERES

C. Leigh Herran — Clemson University

Changxue Xu — Clemson University

Yong Huang — Clemson Univ.

Nicole Coutris — Clemson University

Wenxuan Chai — Clemson University

Drop-on-Demand-Based Fabrication of Alginate Microspheres

MSEC2011-50314

SUBSTRATE SURFACE ETCHING EFFECTS ON MACHINING PERFORMANCE OF DIAMOND-COATED CUTTING TOOLS

Raymond Thompson — Vista Engineering & Consulting LLC

Kevin Chou — The University of Alabama

Dustin Nolen — Vista Engineering & Consulting LLC

Xibing Gong — University of Alabama

For carbide tools, the cobalt binder phase is a very good solvent of carbon, and thus, in diamond deposition process, diamond nucleates on these substrates through a non-diamond layer. The weak graphite layer at the interface results in poor adhesion, which is the main technical challenge to enhance machining performance of diamond-coated tools. Substrate surface modifications are the key solutions to grow highly adherent diamond on carbide tools. Chemical etching is a widely applied method. Though low-cost, the control of material removal process is lack of precision and uniformity. Thus, variations in the etching effect and consequent tool performance may be significant. In this study, both conventional etching (CE) and electrolytic etching (EE) methods were tested to remove substrate surface cobalt. The substrates used were 6 wt.% cobalt fine-grain tungsten

carbides of square-shape inserts . After etching, diamond films were produced by a high-power microwave plasma-assisted CVD process, with a thickness of about 25 μm. A computer numerical control lathe was used to perform machining experiments to evaluate the wear behavior of differently etched tools. Workpieces were round bars made of A359/SiC-20p composite. Machining parameters used consisted of two levels of tool feed. During machining testing, the cutting inserts were periodically inspected by optical microscopy to measure flank wear-land. Worn tools after testing were also examined by scanning electron microscopy. The results show that (1) the coated EE tools have better delamination resistance under indentation loads, (2) coated CE and EE tools have comparable surface roughness, (3) the EE tools have less flank wear, though same wear patterns, and a longer tool life compared to CE tools. The results indicate that electrolytic etching may be an effective alternative to enhance interface adhesion, and thus, tool wear resistance. In addition, effects on machining performance are dependent upon machining conditions.

MSEC2011-50315

ENHANCING FRICTION STIR WELDING THROUGH TEMPERATURE CONTROL

Axel Fehrenbacher — University of Wisconsin–Madison

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Friction Stir Welding (FSW) is a novel joining technology enabling welds with excellent metallurgical and mechanical properties, as well as significant energy consumption and cost savings. One process variable that must be controlled to maintain uniform weld quality under the inherent workpiece variability (thermal constraints, material properties, geometry, etc.) is the weld zone temperature. Our hypothesis is that the weld zone temperature can be controlled, which can help in controlling the weld quality. The objectives of this work are to determine an accurate temperature feedback strategy and to develop a closed-loop feedback control system for temperature in FSW. A wireless data acquisition system was built to measure temperatures at the tool-workpiece interface. A thermocouple was placed in a through hole right at the interface of tool and workpiece so that the tip is in contact with the workpiece material. This measurement strategy reveals temperature variations within a single rotation of the tool in real time. Interface temperatures in the range from 555 °C to 575 °C were commanded to an integral compensator, which regulated the spindle speed between 850 rpm and 1250 rpm to adjust the heat generation and achieve the desired interface temperatures in 6061-T6 aluminum. To simulate changes in thermal boundary conditions, backing plates of different thermal diffusivities were found to effectively alter the heat flow, hence weld zone temperature. The measured temperature stayed within ± 5 °C after introducing the disturbance, compared to a 50 °C change in temperature when no control was applied.

MSEC2011-50316

HIGH VOLUME BATTERY PACK MANUFACTURING FOR PASSENGER VEHICLES

Jeffrey Abell — General Motors

To be decided

MSEC2011-50317

CHALLENGES AND OPPORTUNITIES FOR LITHIUM ION BATTERY MANUFACTURING

S. J. Hu — University of Michigan

Challenges and Opportunities for Lithium Ion Battery Manufacturing

MSEC2011-50318

LIGHTWEIGHT ENGINEERING FOCUSED REDESIGN, MANUFACTURE, AND VALIDATION OF AN UNSPRUNG VEHICLE COMPONENT FOR TOTAL LIFE-CYCLE COST SAVINGS

Mathew Kuttolamadom — CU-ICAR

Student Design Competition Entry

MSEC2011-50320

ELECTROMAGNETIC METAL FORMING MACHINE

Ethan Thibaudeau — University of New Hampshire

Student Design Competition Entry

MSEC2011-50321

MICRO ELECTRODE TUBE NON-CIRCULAR FLARING PROCESS AND DESKTOP MICRO FLARING SYSTEM

Weichao Wu — Northwestern Polytechnical University

Student Design Competition Entry

MSEC2011-50322

M1A1 ABRAM'S TANK MODEL

Alex Weisser — RPI

Student Design Competition Entry

MSEC2011-50323

SMART TOOL TORQUE CALIBRATION TEST STAND

Anthony Morin — University of New Hampshire

Student Design Competition Entry

MSEC2011-50324

WIRELESS REAL-TIME DATA ACQUISITION SYSTEM FOR PROCESS INSTRUMENTATION AND CLOSED-LOOP CONTROL OF FRICTION STIR WELDING

Axel Fehrenbacher — University of Wisconsin-Madison

Student Design Competition Entry

MSEC2011-50325

AUTOMATION OF NON-DESTRUCTIVE ULTRASONIC TRANSMISSION SCANNING OF PIPING AND TUBING

Matthew Standley — University of New Hampshire

Student Design Competition Entry

MSEC2011-50326

PAINTBRUSH REWORK SOP

Michael Church — Oregon State University

Student Design Competition Entry

MSEC2011-50327

G.I.A.N.T. – WIND TURBINE MODEL

Austin Jolley — RPI

Student Design Competition Entry

MSEC2011-50328

RESEARCH LIFE AND HOW TO BE SUCCESSFUL PROFESSIONALLY

Yong Huang — Clemson University

The forum will discuss research positions in industry, academia, and national laboratories and how to be successful professionally in the various settings. The target audience for the forum is recent advanced degree graduates as well as current Master's and Ph.D. students. Three panelists are: Dr. George Hazelrigg (tentative), Dr. Bin Wei, and Prof. Toni Doolen.

MSEC2011-50329

MATERIALS JOINING TECHNOLOGIES FOR LIGHTWEIGHT AND MULTI-MATERIALS BODY STRUCTURES

Zhili Feng — Oak Ridge National Laboratory

Materials Joining Technologies for Lightweight and Multi-Materials Body Structures

MSEC2011-50330

KEY AUTOMOTIVE TRENDS AND MATERIAL SOLUTIONS TO ENABLE SUSTAINABLE TRANSPORTATION

David Glasscock — Dupont

Key automotive trends and material solutions to enable sustainable transportation

MSEC2011-50331

WRINKLE ANALYSIS IN THE TUBE-HYDROFORMING PROCESS

Fuh-Kuo Chen — National Taiwan University

The finite element simulations were employed to examine the major factors that cause a permanent wrinkle remaining on the part surface after the hydroforming operation. The mechanism of expansion of a deep wrinkle during the hydroforming operation was examined and a ratio of local excessive material (rw) was adopted as an index for predicting the formation of a permanent wrinkle. An actual hydroforming process used for manufacturing an automotive part was also studied with the use of the finite element simulations. The finite element analysis reveals that the pre-form die design plays an important role in the hydroforming process and a balanced section length of wrinkles in a pre-form shape is always desired. An optimum pre-form die design was also proposed for the hydroforming process. The defect-free part produced by the proposed die design validates the finite element analysis.

MSEC2011-50332

MECHANICAL VERSUS PNEUMATIC STRETCHING: EVALUATION OF LIMITING STRAINS IN SHEET METALS AT ELEVATED TEMPERATURES

Mohammad Albakri — Masdar Institute of Science and Technology

Fadi Abu-Farha — Penn State Erie

Marwan Khraisheh — Masdar Institute of Science and Technology

With the ever-growing interest in hot forming of lightweight alloy sheets for potential applications in the transportation sector, the need for accurate forming limit diagrams (FLDs) at elevated temperatures is becoming a necessity. In this work, limiting strains of the AZ31B magnesium alloy formed at 400 °C are evaluated following two approaches; pneumatic bulging into elliptical die inserts, and mechanical stretching using a hemispherical punch (Nakazima method). A novel speed\ pressure control algorithm is developed so as to maintain a constant effective strain rate in the sheet, or any particular region of interest, following a user-defined control scheme. This allows for conducting both tests under equivalent strain rate deformation paths to provide a valid basis for comparison between the generated FLDs. The results also provide the sought insights on the disparities between pneumatic and mechanical formability testing.

NAMRC ABSTRACTS

NAMRC39-4704

COMPARSION OF PROCESS CAPABILITY INDEX AND UNCERTAINTY CALCULATIONS WHEN USING CONVENTIONAL AND COORDINATE METROLOGY TOOLS

Mohamed Gadalla — Alabama A&M University

Miroslaw Popielarczyk — Pratt & Whitney

A common practice in the manufacturing environment is to use either a conventional or a coordinate metrology tool for inspecting engineering products. Selecting the correct measuring tool is critical to control a variation of the process and quality of products. Two experiments have been conducted to evaluate the effect of this decision on some metrics such as: the process capability index (Cpk), the value of the measurement uncertainly zone, and the financial ramifications. Data collected from coordinate metrology tool tends to be clustered around the process mean while it is more spread out for the conventional tool. This leads to different process variation behavior depending on the inspection tool. A standard deviation monitoring graph is suggested to insure the integrity of the process capability index calculations, and to avoid false alarms and misleading information. A cost model was also developed to estimate the Return on Investment (ROI).

NAMRC39-4705

THE BAUSCHINGER EFFECT FOR COLD FINISHED MILD STEEL AFTER FRICTION STIR PROCESSING

Brennan S Domec — Frank's Casing Crew & Rental Tools, Inc.

Dr. William J. Emblom — University of Louisiana at Lafayette

Theodore A. Kozman — University of Louisiana at Lafayette

Jim Lee — University of Louisiana at Lafayette

This paper considers the Bauschinger effect on workpieces subjected to friction stir processing. Cold finished, mild steel was selected as the base material for this study. Four-point bend tests were performed on material specimens in a forward direction to 2% of true strain, followed by reverse bending of 4% of true strain or failure. Strain gauges were mounted to the specimens to measure strain while the vertically applied bending force was measured with a high precision load cell. Test results show that friction stir processing exhibits a Bauschinger effect response slightly higher than that of unaltered base material. It is concluded that the Bauschinger effect response of friction stir processed material is independent of orientation relative to the rolling direction of the plate, despite anisotropic effects present in strength.

NAMRC39-4709

MODELING AND INTERPRETATION OF FIBER ORIENTATION-BASED FAILURE MECHANISMS IN MACHINING OF CARBON FIBER-REINFORCED POLYMER COMPOSITES

Kevin A. Calzada — University of Illinois, Mechanical Science and Engineering Department

Shiv G. Kapoor — University of Illinois, Mechanical Science and Engineering Department

Richard E. DeVor — University of Illinois, Mechanical Science and Engineering Department

Johnson Samuel — University of Illinois Mechanical Science and Engineering Department

Dr. Anil Srivastava — TechSolve, Inc.

The development and implementation of a microstructure-based finite element model for the machining of carbon fiber-reinforced polymer composites is presented. A new approach to interfacial modeling is introduced where the material interface is modeled using continuum elements, allowing failure to take place in either tension or compression. The model is capable of describing the fiber failure mode occurring throughout the chip formation process. Characteristic fiber length in the chips, and machining forces for microstructures with fibers orientated at 0, 45, 90, and 135 degrees are examined to aid in the interpretation of the failure mechanisms. For model validation purposes, the model-based machining performance predictions are compared to the machining responses from a set of orthogonal machining experiments. A parametric study is presented that identifies a robust tool geometry, which minimizes the effects of fiber orientation and size on the machining forces.

NAMRC39-4710

MODELING OF AUTOFRETTAGE-INDUCED DEFORMATIONS WHEN MANUFACTURING HIGH PRESSURE PARTS

Dirk Baehre — Saarland University

Horst Bruennet — Saarland University

Compressive residual stresses as a property of machined surfaces have a beneficial effect on the fatigue resistance of hydraulic high pressure components. A widespread process to selectively induce residual stresses in failure critical areas is Autofrettage. It introduces a specific plastic deformation in internal pressurized components via a single pressure overload. This plastic deformation influences the accuracy of the machined components and needs to be considered when designing the corresponding manufacturing process chain. Additionally, the removal of compressive

residual stress loaded layers leads to macroscopic shape deviations especially for complex geometries with internal bore intersections. In this paper measurement and numerical simulation results for a thick-walled cylinder and a high pressure distributor with an internal T-shaped bore intersection are presented. The deformations and shape deviations after Autofrettage and after a following reaming operation are discussed to develop a process chain approach to predict those deformations and shape deviations.

NAMRC39-4711

A NEW APPROACH TO SCHEDULING IN MANUFACTURING FOR POWER CONSUMPTION AND CARBON FOOTPRINT REDUCTION

Kan Fang — Purdue University

Nelson Uhan — Purdue University

Dr. John W Sutherland — Purdue University

Dr. Fu Zhao — Purdue University

Manufacturing scheduling strategies have historically emphasized cycle time; in almost all cases, energy/environmental factors have not been considered in scheduling. This paper presents a new mathematical programming model of the shop floor scheduling problem that considers peak power load and energy consumption (and associated carbon footprint) in addition to cycle time. The new model is demonstrated using a simplified case study, i.e., a flow shop where two machines are employed to produce a variety of parts. In addition to the processing order of the jobs, the proposed scheduling problem considers the operation speed as an independent variable, which can be changed to affect the peak load. Even with a single objective, finding an optimal schedule is NP-hard, so applying commercial software to this more complex, multi-objective scheduling problem requires significant computation time. This paper calls for the development of more specialized algorithms for this new scheduling problem and examines computationally tractable approaches for finding near-optimal schedules.

NAMRC39-4712

FEATURE LEVEL ENERGY ASSESSMENTS FOR DISCRETE PART MANUFACTURING

Amit Deshpande — TechSolve

John Snyder — TechSolve

Dan Scherrer — TechSolve

The next generation of innovation in manufacturing will be driven by affordability and sustainability. Manufacturers are implementing energy efficiency and sustainable manufacturing practices not only as a plan to reduce cost and environmental impact, but as a business strategy to succeed. This paper presents a bottom-up methodology for autonomous, real-time, energy consumption analytics using the MTConnect standard. The temporal aspect of data enables correlation of machining parameters and energy consumption from the lowest component features and up. A case study is utilized to explain the decision support capability to drive part-cost reduction and assess the effect of adding or modifying a certain feature, operation, or quality constraint. Cost structure transparency and the ability to justify improvement changes provide a significant opportunity for improved productivity and energy efficiency. Utilizing smart machine analysis tools, return-on-investment is quantified for production of an aerospace component on two machines.

NAMRC39-4715

PREDICTION OF POROSITY IN CASTING JUNCTIONS USING A MATHEMATICAL MODEL DEVELOPED THROUGH DESIGN OF EXPERIMENTS

Dr. Elsayed Orady — University of Michigan - Dearborn

Abhay Mane — CECS, University of Michigan - Dearborn

James Knight — University of Michigan - Dearborn

Mahmoud Awad — Alhosn University

Proper design of castings is essential to avoid casting defects that cannot be eliminated by design of tooling and process parameters. Shrinkage porosity is one of the defects which usually occur at casting junctions and cannot be easily eliminated. Currently, designers use rules that were established based on experience and intuition and are not supported by proper experimentations. In this paper an approach to design and optimize design of casting junctions using a database of mathematical models has been presented. The mathematical models give relationships between porosity and the junctions' dimensional features. To illustrate this approach, a mathematical model for a V-junction has been developed using Design of Experiments (DoE) and regression analysis techniques. The experimental runs

for the study are established using D-Optimality method and these are then simulated using MAGMASoft, comprehensive software for casting simulation, for measuring porosity in casting junctions. The simulations carried in MAGMASoft are validated by comparing its results with experimental results from previous studies. The mathematical model is then developed by applying regression analysis. The results of the model have been validated and found to agree with both the experimental and the validation simulation experiments.

NAMRC39-4716

THEORETICAL AND EXPERIMENTAL INVESTIGATION OF THE SPRINGBACK CHARACTERISTICS OF METAL FOAM

Dr. Steven Schmid — University of Notre Dame

Paul Nebosky — Sites Medical

Miguel Selles — Polytechnic University of Valencia, Campus of Alcoy

This study examines the elastic recovery (springback) of a porous tantalum foam after sheet forming operations. The foam and sheet-like form is applicable to bone ingrowth surfaces on orthopedic implants and is desirable due to its combination of high strength, low relative density, and excellent osteoconductive properties. Forming of the foam improves nestability during manufacture, and is essential to have the material achieve the desired shape. Experimentally, bending about a single axis using a wiping die is studied by observing cracking and measuring springback. Die radius and clearance strongly affect the springback properties, while punch speed, embossing, die radius, and clearance all influence cracking. To study the effect of the foam microstructure, bending also is examined numerically. A horizontal hexagonal mesh comprised of beam elements is employed, which allows for the densification that occurs during forming. The flow strength of individual tantalum struts is directly measured in an atomic force microscope. The numerical results show that as the hexagonal cells are elongated along the sheet length, elastic springback decreases. By changing the material properties of the struts, the models can be modified for use with other open-cell metallic foams.

NAMRC39-4719

AUTOMATIC GENERATION OF ASSEMBLY SYSTEM CONFIGURATION WITH EQUIPMENT SELECTION FOR AUTOMOTIVE BATTERY MANUFACTURING

Sha Li — The University of Michigan

Hui Wang — The University of Michigan

Dr. Jack Hu — The University of Michigan

Yhu-Tin Lin — General Motors

Jeffrey Abell — General Motors

High power and high capacity lithium-ion batteries are being adopted for electrical and hybrid electrical vehicles (EV/HEV) applications. An automotive Li-ion battery pack usually has a hierarchical composition of components assembled in some repetitive patterns. Such a product assembly hierarchy may facilitate automatic configuration of assembly systems including assembly task grouping, sequence planning, and equipment selection. This paper utilizes such a hierarchical composition in generating system configurations with equipment selection for optimal assembly system design. A recursive algorithm is developed to generate feasible assembly sequences and the initial configurations including hybrid configurations. The generated configurations are embedded in an optimal assembly system design problem for simultaneous equipment selection and task assignment by minimizing equipment investment cost. The complexity of the computational algorithm is also discussed.

NAMRC39-4720

AN EVOLUTIONARY OPERATION SEQUENCE OPTIMIZATION TOOL FOR ROBOTIC SPOT WELDING BASED ON COLLISION-FREE PATH PLANNER IN VIRTUAL MANUFACTURING

Mohammad Givehchi — University of Skövde

Amos Ng — University of Skövde

Dr. Lihui Wang — University of Skövde

Many problems in the lifecycle of Product and Production Development (PPD) can be formulated as optimization problems. But in most of the real-world cases, they are too complex to be solved by analytical models or classical optimization methods. CAx and Virtual Manufacturing (VM) tools are on the other hand being employed to create virtual representation of products and processes before any physical realization is conducted. Synergy of these two domains is of interest in this paper where planning a process with the minimum cycle-time for assembling a spot welded sheet-metal product is desired. The methodology suggests an extendible virtual manufacturing-based optimization approach using evolutionary algorithms. Accordingly, a novel toolset

with integration of evolutionary optimization and a commercial VM environment is developed. More specifically, the latest feature which takes advantage of the collision avoidant segment path planning functionality of the VM tool and integrates it with the sequence optimizer is described.

NAMRC39-4722

AN ONTOLOGY-BASED APPROACH TO DEVELOP SUSTAINABLE MANUFACTURING METRICS FOR SUPPLY CHAIN EVALUATION

Dr. Fazleena Badurdeen — University of Kentucky

Mohannad Shuaib — University of Kentucky

Haritha Metta — University of Kentucky

Chris Stovall — University of Kentucky

Dr. I.S. Jawahir — University of Kentucky

Thomas Goldsby — University of Kentucky

Evaluating sustainable manufacturing practices requires a focus on all four life-cycle stages (pre-manufacturing, manufacturing, use and post-use) in terms of economic, environmental and societal impact from product, process and systems perspectives. As activities spanning the life-cycle of products are conducted by numerous companies that constitute its supply chain, well-defined metrics are necessary for system-level manufacturing sustainability evaluation. This paper presents an integrated approach to developing metrics for sustainable supply chain (SSC) assessment. The process of metrics development following this approach is demonstrated for one level (enterprises) in the systems hierarchy.

NAMRC39-4724

EFFECT OF SHAPE CHANGE OF THE ELASTIC MODEL OF THE FLEXIBLE SENSOR FOR THREE-AXIS LOAD MEASUREMENT OF NORMAL LOAD AND SHEARING LOAD

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Masato Kobayashi — Shinshu University

Sung-Moo Song — Shinshu University

Hiroyuku Takeishi — Chiba Institute of Technology

Hiroaki Fukui — Sanko Co.,Ltd.

Takuya Suzuki — Suzuki Precion Co.,Ltd

In the present study, a flexible tactile sensor for three-axis load measurement is developed. The newly developed sensor consists of three components: a skin layer, an elastic model, and a load measurement layer, which is composed of an upper substrate, a lower substrate, and an electric conductive material. The electric conductive material (PC/20wt%VGCF) used for the load measurement layer has the property whereby resistance decreases when a load is applied. Voltage changes between the upper and lower electrodes can be measured according to the sensor measurement principle. In order to address the difficulty involved in assembly and miniaturization of the sensor, the shape of the elastic model was varied as a sphere, a cylinder and a prism. By changing the shape of the elastic model, the range for normal load and shearing load applied to sensor were able to measure with a high load is investigated, and the cylindrical elastic model was determined to provide the highest load measurement and to best facilitate sensor assembly.

NAMRC39-4725

ADDITIVE MANUFACTURING BASED ON OPTIMIZED MASK VIDEO PROJECTION FOR IMPROVED ACCURACY AND RESOLUTION

Chi Zhou — University of Southern California

Dr. Yong Chen — University of Southern California

Additive manufacturing (AM) processes based on mask image projection such as digital micro-mirror devices (DMD) have the potential to be fast and inexpensive. More and more research and commercial systems have been developed based on such digital devices. However, the accuracy and resolution of the related AM processes are constrained by the limited number of mirrors in a DMD. In this paper, a novel AM process based on the mask video projection has been presented. For each layer, a set of mask images instead of a single image are planned based on the principle of optimized pixel blending. The planned images are then projected in synchronization with the small movement of the building platform. A mask image planning method has been presented for the formulated optimization problem. Experimental results have verified that the mask video projection process can significantly improve the accuracy and resolution of built components.

NAMRC39-4727

PROBING SYSTEM FOR MEASUREMENT OF MICRO-SCALE COMPONENTS

Chan-Seo Goo — University of Victoria

Dr. Martin Jun — University of Victoria

Akinori Saito — Nihon University

The need for quality control of the complex micro-structure has been growing due to increased production of parts with complex 3D micro-scale features. However, wide use of 3D

metrology of miniature parts is difficult due to the lack of cost-effective and precise probing system at the micro-scale. This paper introduces a new probing system using a wire-based probe and acoustic emission (AE)-based sensing method. The design of the probing system allows the size of the probe to be varied relatively easily. Repeatability of less than one micron has been achieved with the proposed probing system.

NAMRC39-4728

INFLUENCE OF CUTTING EDGE ROUGHNESS ON BRITTLE CRACKING IN THE MILLING PROCESS ON SODA LIME GLASS

Takenori ONO — Tsuyama National College of Technology

The effect of tool edge roughness on brittle cracking in the milling process of soda lime glass was discussed. In cutting tests, slotting operations are performed with two types of poly-crystal Diamond-coated carbide ball endmills with different tool edge roughness. After the slotting operations, the surface roughness and crack propagations under the machined surface are observed by atomic force microscope (AFM) and focused ion beam machine tool (FIB). In this experiment, the surface roughness and the length of crack propagation increase with cutting edge roughness. To evaluate the effect of edge roughness on the brittle cracking, the cutting thickness is calculated with three types of edge roughness models. Results of the calculations show the maximum cutting thickness is changed when milling in high-edge roughness.

NAMRC39-4730

EXPERIMENTAL INVESTIGATION OF THE MACHINABILITY OF POLYSTYRENE REINFORCED WITH SINGLE WALLED CARBON NANOTUBES

Chan-Seo Goo — University of Victoria

Le Hien Huynh — University of Victoria

Chris Papadopoulos — University of Victoria

Dr. Martin Jun — University of Victoria

Dr. Simon Park — University of Calgary

The micromachining of single-walled carbon nanotube (CNT) reinforced polymer composite is studied in this paper. Polystyrene was used as the polymer matrix material, and CNT loading of 0.2% by weight is used to synthesize the composite. The composite was processed using a solution processing method. Micro endmilling experiments were conducted to compare measured forces, chip morphologies, surface finishes, and burr formations between plain polystyrene and CNT composite. Micro milling experiments were conducted at a wide range of feed rates to investigate the composite's behavior during machining at both the plowing- and shearing-dominant regimes. Use of CNTs as reinforcements seems to decrease the minimum chip thickness, which is favorable in micromachining because it results in less plowing and burr formations.

NAMRC39-4731

MODELING RESIDUAL STRESSES INDUCED BY HOLE PUNCHING 6013 ALUMINUM ALLOY SIDE RAILS

Dan Mashack — Virginia Tech

Jeremy Rickli — Virginia Tech

Dr. Jaime Camelio — Virginia Tech

Tory Smith — Virginia Tech

Sean Fleming — Metalsa Roanoke

New emission regulations in the US have increased parasitic weight in commercial vehicles. As a result, payload capacity in weight-restricted commercial vehicles has decreased. Manufacturing commercial vehicle side rails from high strength, lightweight aluminum alloys can reduce frame weight, thus, preserving payload capacity and profit margins of bulk haulers. A 6013 aluminum alloy has been identified as a potential side rail material candidate. Each time a new material is proposed, its mechanical behavior and manufacturability need to be tested and validated. A common operation during side rail production is punching. Punched holes in side rails are essential to vehicle functionality but are a direct cause of cracking, leading to side rail failure. A preliminary investigation into the manufacturability of punching holes in 6013 aluminum alloy using a manufacturing system designed for high strength steel is presented in this paper. A 2D and 3D FEA model is developed to simulate residual stresses surrounding a hole punched in the web center of side rails. The 2D and 3D model behavior is compared, and the model sensitivity is tested in regards to punch velocity, die clearance, and friction coefficient.

NAMRC39-4732

EXPERIMENTAL STUDY OF THE EFFECT OF TOOL ORIENTATION ON SURFACE QUALITY IN FIVE-AXIS MICRO-MILLING OF BRASS USING BALL-END MILLS

Mohammad Javad Barakchi Fard — The University of Western Ontario

Dr. Evgueni Bordatchev — NRC-IMI-CAMM

The effect of tool orientation on the final surface geometry and quality in five-axis micro-milling of brass using ball-end mills is investigated. Straight grooves are cut with different

tool inclination and tilt angles, and the resulting surfaces are characterized using an optical profilometer and microscope. Results of various cutting experiments and analysis of the final surface geometry show that varying the tool orientation reduces rubbing of the material at the bottom of the grooves, which often occurs in ball-end milling of brass. Results also indicate that a non-zero tool inclination angle can result in more accurate geometry profiles compared to the case where the tool axis is normal to the surface. The experimental analysis for surface roughness profiles also shows that applying a tool inclination angle of 15 deg can considerably improve the surface roughness at the bottom of the grooves.

NAMRC39-4733

FIXTURE SHAPE RIGIDITY EVALUATION BY AN INTEGRATED MACHINING & VIBRATION ANALYSIS

Dr. Yajun Fan — Caterpillar Inc.

Richard Huff — Caterpillar Inc.

Vibration occurs in tools and workpiece during high speed machining. Large vibration leads to issues in machining quality, efficiency and tool life. Insufficient dynamic rigidity is one of the reasons for large vibration. In this case, parts are reinforced by a jig to supplement inadequate rigidity. Therefore jig rigidity analysis considering dynamic cutting loads is critical for jig (fixture shape) design. In most of fixture rigidity analysis, the dynamic loads during machining are unknown or represented by some simplified analytical models. In the paper, an integrated machining and vibration analysis has been conducted. In this analysis, a 3D machining simulation has been run first, and then the machining forces are sequentially mapped to the following eigenvalue analysis as the input loads. This analysis shows when the most severe vibration happened and reveals the causes of the vibration, and provides information used to optimize the fixture shape.

NAMRC39-4734

CFD INVESTIGATION OF THE IMPACT OF THE FLUID PROPERTIES AND DELIVERY CONDITIONS ON FLOW AND HEAT TRANSFER IN GRINDING

Stefan Mihic — University of Toledo

Sorin Cioc — University of Toledo

Dr. Ioan D. Marinescu — University of Toledo

Michael C. Weismiller — Master Chemical Corporation

Fluids have an important role in grinding. Correct fluid application results in enhanced process stability, better work piece quality and tool life. This paper shows that CFD models can be used to simulate the fluid flow and heat transfer in a grinding process, replacing numerous experiments that are expensive, time-consuming and with very limited ability. The most important properties of created 2-D and 3-D models are described, along with results obtained. The results show very detailed distributions of temperatures, pressures and flow rates in and around the grinding region. The data obtained is essential in studying the influence of the grinding fluid on the grinding process, as well as in determining the best fluid composition and supply parameters for a given application. The results agree well with experimental global flow rates and temperature values and show the feasibility of both 2-D and 3-D simulations in grinding applications.

NAMRC39-4735

OPTIMIZATION OF PARAMETERS IN ROLL FORMING PROCESS OF ALUMINUM AUTOMOTIVE COMPONENT BY NEURAL NETWORK AND GENETIC ALGORITHM

Park Hong-Seok — University of Ulsan

Tran Viet Anh — University of Ulsan

Roll forming (RF) process is used in manufacturing of many automotive components. Today, the material of roll-formed components is gradually changed from steel to aluminum for reducing the total weight of a car. The RF process of an aluminum component has many unexpected defects such as the existence of fracture or buckling. This paper presents the optimization of process parameters in the RF process of an aluminum automotive component by using the neural network (NN) and genetic algorithm (GA). The multilayer perceptron is used to build the neural network which models the damage evolution, variation of longitudinal strain and spring back angle at the final pass in the process. The genetic algorithm is employed to optimize the process parameters. Five parameters considered are the inner distance between roll stands, rotation velocity of rolls, friction coefficient, upper and lower radii of rolls. The optimization objective is minimizing the overall damage while keeping the spring back angle and longitudinal strain less than allowable limits. The optimum configuration of process parameters results in producing a high quality aluminum automotive component without the existences of fracture and defects.

NAMRC39-4737

AERO-LAP POLISHING OF POLY CRYSTALLINE DIAMOND INSERTS USING MULTICON MEDIA

Ramesh Kuppuswamy — University of Cape Town

Serdar Ozbayraktar — Diamond Research Laboratory, E6 Group

Habib Saridikmen — Element 6 Ltd

Increasing use of Poly Crystalline Diamond (PCD) for cutting tools and wear parts is vividly seen in automobile, aerospace, marine and precision engineering applications. The PCD inserts undergo serious of manufacturing processes such as: grinding to form the required shape and polishing to give a fine finish. These operations are not straight forward as PCD is extremely resistant to grinding and polishing. Single crystal diamond can be easily polished by choosing a direction of easy abrasion, but polishing PCD imposes serious difficulties as the grains are randomly oriented. Prior attempts on polishing PCD were tried by applying electro discharge grinding (EDG), dynamic friction polishing and grinding by a vitrified bonded diamond wheel. The surface textures produced using a EDG process contains micro cavities and particle pullout and surface defects such as: micro-grooving, edge chipping, cracks, gouch marks were observed on ground PCD. The Dynamic friction Polishing transforms the PCD material for ease of polishing and hence the surface and sub-surface properties of PCD have been changed which results in deterioration of strength. Furthermore such process accelerates the cracks, chip off and edge damage while using as a cutting tool. Therefore a new method aero-lap polishing was attempted as it applies controlled amount of impinging force by which the surface damage can be significantly reduced. The study did establish an improvement of surface finish of PCD from Ra =0.55 ?m, Rt =3.9 ?m to Ra =0.29 ?m, Rt =2.3 ?m within 15 ?25 minutes of Polishing time along with significant reduction in surface defects.

NAMRC39-4738

THE EFFECT OF CUTTING FORCE MODEL COEFFICIENT VARIABILITY ON PROCESS PLANNING IN MILLING

Firat Eren — University of New Hampshire

Dr. Robert Jerard — University of New Hampshire

Dr. Barry Fussell — University of New Hampshire

This paper describes the effect of force model coefficient variability on process planning. Specifically, the statistical variations in model predicted machining forces while cutting aluminum, carbon steel, stainless steel and titanium are determined. An accurate estimate of the variability is essential for use in process planning to determine appropriate factors of safety when setting cutting conditions that are both safe and efficient. Force model coefficient calibration processes are described and the variation in the coefficients is determined through a multivariable regression of a number of experimental cuts. We show that the model accuracy decreases with changes in the radial depth of cut and spindle speed. Monte Carlo simulations of the cutting force are then used to determine the mean and standard deviation of the resultant peak force. A factor of safety is established for process planning using the mean plus three standard deviations. Statistically, 99.8% of the actual peak cutting forces should fall below the predicted value. The maximum expected peak force can be determined for each tool move in a NC program and used to select safe cutting conditions.

NAMRC39-4739

MECHANICAL AND MICROSTRUCTURAL PROPERTIES PREDICTION BY ARTIFICIAL NEURAL NETWORKS IN FSW PROCESSES OF DUAL PHASE TITANIUM ALLOYS

Gianluca Buffa — University of Palermo

Livan Fratini — University of Palermo

Fabrizio Micari — University of Palermo

Friction Stir Welding (FSW), as a solid state welding process, seems to be one of the most promising techniques for joining titanium alloys avoiding a large number of difficulties arising from the use of traditional fusion welding processes. In order to pursue cost savings and a time efficient design, the development of numerical simulations of the process can represent a valid choice for engineers. In the paper an artificial neural network was properly trained and linked to an existing 3D FEM model for the FSW of Ti-6Al-4V titanium alloy, with the aim to predict both the microhardness values and the microstructure of the welded butt joints at the varying of the main process parameters. A good agreement was found between experimental values and calculated results.

NAMRC39-4741

EFFECTS OF TOOL MICRO-GEOMETRY AND COATINGS IN TURNING OF TI-6AL-4V TITANIUM ALLOY

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Dr. Tugrul Ozel — Rutgers University

This paper presents investigations on turning Ti-6Al-4V alloy with uniform and variable micro-geometry inserts with single or multi-layer coatings. Turning of Ti-6Al-4V using inserts with uncoated, TiAlN coated, and TiAlN+cBN coated single

and multi-layer coated tungsten carbide inserts is conducted, forces and tool wear are measured. 3-D finite element simulations are is utilized to predict chip formation, forces, temperatures and tool wear on these inserts. Predicted forces and tool wear contours are compared with experiments. The temperature distributions and tool wear contours demonstrate some advantages of coated insert designs.

NAMRC39-4742

STATISTICALLY BASED PROCESS OPTIMIZATION FOR IMPROVED SURFACE QUALITY IN MICRO-END MILLING OF TI-6AL- 4V TITANIUM ALLOY

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Micro-end milling is one of the promising methods for rapid fabrication of medical devices and implants with 3D complex shapes. However, controlling the micro-end milling process to obtaining the desired results is much harder compared to that of macro-end milling due to the size effect and uncontrollable factors. The problem is much pronounced when workpiece material is a difficult-to-process material such as Titanium base alloys which are widely used as material of choice for aircraft structures, turbine blades and medical implants. In order to find the optimal process parameters which minimize the surface roughness and burr formation, the experiment was conducted based on Taguchi method then mathematical models were developed using Response surface methodology. The models can then be used to find the predicted response or optimal process parameters. The results show that the average surface roughness as low as 0.069 micrometer is achievable at the optimal condition. However, the trade-off is a severe burr formation.

NAMRC39-4743

STUDY OF COATED MICROTOOLS IN ELECTROCHEMICAL MACHINING (ECM)

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Coated tools have improved the performance of both traditional and nontraditional machining processes and have resulted in improved machining characteristics. However, a study on the performance of coated tools in micromachining, particularly in ECM, has not yet been adequately conducted. One possible reason is the difficulties associated with the preparation of coated microtools. This paper describes a method of preparation of nickel coated tungsten microtools by electrodeposition and reports on the performance of these tools in microECM experiments. The tungsten microtool was electroplated with nickel with direct and pulse current. The effect of the various input parameters on the coating characteristics was studied and performance of the coated microtool was evaluated in pulse ECM. The coated tool removed more material than the uncoated tool under similar conditions and was more electrochemical stable. It was concluded that nickel coated tungsten microtool can improve the pulse ECM performance.

NAMRC39-4744

COMPENSABILITY OF ERRORS IN PRODUCT QUALITY IN MULTISTAGE MANUFACTURING PROCESSES

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Recent advances in model-based feedforward control of quality in multistage manufacturing processes (MMPs) are used to introduce the concept of compensability of errors in product quality. It is defined as the system-level ability to automatically eliminate quality errors accumulated in the product, given the allocation of measurements and controllable tooling. Significant similarities are observed with the control theory concepts of controllability and observability. In addition, just like in control theory, we were able to introduce relatively simple matrix rank tests to determine the compensability conditions in a MMP and couple them with previously introduced notions of diagnosability. The theory introduced in this paper is crucial for optimal allocation of measurements and controllable tooling in MMPs. Compensability studies based on the newly introduced methods are conducted using models of dimensional error flows in two automotive cylinder head machining lines.

NAMRC39-4745

LASER WELDING OF NONWOVEN POLYGLYCOLIC ACID (PGA) SCAFFOLD

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This paper presents an experimental study on laser-welding of synthetic biodegradable polyglycolic acid (PGA) scaffold for applications in biomedical/tissue engineering. An experimental setup for laser spot welding is built which uses a spherical lens to focus the beam and apply pressure at the welding zone. A factorial design of experiments is used to study the effects of the operating parameters such as laser power, beam diameter, heating time and contact pressure on weld quality. The weld quality is assessed in terms of weld area, weld strength, and discoloration. The successful welds

obtained by the laser welding process have no discoloration and are stronger than the tensile strength of the original nonwoven sheets of PGA scaffold.

NAMRC39-4750

GREENHOUSE GAS EMISSION MITIGATION OF GLOBAL AUTOMOTIVE MANUFACTURING THROUGH CLEAN ENERGY SUPPLY

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Xiang Zhao — General Motors Company

Chris Yuan — University of Wisconsin, Milwaukee

Automotive manufacturing is very energy-intensive. The consumed energy contributes to generation of significant amount of greenhouse gas (GHG) emissions from automotive manufacturing industry. In this paper, a study is conducted on assessing the application potential of such clean energy power systems as solar PV, wind and fuel cells in reducing the GHG emissions of global auto manufacturing industry. The study is conducted on those representative clean energy systems available on the commercial market at six global locations. The results demonstrate that wind power is superior to other two clean energy technologies in the economic performance of the mitigation effect. Among these six selected countries, the highest mitigation potential of GHG emissions is in China, through wind power supply. The maximum GHG reduction can be made up to 60 tons per $1000 economic cost investment on wind energy supply in China. The application of wind power systems in the United States and Germany may also obtain a maximum of GHG reduction between 40-50 tons per $1000 economic input. When compared with the wind energy supply, applications of solar and fuel cell power systems have much less potential for GHG mitigation in the selected six countries. The median values of GHG mitigation range resulting from solar and wind power supply are almost at the same level.

NAMRC39-4751

EFFECT OF PROCESSING MEDIUM AND CONDITION ON ABSORPTION ENHANCEMENT OF FEMTOSECOND LASER TREATED A-SI:H THIN FILM

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Hydrogenated amorphous silicon (a-Si:H) thin films have been considered for use in solar cell applications because of their significantly reduced cost compared to crystalline bulk silicon, however, their overall efficiency and stability are less than that of their bulk crystalline counterparts. Limited work has been performed on simultaneously solving the efficiency and stability issues of a-Si:H. Surface texturing and crystallization on a-Si:H thin film can be achieved through one-step femtosecond laser processing, which can potentially alleviate the disadvantages of a-Si:H in solar cell applications. In this study, submicrometer conical and pillar-shaped spikes are fabricated by irradiating a-Si:H thin films deposited on glass substrates with hundreds of 800nm-wavelength, 130fs-duration laser pulses in air and water environments, respectively. Enhanced light absorption is observed due to light trapping based on surface geometry changes, while the formation of a mixture of hydrogenated nanocrystalline silicon (nc-Si:H) and a-Si:H after crystallization suggests that the overall material stability can potentially be increased. The relationship between crystallinity, fluence and scanning speed is also discussed. Furthermore, a comparison of absorptance spectra for various surface morphologies is performed. Finally, absorptance measurements across the solar spectrum show that the combination of surface texture and crystallinity induced by femtosecond laser processing is very promising for a-Si:H thin film solar cell applications.

NAMRC39-4752

OPTIMAL PART ORIENTATION IN RAPID MANUFACTURING PROCESS FOR ACHIEVING GEOMETRIC TOLERANCES

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Rapid Manufacturing (RM) processes have evolved from the Rapid Prototyping (RP) paradigm and are increasingly being used to manufacture parts, tools and dies in addition to prototypes. The advantages of RP methods to produce complex shapes without the use of specialized tooling can be

naturally extended to RM processes. For RM to be accepted as a mainstream manufacturing process, parts created by RM have to consistently satisfy critical geometric tolerances specifications on various features of the part. This paper studies the relation between cylindricity tolerance, one of the key form tolerances, and part build orientation in layered manufacturing. The effect of build orientation on cylindricity error is analyzed by three methods: first by a simple analytic method, second by simulating the manufactured surface using a CAD file of the part and third by using a STL file. The method is demonstrated by calculating optimal build orientation for test parts with multiple cylindrical features.

NAMRC39-4754

DESIGN FOR MANUFACTURE OF BIPOLAR PLATES FOR A PEMFC: A NUMERICAL STUDY

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The machining time of bipolar plates, as related to polymer electrolyte membrane fuel cell performance, is discussed in this paper, based on Design for Manufacture. Analytical and numerical approaches have been used to compare bipolar plates of different geometrical configurations and composed of different material. Specifically, serpentine and parallel bipolar plate configurations composed of stainless steel, aluminum, and graphite have been considered. Numerical studies were conducted in SurfCAM™. It has been found that decreasing rib size has a substantial effect on the total machining time, which directly corresponds to fabrication cost. Machining time was then correlated to performance, where it has been shown that increasing machine time, thus decreasing the rib size, leads to increased performance.

NAMRC39-4755

SYSTEM FOR COMPUTER AIDED CAVITY LAYOUT DESIGN FOR DIECASTING DIES

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Diecasting is one of the forming methods which is used for producing large number of components with good surface finish by injecting cast alloys in a metal mould under high pressure. Design of a diecasting die requires human expertise and is normally performed by trial and error method, which leads to monetary and time loss. Automation at initial die design stage will result in higher productivity besides reducing production lead time. Decision about number of cavities, layout pattern and placement of cavities in diecasting is critical for die design and manufacturing. This paper presents research work related to system for computer aided cavity layout design for diecasting dies. Proposed system consists of three modules namely determination of number of cavities, selection of layout pattern and placement of cavities in the die-base. It enables die designers to generate cavity layout design automatically from CAD (Computer Aided Design) file of the part with little information provided manually. Optimal number of cavities is determined by considering economic, technical, geometrical and time limitations followed by selection of layout pattern. Thereafter, cavities are placed in the die-base. The developed system depends upon database of diecasting machines and materials along with a knowledgebase of die design. This system has been tried on a number of diecasting parts and results have been found to be on the lines of those obtained from industry. Proposed system is more comprehensive than those available presently and is a step forward in the direction of design-manufacturing integration for diecasting.

NAMRC39-4757

INFLUENCE OF SIZE EFFECT AND RADIAL RUNOUTS ON THE END MILLING OF A NICKEL-BASED SUPERALLOY

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Nickel-based superalloys are a class of material difficult to machine. Due to the mechanical properties and specific microstructure, nickel-based superalloys exhibit rapid tool wear and high specific cutting forces, thus the machining is very sensitive to dynamics instabilities. This paper presents a numerical model based on the experimental results from end milling tests on nickel-based superalloy. Using the process parameters, a chip thickness has been calculated for different radial runouts of the tool. A correlation between the specific cutting force and undeformed chip thickness are used to estimate the size effect and the radial runout based on the experimental results. The effect of speed on the force model has been also studied.

NAMRC39-4759

EVALUATION OF OPTICAL FIBER POSITIONING USING SILICON V-GROOVES

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David Mills — University of Florida

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This paper describes the design, fabrication, and measurement of silicon v-grooves used to position optical fibers in micro-sensors. Three designs were selected, produced, and assembled (10 sets each). Images were analyzed to determine the v-groove dimensions and fiber center locations. While the fibers were positioned accurately in the X direction (parallel to the wafer surface), the Y direction location was biased because the etched v-grooves were too wide and deep. This was due to angular misalignment between the mask and wafer crystallographic axes. A Monte Carlo simulation is described that calculates the width and depth distributions for a selected level of misalignment uncertainty. The simulation then uses the bias in Y position of the fiber center to determine the corresponding fiber-to-fiber coupling efficiency.

NAMRC39-4761

EXPERIMENTAL STUDY ON CUTTING TEMPERATURE IN ROTARY ULTRASONIC MACHINING

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Rotary ultrasonic machining (RUM) has been used to machine various difficult-to-machine materials. Investigations have been reported regarding effects of input variables on several output variables (including cutting force, torque, surface roughness, edge chipping, material removal rate, and tool wear) in RUM. However, there is no report on any study on cutting temperature in RUM. This paper presents an experimental study on cutting temperature in RUM using titanium as workpiece material. Results show that cutting temperature with ultrasonic vibration was lower than that without ultrasonic vibration. Higher feedrate and lower coolant flow rate caused higher cutting temperature.

NAMRC39-4763

MICRO DIMPLE MILLING ON CYLINDER SURFACES

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The paper presents a micro dimple machining on a cylinder surface with a two-flutes ball end mill. When the cutter axis is inclined and the depth of cut is less than the tool radius, the non-cutting time, during which neither of the two cutting edges contacts the workpiece, appears in a rotation of the cutter. The rotation of the workpiece and the feed of the tool are controlled so that the removal area of each cutting edge does not overlap using the non-cutting time. In order to incline the tool with respect to the tangential direction on the cylinder surface, the tool is located at a position oriented at 45 degrees from the top of the cylinder. An analytical model is presented to control the shapes of the dimples with the cutting parameters. The presented machining is verified in the cutting tests with measuring the shape and the profile of the dimples. Pre-machining operations are conducted to have a high cylindricity of the workpiece in longitudinal turning and polishing. The cutter runout of the tool is also eliminated by adjusting the orientation and the position of the tool in the collet chuck with measuring the cutting force. The micro dimples are machined accurately as they are simulated

NAMRC39-4764

TOOL LIFE PREDICTION USING BAYESIAN UPDATING

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According to the Taylor tool life equation, tool life reduces with cutting speed according to a power law. The relationship is quantified using an exponent, n, and a constant, C, which are tool-workpiece dependent. However, tool wear is also considered to be a stochastic process and difficult to predict. The Taylor tool life model is deterministic and there is inherent uncertainty in the empirical constants, n and C. In this work, Bayesian inference is applied to estimate the Taylor tool life constants using a discrete grid method. Tool wear tests are performed using an uncoated carbide tool and 1018 steel workpiece. The test results are used to update the beliefs about the Taylor tool life constants. The updated beliefs are then used to predict tool life using a probability distribution function.

NAMRC39-4771

PREDICTION AND ANALYSIS OF FRACTURE IN SINGLE POINT INCREMENTAL FORMING USING A DAMAGE BASED MATERIAL MODEL

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Incremental forming is a sheet metal forming process that has envisioned considerable interest in the research community due to greater formability, economical and product independent tooling and greater process flexibility. However, lack of the ability to predict fracture has considerably hindered its industrial adoption. This work uses finite element analysis with a damage based material model to predict fracture in Single Point Incremental Forming (SPIF). The fracture envelope is described in the stress space and is a function of both the hydrostatic pressure and the deviatoric stress state. The tool forces and fracture depths from simulations and those from experiments are found to agree with each other well. An in-depth analysis of the deformation is performed to show that the through-the-thickness shear affects the formability much more significantly than the hydrostatic pressure. Furthermore, the implications of this effect on increasing formability in SPIF are discussed.

NAMRC39-4773

AN INVESTIGATION OF HYDROXIDE CATALYSIS BONDING STRENGTH

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Precision bonding is an important manufacturing step for many glass-glass and glass-metal assemblies. Many bonding methods are available, such as optical contacting, epoxy bonding, and hydroxide catalysis bonding (HCB). While HCB has been studied in the literature and used in selected space applications, it has not been extensively explored for use in commercial applications, e.g., bonding of components for displacement measuring interferometers and laser range finders. In this paper, the mechanical strength of hydroxide catalysis bonding is explored. The influences of: 1) amount of aqueous bonding solution; 2) concentration of bonding solution; and 3) curing time are investigated. Shear strength test results are reported. Detailed descriptions of material preparation, bonding, and the lap shear breaking process are provided.

NAMRC39-4774

A WEB-BASED FRAMEWORK FOR SEMANTIC SUPPLIER DISCOVERY FOR DISCRETE PART MANUFACTURING

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Web-based outsourcing has recently gained popularity among small and medium sized manufacturing companies as an efficient method for building flexible network of manufacturing counterparts. Several electronic marketplaces have emerged within the last few years with the objective of enabling large communities of buyers and sellers to virtually meet and establish new partnerships. Although e-marketplaces typically provide different automated search capabilities, they mainly rely on human users for final screening and evaluation of qualified suppliers. As the size of supply and demand pools increase, human-based search becomes inefficient. This paper describes an effort for enhancing the automation capabilities of web-based markets through an ontological approach. The proposed ontology is referred to as Manufacturing Service Description Language (MSDL). MSDL provides formal semantic for manufacturing services, thus enabling machine agents to actively participate in supplier discovery process. In particular, the focus of this paper is on the user interfaces required for describing the manufacturing requirements of particular work orders at a semantic level as well as the feature recognition module used for automated extraction of manufacturing requirements based on the CAD model of the parts.

NAMRC39-4775

EXPERIMENTAL INVESTIGATION OF KEY ASSUMPTIONS IN ANALYTICAL FAILURE CRITERIA FOR SHEET METAL FORMING

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Tearing concerns in sheet metal forming can be predicted based on the strain and stress in the material using analytical models, e.g., the Marciniak-Kuczynski (M-K) model and the Derov et al. model respectively. An assumption to these models is that a thin area of concentrated deformation exists which is referred as the defect region. Other key assumptions for the models are related to when the material is predicted to fail. For the M-K model (1967), the failure is related to the

incremental strain ratio inside and outside the defect region. Similarly, for the Derov et al. (2008) model, the failure is related to a critical stress concentration factor, i.e., the ratio of the effective stress inside and outside the defect region. In order to investigate these key assumptions, Marciniak tests with coupled Digital Imaging Correlation (DIC) to measure the strain in the material as well as the size of the defect region were conducted on 1018 steel with four specimen geometries, which varied the strain path from uniaxial to balanced biaxial. The results show that the parameters used to predict failure (i.e., the incremental strain ratio and critical stress concentration factor) were not constant for the various strain paths for both analytical models considered.

NAMRC39-4777

OPTIMAL LOAD PATH INPUT IN TUBE HYDROFORMING MACHINES

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Tube Hydroforming (THF) is a metal-forming process that uses a pressurized fluid in place of a hard tool to plastically deform a given tube into a desired shape. In addition to the internal pressure, the tube material is fed axially toward the die cavity. To successfully hydroform a part, good coordination between fluid pressure and material feed is a must. This pressure-material displacement relationship is knows as a load path. The load path is specific to a part and it is entered in a THF machine as pressure vs. time and displacement vs. time input variables. A methodology of decomposing the pressure- displacement loading path as a time variable to obtain pressure-time and displacement-time variant that is optimal for the THF machine system is presented. THF experiments for double T-shaped parts are carried out to demonstrate that using different pressure-time and displacement-time variants can result in a significant increase on the maximum power required by the THF machine actuators.

NAMRC39-4785

A SOLID MODELER BASED SIMULATION OF CHIP LOAD IN BROACHING OPERATION

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Broaching is a widely used cutting operation to produce circular and noncircular profiles either internal or external. Due to the diverse capabilities of broaching, and various cutting edge profiles, simulation of any broaching operation is very complicated. In this paper, a systematic approach for the simulation of a broaching operation is developed by employing solid modeling techniques. ACIS 3D solid modeler has been utilized as a geometric engine to represent the cutting edge, simulate the tool and workpiece engagement, and update the part. The workpiece geometry is also defined as a block in ACIS 3D solid modeler. In each step, the intersection of a cutting edge with the boundary of the workpiece block is considered as a chip load. The process will continue for each increment of tool motion to obtain the chip load for a complete stroke of the broaching tool. The resultant chip load for both an orthogonal and oblique cutter is calculated by summing up the differential chip load for the simultaneously engaged cutting edges. The simulation results were verified based on available experimental data from open literatures.

NAMRC39-4787

MICRO-SCRATCH TESTING AND SIMULATIONS FOR ADHESION CHARACTERIZATIONS OF DIAMOND-COATED TOOLS

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In this study, micro-scratch tests were conducted on a diamond-coated tungsten-carbide substrate to investigate the coating adhesion. High intensity Acoustic Emission (AE) signals were detected once the coating delamination initiated during the scratch test. It has also been found that the tangential force increased gradually with the normal force, but varied significantly when the critical load of coating delamination was reached. A finite element (FE) model with a cohesive-zone interface was developed to simulate the scratch process and the coating delamination phenomena. The preliminary results indicate that it is feasible to use the FE combined with scratch tests to evaluate the coating interface characteristics.

NAMRC39-4788

APPLICATION OF CHEMICAL TRANSFORMATION INDUCED FRACTURE FOR CUTTING OF SUPERHARD MATERIALS

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A hybrid CO2 laser/waterjet machining system is used to cut superhard materials – polycrystalline diamond (PCD) and polycrystalline cubic boron nitride (pCBN) through a “score and snap” mechanism — laser heating leads to localized damage and chemical transformation of surface layers; and subsequently, stress fields developed due to constrained expansion of transformed material and waterjet quenching act on the laser made “score” to propagate crack through the thickness. In the case of PCD samples, scanning electron microscopy (SEM) and micro Raman spectrometry were performed on the cut surfaces to identify the mechanism governing sample separation. Experimental results indicate that cut surfaces were divided into two zones – a thin transformed zone near the top where the PCD grains have transformed to graphite and diamond-like carbon; and a fracture zone with the same composition as received substrate. In the case of pCBN samples, scanning electron microscopy (SEM) and X-ray photoelectron spectroscopy (XPS) analysis of the machined samples indicate that cut surface is composed of two different zones – a thin “transformed zone” near the top surface composed of oxidized products of PCBN and binder phase; and a “fracture zone” with roughness characteristics of fracture and same composition as PCBN blank. These observations suggest that during the localized laser heating and subsequent waterjet quenching, PCD and, PCBN materials near the top surface underwent chemical transitions. Build-up of tensile stresses in the surrounding material resulted due to (i) volumetric expansion of transformed material creating an asperity/ wedge effect and (ii) thermal gradients associated with rapid quenching. These tensile stresses in the surface layers lead to crack formation and caused separation of superhard materials along the laser path.

NAMRC39-4789

MODEL-AUGMENTED METHODS FOR ESTIMATION OF CONTACT PRESSURE DISTRIBUTION

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On-line measurement of the contact pressure distribution (CPD) at the tool-workpiece interface during sheet metal stamping is critical to advancing the state-of-art in tool wear and product quality monitoring. Since the number of sensors that can be integrated into a tool structure is limited by concerns of structural integrity and cost, estimation of CPD through a small number of sparsely located sensors has created unique challenges in information acquisition and representation. Specifically, the problem of determining continuous CPD from discrete sensor measurements is under-constrained and thus ill-posed. A mathematical framework is needed for treating such a problem. This paper presents three mathematical approaches - Regularization, Kriging, and Spatial Blending to address this problem and discusses their relative merits and limitations.

NAMRC39-4790

AFM PROBE BASED NANO MECHANICAL MACHINING OF GLASS

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Chaneel Park — University of Calgary

Dr. Simon Park — University of Calgary

In recent years, demands for miniature components have increased due to their reduced size, weight and energy consumption. In particular, brittle materials, such as glass, can provide high stiffness, hardness, corrosion resistance and high-temperature strength for various biomedical and high-temperature applications. In this study, cutting properties and the effects of machining parameters on the ductile cutting of soda lime glass are investigated through the nano-scale scratching process. In order to understand the fundamentals of the material removal mechanism at the atomic scale, such as transition from ploughing to shearing regimes, machined surface quality, cutting forces and the nature of deformation, theoretical investigation along with experimental study are needed. Scribing tests have been performed using a single crystal diamond atomic force microscope (AFM) probe as a scratching tool, in order to find the cutting mechanism of soda lime glass in the nano-scale. The thrust and cutting forces are obtained through the calibration procedures. The effects of feed rates and the ploughing to shearing transition of soda lime glass have been investigated.

NAMRC39-4791

ON-MACHINE MONITORING OF TOOL WEAR WITH TOUCH PROBES

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Dr. Thomas R. Kurfess — Clemson University - International Center for Automotive Research

An accurate mechanistic machining model for forces and tool wear requires exact measurements of the tool wear. This is even more critical when difficult to machine materials are involved and the tool wears rapidly. This study investigates the possibility of using on-machine touch probes for detecting tool wear, and presents details on how the flank wear can be correlated with the tool geometry, amplitude of cutting forces, and tool deflection. The advantages of this method are: (i) accurate and quick measurements, (ii) use of already existing equipment on most of CNC machines, and (iii) easy integration in control when force models are used, or when a method of compensating for tool wear is sought.

NAMRC39-4792

COOLING RATE LIMITATIONS IN THE DIFFUSION BONDING OF MICROCHANNEL ARRAYS

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Gopi Lingam — Oregon State University

A significant barrier to the diffusion bonding of microchannel arrays is the large capital investment required to setup production. This large capital investment extends from long heating and cooling cycles leading to poor production capacities. Empirical studies in industry have shown that cooling rate is limited by the warpage of microchannel laminae, which is believed to be caused by thermal buckling. In this paper, the limits of cooling rates based on thermal buckling during the diffusion bonding of microchannel laminae are investigated. Finite element analyses of the transient thermal and stress behaviors of these microchannel laminae were conducted to identify the maximum cooling rates for different lamina thicknesses. Findings confirm that cooling rates are limited by the thermal buckling of unconstrained microchannel laminae during cooling of the device. Finite element analysis results are used to extrapolate implications for microchannel production.

NAMRC39-4794

STUDY OF SPECIFIC ENERGY AND FRICTION COEFFICIENT IN MQL GRINDING USING OIL-BASED NANOLUBRICANTS

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An investigation on minimum quantity lubrication (MQL) grinding was carried out with the scope of documenting the process efficiency of oil-based nanolubricants. The nanolubricants were composed of molybdenum disulphide nanoparticles (< 100 nm) over coated with organic agents, dispersed in two different base oils - mineral oil (paraffin) and vegetable oil (soybean). Surface grinding tests were carried out on cast iron and EN 24 steel under different lubrication conditions- MQL using nanolubricants (varying compositional chemistry and concentration of nanoparticles), pure base oils (without nanoparticles) and base oils containing molybdenum disulphide microparticles (3-5 microns), and flood grinding using water-based coolant. Specific energy, friction coefficient in grinding and G-ratio were used as measurands for determining the process efficiency. Results show that MQL grinding with nanolubricants increases the process efficiency by reducing energy consumption, frictional losses at the wheel-workpiece interface and tool wear. The process efficiency is also found to increase with increasing nanoparticle concentration. Soybean and paraffin based-nanolubricant performed best for steel and cast iron, respectively, showing a possible functional relationship between the compositional chemistry of nanolubricant and the workpiece material, which will be the goal of future work.

NAMRC39-4795

AUTOMATED MICRO-TRANSFER PRINTING WITH CANTILEVERED STAMPS

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Dr. Placid Ferreira — University of Illinois at Urbana Champaign

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Dr. John A. Rogers — University of Illinois at Urbana-Champaign

This paper demonstrates the use of a flexible instrumented stamp to enable automated micro transfer printing as a route to large-area, deterministic assembly of microstructured device components or 'inks'.. The ability to instrument the stamp, a critical component for retrieval and placement of a micro device, to detect contact and monitor localized forces during critical events in the printing process not only allows for the development of a robust manufacturing process, but also for a unique vantage point from which to study fundamental issues and phenomena associated with adhesion and delamination of thin films from a variety of substrate materials. This paper presents basic design analysis on the requirements of the cantilevers for compatibility with a typical transfer printing environment. Off-the-shelf thin film strain gages are integrated with a thin elastomeric post as a preliminary prototype and the feasibility of transfer printing with it is demonstrated. Further, the set-up is calibrated to produce force signals for event detection and in-situ diagnosis of the process.

NAMRC39-4796

MODELING OF A SUBCRITICAL CO2 MICROCELLULAR FOAM EXTRUSION PROCESS

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Dr. Wei Li — The University of Texas at Austin

Subcritical CO2 microcellular foam extrusion is a novel manufacturing process to produce environmentally benign microcellular plastics for packaging and construction applications. The process uses pre-saturated polymer pellets to deliver foaming agents. The benefits of this method are two-folds. First, it allows low gas saturation pressure in the extrusion process such that the conventional extrusion equipment can be applied; Second, it activates nucleation sites in the saturation step, thus the bubble nucleation and growth can be decoupled for easier process control. The subcritical CO2 microcellular foam extrusion process has been experimentally demonstrated. In this study, we develop a process model to predict the effects of various process parameters. The pellet saturation and bubble growth process were characterized. The gas concentration in the pellets and final bubble size were predicted. The model presented in this paper can be used to optimize the subcritical microcellular extrusion process.

NAMRC39-4797

ENVIRONMENTAL IMPACT AND COST ASSESSMENT OF PRODUCT SERVICE SYSTEMS USING IDEF0 MODELING

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Mary E. Vanlue — Oregon State University

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The product service system (PSS) concept is increasingly recognized by manufacturing industry as a way to stimulate sustainability competitiveness. By providing use value of products through coupled services, companies are able to focus on addressing customer needs in other ways than simply through technology improvements or aesthetic modifications. When changing its strategy toward a PSS approach, a traditionally product-focused company is faced with the challenge of designing and evaluating the PSS from environmental, economic, and social perspectives. In particular, manufacturing companies must consider a variety of factors from across the life cycle, not just for materials, manufacturing, and use, but also for associated services. They must then analyze tradeoffs for several PSS design scenarios. The utility of the IDEF0 systems modeling tool is explored as a way to support strategic sustainable business decision making in conjunction with life cycle assessment and life cycle cost analysis.

NAMRC39-4798

MODEL FOR THE INDENTATION FORCE IN METAL CUTTING

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Two models have been developed for the indentation force when cutting with tools of finite edge radii, under sliding and sticking friction conditions. From results of finite element analysis (FEA) with sliding at the chip-tool interface, it is found that the flow stress along the primary shear zone (PSZ) is nearly constant and that the indentation pressure at the cutting edge varies between 1.5 and 2.5 times the flow stress. Using this, a simple model for the indentation force has been developed and used to obtain a closed form solution for the

true flow stress in the PSZ and the friction coefficient at the chip-tool interface, based on experimentally measured forces, shear angle and cutting edge radius. From FEA results for sticking friction with m=1, a new slip-line field (SLF) model has been developed and used to estimate the indentation force. It is found that there is a triangular dead metal zone (DMZ) centered about the arc of the cutting edge. The straight boundaries of the DMZ meet at the stagnation point of the flow and are bordered by triangular retarded flow zones (RFZs), which can be approximated as centered fan fields. There is no plastic deformation along the machined surface beyond the end of contact with the tool, which occurs at the lowermost point of the arc of the cutting edge. For m=1, all of the primary shear deformation originates near this point and is conveyed through the lower RFZ. It is found that half the shear deformation is complete along the slip line through the middle of the PSZ, and this slip line is horizontal within the lower RFZ. Based on this an approximate relationship for the slope of the free-surface of the PSZ is developed, and leads to simple equations for the cutting and thrust components of the indentation force.

NAMRC39-4799

ALGINATE MICROSPHERE FABRICATION USING BIPOLAR WAVE-BASED DROP-ON-DEMAND JETTING

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Scale-up microsphere fabrication with controllable size has always been an exciting manufacturing challenge. The objective of this study is to experimentally study an alginate microsphere fabrication process using nozzle jetting. Alginate microspheres have been fabricated using bipolar wave-based drop-on-demand jetting, and its formability and size have been studied especially as a function of sodium alginate and calcium chloride concentrations, voltage rise/fall times, dwell and echo times, excitation voltage amplitudes, and frequency. It is found that 1) the formability is sensitive to the sodium alginate and calcium chloride concentrations, dwell and echo voltages, and voltage dwell time; and the formability decreases with the sodium alginate concentration but increases with the calcium chloride concentration, dwell and echo voltages, and voltage dwell time; 2) the size is not sensitive to the sodium alginate and calcium chloride concentrations but increases first with the dwell time and then decreases; and 3) the size increases with the dwell and absolute echo voltage amplitudes.

NAMRC39-4800

EVALUATION OF TOOL-GRADE CERAMICS FOR USE AS PRECISION CUTTING TOOLS

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Dr. Burak Ozdoganlar — Carnegie Mellon University

This paper presents an evaluation of geometry and quality of wedge-shaped ceramic tools fabricated through a precision lapping process, with the aim of assessing the potential of tool-grade ceramics as tool material for micro-scale and precision cutting operations. The surface smoothness/condition and edge sharpness/quality of the fabricated tools are evaluated. Five types of tool-grade ceramics, a fine-grade tungsten carbide, and pure alumina are lapped on two adjacent faces to create a tool with a cutting edge. It was observed that certain ceramics had gaps/voids on their surface after lapping, resulting in serrated/non-uniform and non-sharp cutting edges. Except for the whisker-reinforced ceramic material, all tool-grade ceramics produced sharper and more uniform cutting edge, and a smoother rake/flank face, as compared to those of carbide and pure alumina. These results show that most of the tool-grade ceramics can be sharpened and smoothened to be used as precision cutting tools.

NAMRC39-4802

A HIGH-RESOLUTION ELECTROHYDRODYNAMIC JET PRINTING SYSTEM

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This paper discusses the design and integration of a second-generation electrohydrodynamic jet (e-jet) printing system. As electrohydrodynamic jet (e-jet) printing gains recognition as a novel, low-cost, high-quality direct-write process for flexible electronics manufacturing, that has the ability to deliver print resolutions that exceed those possible by conventional (thermal and piezoelectric) inkjet printing technologies by about two orders of magnitude, it has become necessary to develop an e-jet printer with a number of features for

prototype manufacturing. This second-generation printing tool incorporates a number of new capabilities, including higher printing speeds with a new pulsed-jet mode of printing, multi-materials capabilities with a dual print head, interpolation and NC programming for line writing capabilities in addition to raster-scan printing, and automated image analysis-based overlay registration capabilities for quick set up. Applications such as drop-on-drop printing for combinatorial chemical analysis as wells as crossover interconnects for microelectronic circuits are demonstrated.

NAMRC39-4804

SOFTWARE-BASED TOOL PATH EVALUATION FOR ENVIRONMENTAL SUSTAINABILITY

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Sushrut Pavanaskar — UC Berkeley

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Currently available life cycle assessment (LCA) tools provide only a rough estimation of the environmental impact of different manufacturing operations (e.g. energy consumption). To address this limitation, a web-based and application programming interface (API) based process analysis software tools were developed to estimate the energy consumption of a computer numerically controlled (CNC) machine tool operation and to evaluate its environmental impact as a first step towards sustainable manufacturing analysis. Acceleration/deceleration of machine tool axes and the direction of axes movement were considered to estimate the total energy demand and processing time of the machine tool operation. Several tool path generation schemes were tested to analyze the energy consumption and resulting green house gas emission of CNC machine tool operation. It showed that tool path generation schemes affect the amount of energy and the processing time required to machine the same part, and location of the machining resulted in different amount and characteristics of green house gas emission.

NAMRC39-4805

ORTHOGONAL MACHINING OF SINGLE-CRYSTAL AND COARSE-GRAINED ALUMINUM

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Orthogonal machining of single-crystal and coarse-grained (i.e., grain size considerably larger than the uncut chip thickness) materials has been a subject to many studies in the literature. The first part of this paper presents background on machining single-crystal materials, including experimental and modeling attempts. The second part briefly describes more recent modeling results from the authors, and presents new experimental results on planing and plunge-turning of single-crystal and coarse-grained aluminum using diamond tools. The experiments indicate that (1) cutting across grains of a coarse-grained aluminum workpiece produces distinctly varying forces and surface roughness from one grain to another, (2) plunge-turning and planing of single crystal aluminum provide equivalent force data for large rake angles, (3) forces alter between two distinct levels while cutting single crystals with small rake angles, and (4) with small rake angles, subsurface damage on single-crystal aluminum is extensive, reaching depths comparable to the un-cut chip thickness.

NAMRC39-4807

STRENGTH AND MICROSTRUCTURE OF LASER FUSION WELDED TI-SS DISSIMILAR MATERIAL PAIR

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The ability to efficiently create robust and reliable dissimilar metal joints has the potential to enable new functionalities and reduce the manufacturing costs of medical devices. The need for dissimilar material welds in the medical device industry is driven by the unique properties exhibited by biocompatible materials such as stainless steel and titanium, as well as shape memory materials such as NiTi. Many material pairs, however, suffer from significant intermetallic phase formation during welding which greatly reduces their strength. This study investigates the microstructures and strength of the laser fusion welded titanium-stainless steel dissimilar material pair as a simplified model of the NiTi-stainless steel pair. Compositional and structural analysis of the weld pool is performed and fracture morphologies are analyzed in different regions of the weld joint. The role of weld pool geometry, heat flow, and quench rate on the resultant phases, microstructures, and strength of the welds is discussed.

NAMRC39-4808

THE EFFECT OF MACHINING VARIABLES ON THE MACHINABILITY OF TURNING/BORING COMPACTED GRAPHITE IRON

Dr. John Agapiou — General Motors

Compacted graphite iron (CGI) has been found to be the optimum material for diesel blocks. CGI offers superior strength characteristics but lower machinability compared to gray iron. The reduced sulfur content of CGI prevents the beneficial formation of a protective manganese sulfide layer on the cutting insert in grey iron machining. The longest tool life penalty of about 90% has been documented with continuous cuts such as cylinder boring. It is necessary to identify solutions for machining CGI at similar speeds as gray cast iron. This paper describes machining investigations using several new coated carbide grades and polycrystalline tools, insert geometries, and cutting conditions. The wear mechanisms, tool wear and tool life were investigated. The cutting forces were measured, while the tool temperature was modeled using 2D FEM to estimate the temperature in the cutting zone to be related to tool wear mechanisms. A better understanding of tool wear mechanisms will help the advancements in tool material, coatings and designs. The limitations of the current technologies will be discussed.

NAMRC39-4811

MODELING OF TRANSPORT PHENOMENA AND THERMAL STRESS IN SPOT LASER KEYHOLE WELDING

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Hai-Lung Tsai — Missouri University of Science and Technology

Due to the highly-localized heating and non-uniform cooling in spot laser keyhole welding, complex residual stresses are often found in final welds, which can cause detrimental effects on mechanical properties of the welds and result in problems like cracking and distortion. Since the formation of thermal stress is tightly related with the heating, melting, solidification, and cooling processes in welding, accurate analysis of the transient thermal transport phenomenon in welding is critical to predict the thermal stress information in final welds. In this study, a comprehensive thermal model analyzing the heating, melting, solidification, cooling processes in spot laser keyhole welding is integrated with a mechanical model to accurately predict the thermal stress evolutions in laser welding and the resultant residual stresses in final welds as well. High compressive residual stress was found on the top surface of the workpiece in welding which causes rough surface (bumps) of the final weld. Residual tensile stress in some locations in the final weld was found to be higher than the critical level which indicates the potential thermal cracking occurrence. The proposed models can be used to further study the thermal stress formation mechanisms in laser welding and to provide a cost-efficient way to optimize the welding operations.

NAMRC39-4812

TOOL TEMPERATURES IN ORTHOGONAL CUTTING OF ALLOYED TITANIUM

Dr. Robert Ivester — NIST

This paper presents infrared-based measurements and analysis of cutting tool temperatures for orthogonal machining of alloyed titanium. High-speed infrared video provided the basis for measurement of cutting tool temperature distribution as reported here for cutting speeds from 55 m/min to 125 m/min with tungsten carbide tooling with and without a titanium nitride coating. The presence of the coating provides a reduction in tool temperature of approximately 80 °C. Increasing the cutting speed from 55 m/min to 125 m/min increases the peak tool temperature by approximately 135 °C.

NAMRC39-4814

SEGMENTATION AND SEGMENT DYNAMICS OF A SERIAL MANUFACTURING SYSTEM

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Jun Ni — University of Michigan

Throughput analysis is very important for design, operation and management of manufacturing systems, and has been studied in literature for over 50 years. Although many models have been developed to study the throughput of synchronous serial manufacturing systems, two shortcomings are observed. First, most existing models estimate only the average (or expected) throughput of systems, not obtaining the complete throughput distribution and second, most existing models only consider the steady state of systems, not accounting for their short term or transient behavior. In this paper, we introduce a new segmentation approach that divides a serial manufacturing system into segments and models the evolution of each segment over a given manufacturing cycle. The dynamics of each segment and their interaction with the rest of the manufacturing system are modeled. This approach will be used in future to obtain the throughput distribution of a serial synchronous manufacturing system.

NAMRC39-4815

EFFICIENT MACHINING OF HARDENED AISI 52100 STEEL USING A LASER-BASED HYBRID PROCESS

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Fukuo Hashimoto — The Timken Company

Dr. Shreyes N. Melkote — Georgia Institute of Technology

Cost-effective machining of hardened steel components has traditionally posed a significant challenge. This paper presents a viable hybrid machining approach for increasing the material removal rate and lowering tooling costs for machining of hardened steel parts. The approach consists of laser-induced tempering of the hardened workpiece surface followed by conventional machining at higher material removal rates to efficiently cut the laser-treated surface with ceramic tooling. Laser parameters for softening the hardened steel via tempering as well as cutting parameters that yield the largest reduction in cutting forces are identified through experiments on hardened AISI 52100 bearing steel. Results for the proposed hybrid process yield lower cutting forces and tool wear compared to the conventional hard turning process. In addition, unlike laser-assisted hard turning reported in the literature, the achievable material removal rates in the proposed approach are not limited by the laser power available.

ICM&P ABSTRACTS

ICMP2011-51003

DEVELOPMENT OF AN ALUMINUM BASED ACTIVE COMPOSITE EMBEDDED WITH OXIDIZED TITANIUM FIBER

Hiroshi Asanuma — Chiba University

This paper describes development of an aluminum based active composite which can generate multifunctions useful to become a type of smart material. In order to realize the purpose, continuous titanium fiber was embedded in the matrix, of which surface was oxidized to be insulated from the matrix and form a heater and a temperature/strain sensor, together with stainless steel reinforcement fiber. According to the experimental results, it became clear that the embedded titanium fiber can generate enough heat to cause actuation of the composite, and it can also work as a temperature sensor to be used for its shape control.

ICMP2011-51004

MECHANICAL PROPERTIES OF METALLIC CELLULAR MATERIALS CONTAINING POLYMER

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Toru Shimizu — AIST

Fuxing Yin — National Institute for Materials Science

Kimiyoshi Naito — National Institute for Materials Science

Cellular materials have unique thermal, acoustic, damping and energy absorbing properties that can be combined with their structural efficiency. Therefore, many kinds of cellular materials have been developed and tested as energy absorbing and damping materials. Particularly, closed cellular materials are thought to have many favorable properties and applications. In this study, a metallic closed cellular materials containing polymer was fabricated by the penetrating polymer into metal foam. The aluminum and stainless steel foams were selected for the metal foam and epoxy resin and polyurethane resin were selected for the penetrated polymer. The mechanical and damping properties shock absorbing property of this material were measured. The results of the compressive tests show that this material has different stress-strain curves among the specimens that include different materials in the cells. The internal friction of this material was measured and the result shows that the internal friction of this material is larger than that of pure aluminum closed cellular material without any polymer and change with increasing of temperature. However, shock absorbability decreased by penetrating polymer.

ICMP2011-51005

EFFECTS OF CURING TEMPERATURE ON THE INTERFACIAL FAILURE CRITERION IN A GLASS FIBER/EPOXY COMPOSITE

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Jun Koyanagi — JAXA

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Effects of curing temperature on the interfacial failure criterion in a glass fiber/epoxy composite are investigated experimentally by using the cruciform specimen method. In this method, the combination of the tensile and shear stresses can be changed by changing the angle between the loading and the fiber directions in specimens, which we refer to as cruciform angle. Specimens are loaded in tension by using a small loading device installed on the stage of an optical microscope. The onset of fiber/matrix interfacial debonding is detected optically. The relation between the applied specimen stress and the interfacial stresses are determined by using the finite element analysis (FEA). In the analysis, both the thermal residual stresses during processing and the material nonlinear mechanical properties are considered. The procedure to establish the interfacial failure criterion is proposed by using the experimental data from the several cruciform angles based on an assumed form of interfacial failure criterion. As a trial, both the quadratic and parabolic failure criteria are considered. The parameters in both criteria, the interfacial tensile and shear strengths are determined. It is shown that the method is capable of establishing the interfacial criterion without the influence of stress singularity which we encounter if we employ conventional interfacial evaluation methods, such as the fiber pull out test, the fragmentation test and microbond test.

ICMP2011-51008

MICROSTRUCTURE AND MECHANICAL PROPERTIES OF MG-ZN-Y ALLOY SHEET WITH A LONG PERIOD STAKING ORDERED PHASE

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Magnesium alloys have several distinct advantages as structural materials because of their low density and high specific strength. In 2001, a rapidly solidified powder/ metallurgy (RS P/M) Mg97Zn1Y2 (at.%) alloy with yield stress above 600 MPa and 5 % elongation at room temperature was developed. It is believed that the mechanism behind the strength the RS P/M Mg alloy relies not only on a grain refinement of about 200 nm but also on the long period stacking ordered (LPSO) phase formed in each Mg grain. Recently, high strength Mg alloys, such as Mg-Zn-Y alloys have been developed by using the LPSO phase as a strength factor. This paper describes the microstructure and mechanical properties of Mg-Zn-Y alloy sheets prepared from the cast alloys. A tensile test was performed along the RD for the Mg98Zn1Y1, Mg96Zn2Y2, and Mg94Zn3Y3 alloy sheets and their annealed states (773 K for 0.6 ks) at room temperature. These alloy sheets exhibited yield stress of 276, 319, and 379 MPa, and elongation of 12, 11, and 8 %, respectively. Yield stress of the alloy sheets increase drastically after hot-rolling compared with their cast state. From microstructure observation, it is suggested that the strength factor of these alloy sheets results from (i) the formation of basal texture of the LPSO phase and (ii) uniform dispersion of a fine Mg3Zn3Y2 phase. After annealing the sheets, yield stress tended to decrease, although elongation increased. Large elongation, i.e., above 20 %, was achieved in the Mg98Zn1Y1 and Mg96Zn2Y2 alloy sheets. It is thought that such large elongation originates from the re-crystallization of the Mg phase. Texture randomization due to re-crystallization of the Mg phase occurred in the annealed Mg-Zn-Y alloy sheet was confirmed by EBSD analysis. The formability of the Mg-Zn-Y alloy sheet and an AZ31-O sheet was evaluated via a 90 degrees V-bending test at room temperature. The annealed Mg96Zn2Y2 alloy sheet could be bent without cracking with a minimum bending radius per thickness of R/t = 3.3, which is less than that of as-rolled Mg96Zn2Y2 alloy sheet and the AZ31-O sheet. This improvement in the cold formability of the Mg96Zn2Y2 alloy sheet considered due to an increase in randomness of the Mg phase that results from re-crystallization of the Mg phase. From these results, it is concluded that Mg alloy sheets combining high strength and reasonable elongation could be prepared by using Mg-Zn-Y cast alloys.

ICMP2011-51009

CREATION OF HIGH STRENGTH AND HIGH DUCTILITY SINTERED MATERIALS WITH HARMONIC MICROSTRUCTURE

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Conventional material developments have emphasized ultrafine grain refinement and homogenization. However, “nano- and homo-” materials do not usually satisfy the need to be both strong but ductile, which are of course rather contradictory characteristics. We have succeeded in designing a “Harmonic Structure Material” that is both a “nano- and harmonic” material which has overcome that antinomy through use of one of the non-equilibrium powder metallurgy (PM) processes called the severe plastic deformation PM process. In the present study, IF steel, SUS 316L, SUS304L stainless steels, pure titanium and Ti-6Al-4V alloy powders are subjected to mechanical milling (MM) for various periods of time. The MM powders have two kinds of microstructure, which can be controlled by the MM conditions. They include ultra fine and coarse grain structures known as “shell” and “core”, respectively. Subsequently, these MM powders are sintered using conventional sintering processes. The sintered materials with the shell and the core have a network structure of continuously connected shells, which we refer to as a harmonic structure. The sintered materials with the harmonic structure simultaneously demonstrate both high strength and elongation. These outstanding mechanical properties are influenced by harmonic structure characteristics such as shell and core grain sizes, shell area fraction and shell network size. Thus, the harmonic structure can be considered as a remarkable design for improving the mechanical properties of powder metallurgy (PM) materials.

ICMP2011-51013

FINITE ELEMENT ANALYSIS OF CUTTING DEFORMATION OF STACKED POLYCARBONATE SHEETS SUBJECTED TO TWO-LINE WEDGE INDENTATION

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This paper describes a pushing-cut process of stacked polycarbonate (PC) sheets. In this work, the cutting line force of a 30/90 deg. facet blade on the upper PC worksheet and the deformation of its PC worksheet were simulated by an FEM code in order to reveal the effect of stacked structure on deformation flow of a PC worksheet mounted on a PC

underlay. The deformation profile of the PC worksheet was observed with respect to indentation of the blade by varying the friction coefficients of the worksheet with the blade and that with the underlay, and also the anaphase work-hardening effect of the PC sheet was discussed for estimation of the final cutting stage.

ICMP2011-51014

OXIDE LAYERS SINKING ON STRESS SHOT PEENED SURFACE, THE EFFECTS OF THE PARABOLIC LEAF SPRING SURFACE RESIDUAL STRESS AND FATIGUE PERFORMANCE

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Parabolic leaf springs are safety components regarding the commercial vehicles from durability and vehicle dynamics perspectives. The surfaces of the springs work under high stress due to dynamic loading and any defect on surface has a deep effect on the durability attribute. The surface cracks are the main reason for the failures under cyclic loads. Regarding to parabolic leaf spring endurance tests, production processes are determining the durability and robustness of leaf springs. Leaf springs have got critical and essential stress shot blasting processes which effects fatigue life .This process require know- how which might be maintained after having long term trials. The main purpose of a stress shot blasting operation is to remove the micro cracks occurring at heat treatment process and to reach a certain level residual stress value on surface. Oxide layer formation which occur at heat treatment process cause flash sinks surface defects during shot blasting operations and these surface defects cause fatigue failure on the endurance. Leaf springs with different shot blasting process characteristics have been produced at Olguncelik Plant in order to measure different surface defect size. All of results obtained from fatigue life have been considered with residual stress values, and the effects of oxide layer defect sizes have been verified by using experimental techniques. Residual stress values have been measured by high technology systems with reliable results. Consequently , evaluation of surface defect sizes of oxide layers have been measured and their effect on fatigue performance have been specified. Preventative actions and improvements have been summarized concerning these failures.

ICMP2011-51018

DEVELOPMENT OF AN EFFICIENT INVERSE ANALYSIS TECHNIQUE FOR MONITORING OF ELECTROPLATING CURRENT DENSITY ON TARGET REGION IN LSI FABRICATION

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Copper electroplating is widely used to fabricate Large-Scale Integration (LSI) whose components are from nanoscale wires to microscale bumps because of its excellent via/trench filling ability, good adhesion and lower process temperature and low cost. During electroplating it is necessary for fine plating to monitor the plating current density to ensure uniformity and quality. Our research focuses on the techniques for monitoring the current density distribution of the real-time electroplating. In the previous research, a novel technique to estimate electroplating current densities on plated surfaces from the data of the electric potentials in the plating cells has been developed for LSI fabrication technology. An electric potential at a point can be measured by using a capillary inserted in the cell. On the other hand, evaluation of a physical quantity on a boundary from known values in the domain is an inverse problem. This proposed technique applies Tikhonov regularization on the mathematical model of the electric field derived by boundary element method (BEM) to solve this inverse problem. Further we have conducted experimental verification and demonstrated the effectiveness of the present method by actual measurements. However we have applied with only 2 dimensional (2D) BEM analysis in our previous researches since the 2D BEM analysis is more accurate and calculates in less time than 3 dimensional (3D) BEM analysis. The 2D BEM analysis can be applied on only axially uniform domains and axially symmetric domains. Hence it limits the application range of the proposed method. In this research, we applied the monitoring technique with the 3D BEM analysis. Although the inverse analysis using the 3D BEM analysis tends to be large scale, it is important for the practical usage to monitor current density on target region accurately and efficiently. Therefore we have developed an efficient inverse analysis technique for monitoring of electroplating current density on the target region. This proposed technique consists of 2 steps: discard of low sensitive components in the observation equation for the inverse analysis and reutilization of the discarded components. Furthermore we have verified the proposed technique by using numerical simulations. Comparing the proposed method with simultaneous estimation of the entire current densities which is the method developed in our previous research, those results show that the proposed method can estimate the current density on the target region more efficiently than the previous method.

ICMP2011-51019

EFFECT OF FRICTION WELDING CONDITION AND WELD FAYING SURFACE PROPERTIES ON TENSILE STRENGTH OF FRICTION WELDED JOINT BETWEEN PURE TITANIUM AND PURE COPPER

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This paper describes the effect of the friction welding condition and the weld faying surface properties on the tensile strength of the friction welded joint between pure titanium (P-Ti) and pure copper (OFC). When the weld faying surface of the P-Ti side specimen was finished with a surface grinding machine, the joint did not have 100% joint efficiency and OFC side fracture regardless of the friction welding conditions. The joint efficiency of the joints with a friction pressure of 75 MPa was approximately 64% regardless of the forge pressures, and all joints fractured at the weld interface, although that efficiency exceeded that of the joints made with other friction pressures. To improve the joint efficiency, one was made with a P-Ti side specimen whose weld faying surface was finished by buff polishing. The joint efficiency was increased to approximately 85%, although the joint fractured at the weld interface. Moreover, a joint at a friction pressure of 75 MPa with a forge pressure of 270 MPa or higher was obtained with an OFC side fracture, although it did not achieve 100% efficiency. The fact that the joint did not fracture at the OFC base metal was due to the mechanically mixed layer at the weld interface that depended on the maximum height of the P-Ti side. In addition, when the compressive stress was higher than the yield stress of the OFC base metal, its tensile strength was lower than that without a compressive load. The tensile strength along the radial direction of the OFC base metal was also slightly lower than that of the longitudinal direction. Hence, the fact that the joint did not also achieve 100% joint efficiency was due to the decrease in the tensile strength of the OFC base metal by the Bauschinger effect and the difference of the anisotropic property.

ICMP2011-51020

LASER POLYMERIZATION OF FULLERENE NANOFIBERS

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Fullerene nanowhiskers (FNWs) are the single-crystal non-tubular nanofibers that are composed of fullerene molecules such as C60 [1], C70 [2], endohedral fullerenes [3] and so forth. On the other hand, fullerene nanotubes (FNTs) are the tubular nanofibers composed of fullerene molecules. Both the fullerene nanowhiskers and fullerene nanotubes are collectively called fullerene nanofibers [4]. FNWs can be synthesized by the liquid-liquid interfacial precipitation method (LLIP method). Although the C60 molecules of as-grown C60NWs are loosely connected with adjacent C60 molecules via weak van der Waals bonding forces, it was shown that the C60 molecules could be polymerized by irradiation of visible light laser beams [5]. Since the photopolymerized C60NWs should have enhanced mechanical strength, environmental stability and so forth, detailed polymerization experiments are expected. Hence, the present study aims to investigate the photopolymerization of C60NWs using a Raman spectroscopy apparatus (JASCO, NRS-3100, Japan) . Since the peak position of Ag(2) mode is a good indicator of photopolymerization as shown by Rao et al.[6], the degree of photopolymerization is investigated as a function of the Ag(2) peak position. The Ag(2) peak position was observed to be shifted downward by the laser beam exposure with a wavelength of 532 nm and the value of peak shift was dependent on the dose of laser beam energy. [1]K.Miyazawa, Y.Kuwasaki, A.Obayashi and M.Kuwabara, J.Mater.Res., 17[1] (2002) 83. [2]K.Miyazawa, J. Am. Ceram. Soc. , 85[5] (2002)1297. [3]T.Wakahara, Y. Nemoto, M.Xu, K.Miyazawa and D.Fujita, Carbon, 48 (2010)3359. [4]K.Miyazawa, J. Nanosci. Nanotechnol., 9 (2009)41. [5] M. Tachibana, K. Kobayashi, T. Uchida, K. Kojima, M. Tanimura and K. Miyazawa, Chem.Phys.Lett., 374 (2003) 279. [6] A.M.Rao, Science 259 (1993)955.

ICMP2011-51023

DEVELOPMENT OF PRECISION PROFILE CONTROL SYSTEM WITH FUZZY MODEL AND CORRECTION FUNCTION FOR TUBE DIELESS DRAWING

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Dieless drawing offers several advantages not only lack of the expensive dies and lubricant but also the ability to draw difficult material since the process is carried out at elevated temperature. However dimensional stability and accuracy is still unsolved issue.?A finite element Method (FEM) is utilized to examine a valid deformation behavior. AS the result a correction function is formulated from deformation progress of dieless drawing to predict elongation of desired profile. A new approach to control desired profile of dieless drawing parts by applying a fuzzy model and correction function is presented in this paper. The result shows that by applying fuzzy control and correction function model, dimensional accuracy of drawn tube profile increases significantly.

ICMP2011-51024

ANALYSIS ON FILAMENT WINDING SPHERE SURFACE COMPONENT WITH THREE POLAR-HOLES

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Some kinds of filament winding components work as connecting piece which has many holes. Traditionally, the hole is usually machined after the fabrication of composite components. This will lead to the fibers around the holes is cut off. It also increases the risk of delamination and crack around the area of the holes. In order to eliminate these defects, the multi-polar holes filament winding process was proposed. The winding trajectories of a sphere with three polar holes were calculated theoretically. Then, by calculating the area of fiber sparse zone and fiber volume fraction of this winding component, it was found the relationship between radiuses of polar holes and the area of fiber sparse zone.

ICMP2011-51027

DEPTH CONTROLLED NANOINDENTATION TESTER PRECISELY DETECTING INITIAL INDENTATION DEPTH WITH A LOAD SENSOR AT 0.1 MICRO-NEWTON RESOLUTION

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Nanoindentation has been evolved as a powerful tool to investigate mechanical properties of materials surface for the last two decades. Although the nanoindentation is extensively used for characterizing various materials, special attention should be paid in its application to the characterization of soft organic materials. Especially it is very difficult to measure correctly initial indentation depth between the indenter and the organic materials surface. Because indentation depth obtained with the organic materials is extremely larger than those of ceramics and metals even in the initial part due to the lower Young's moduli and hardness of organic materials. Despite of the problem about initial indentation depth, the nanoindentation is being expected to be used more and more to the soft organic materials. In the present study the author discusses essential problems concerning the load-controlled nanoindentation testers. And he also reports a newly developed depth-controlled tester which can correctly detects the intial indentation depth with a load sensor at a 0.1 micro-newton resolution and precisely positions with a remote-controlled XYZ stage. Indentation tests are conducted with a multi-layered hard disc to investigate testers performance at the maximum loads 1, 5, and 10 mN respectively and indentation modulus and hardness of the disc surface are determined. Repeated indentation cycles at the maximum load of 1 mN and the maximum indentation depth of about 60 nm reasonably gave rise to the 1st load-indentation depth(P-h) curve containing a hysteresis loop due to a plastic deformation and the following 2nd one containing a closed loop due to an elastic deformation. And also the 2nd P-h curve perfectly traced the 1st unloading curve. Loading curves at the three different maximum loads almost conformed on a same semi-quadratic curve. Corrected indentation moduli of the three loads became almost stable to load changes with a correction depth of 10 nm, while corrected hardness value of the load 1 mN was still higher than the others of load 5, and 10 mN, indicating the existence of a some ten nanometers diamond like carbon layer. Indents on the hard disc surface were confirmed to be precisely arrayed within a positioning accuracy of 2 micro-meter with a microscopic observation.

ICMP2011-51028

TENSILE STRENGTH OF CARBON FIBERS RECLAIMED FROM CF/EPOXY USING SUB- AND SUPERCRITICAL FLUIDS

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Toshiro Ueda — Shizuoka University

Keiichiro Tohgo — Shizuoka University

Tomoyuki Fujii — Shizuoka University

Idzumi Okajima — Shizuoka University

Masataka Hiramatsu — Shizuoka University

Takeshi Sako — Shizuoka University

CFRP (Carbon Fiber Reinforced Plastics) has been used for weight saving because CFRP has high specific strength and high specific elastic modulus. CFRP is applied to aerospace vehicles, sports goods and so on. Applications of CFRP in automotive area has been widely discussed. This will bring increasing waste of CFRP. Therefore CFRP recycle is an important issue. A variety of techniques have so far been investigated for recycling carbon fibers from polymer composites. Researchers have been published papers on recycling techniques such as crushing CFRP, decomposition using nitric acid and pyrolysis. These methods have disadvantages that reclaiming carbon fibers is difficult and surface deterioration occurs. In this study, carbon-fiber reinforced epoxy was decomposed using subcritical water and supercritical methanol to reclaim carbon fibers. The tensile strength of the reclaimed carbon fibers was measured. Then SEM observation, XPS, and Raman spectral analysis were conducted to elucidate the change of tensile strength caused by decomposition. The tensile strength decreased by 6% in the case of decomposition with supercritical methanol, and by 12-17% with subcritical water. The surfaces of reclaimed carbon fibers were resin-free. Decomposition did not affect the fiber surface and fracture surface morphology. Subsequent XPS analysis revealed that functional groups of the carbon fiber surface had been removed. Raman spectral analysis showed decreased graphitization of the carbon fiber surface. These results imply that the fracture toughness of the carbon fiber surface decreased because of breakage of carbon-carbon bonds in the carbon fibers as a result of decomposition.

ICMP2011-51029

NUMERICAL ANALYSIS OF INTERFACIAL BONDING OF ALUMINUM POWDER PARTICLE AND ALUMINUM SUBSTRATE BY COLD SPRAY TECHNIQUE USING THE SPH METHOD

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Tomonaga Okabe — Okabe Laboratory, Department of Aerospace Engineering, Tohoku University

Kazuhiro Ogawa — Tohoku University

The deposition mechanism of the cold spray (CS) technique is investigated numerically using the smoothed particle hydrodynamics (SPH) method. The CS process is simulated by modeling the impact of a spherical aluminum powder particle on aluminum substrate. In this work, the adhesive interaction between the contacting surfaces is described by intersurface forces using the cohesive zone model. Simulation results show that successful bonding is achieved above the critical velocity, but rebound was observed at high velocities. This indicates that optimum deposition is achieved only within a certain range of particle velocities. The numerically calculated deposition range is in direct agreement with the experimental results. Furthermore, the particle deformation behavior was also well comparable to the experimentally evaluated impact morphology. The analyses demonstrate the feasibility of the SPH method in simulating the CS process.

ICMP2011-51030

APPLICATION OF RANDOM WALK THEORY TO GRAIN MOTION DURING SUPERPLASTIC DEFORMATION IN TZP CERAMICS

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Kouichi Yasuda — Tokyo Institute of Technology

Tadashi Shiota — Tokyo Institute of Technology

This study focuses on grain motion during superplastic deformation of ceramics. Incremental superplastic deformation in TZP (Tetragonal Zirconia Polycrystal) ceramics was conducted at 1400? in tension. The increment of true plastic strain was set to be about 2%, and the specimen was deformed up to 30.3%. After each deformation, specified 748 grains were observed by FE-SEM, and the grains were found to move to a tensile loading direction in zigzag way like a Brownian particle. So, the zigzag motion was stochastically analyzed based on Langevin equation which is a motion equation of a Brownian particle. From the analysis, constraint by surrounding grains was found to change dynamically as superplastic deformation advances: At an earlier stage of superplastic deformation, the constraint is spatially distributed. As superplastic deformation advances, however, it becomes gradually uniform.

ICMP2011-51031

A STUDY ON THE BASALT FIBER REINFORCED COMPOSITES

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Guijun Xian — Harbin Institute of Technology

Hiroyuki Hamada — Kyoto Institute of Technology

Due to its low price and high chemical resistance, basalt fiber is emerging as a novel reinforcement for fiber reinforced polymer (FRP) composites used in civil engineering in recent years. Compared to widely applied glass fiber based FRP (GFRP) and carbon fiber based FRP (CFRP), however, much less research works on the durability performances of basalt fiber reinforced polymer (BFRP), have been done by now, which seriously hinders its wide and safe application. In the present study, mechanical and thermal properties of BFRP bar at elevated temperature and the hydrothermal ageing of BFRP plates were conducted. It is found that the tensile tests of BFRP bars were performed in the temperature range from room temperature to 350oC. Three stage of deterioration of the tensile strength and modulus are observed based on the changing rate, which includes the first and third stages of slow change and the second stage of dramatic reduction. It was found the strength and stiffness of BFRP still remains high values (e.g., more than half of the room temperature values) even at the high temperature. The deterioration is attributed to the decreased force transferring capacity of the resin. On the other hand, the evolution of the water uptake and mechanical properties with the ageing time was investigated. It is found that the mechanical property degradation of the BFRP plate samples in water is much less than that in alkaline solutions. The results indicate the current basalt fiber need to be modified in its chemical compositions, surface treatment for enhanced durability performance.

ICMP2011-51032

VERTICAL TYPE TWIN ROLL CASTER WITH SCRAPERS FOR CASTING CLAD STRIPS

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Hisaki Watari — Gunma University

In a conventional way, fabrication of aluminum alloy clad strip includes various processes. First, slabs of aluminum alloys are cast by D.C. casting. Then, the slabs are scrapped, homogenized, hot rolled and cold rolled to make aluminum alloy strips. The strips are bonded by hot rolling after cleaning their surfaces. It is not an environmentally friendly way. Process saving is required at production of clad strips. The purpose of this study, therefore, is to devise a process that is able to save some of the processes to reduce the production-energy. In this study, a vertical-type twin-roll caster with scrapers in order to cast three-layer clad strip is devised. The caster consists of two rolls made of copper which are 300mm in diameter and 44mm in width. Each roll is equipped with a scraper to prevent a mixture of two kinds of melts. Three-layer clad strip, consisting of a base layer and surface layers, was cast using the vertical type twin roll caster with scrapers. The cast clad strip had clear interface. The scrapers were useful to drag only the solidification layers. The cast clad strip was not broken at the interface after continuous bending test. Also, the strip was able to be cold-rolled and the layers were not peeled at the bonded interface. Therefore, these layers were strongly bonded and not pealed easily. It was proved by line analysis that Si contained in the base strip was not defused to the surface strip, which means that the two strips were not mixed at the interface. Casting of three-layer clad strip in one process by using the vertical type twin roll caster with scrapers was successful. The vertical type twin roll caster with scrapers used in this study should be effective for saving the manufacturing processes of clad strips.

ICMP2011-51034

STIRRING PHENOMENON OF ALUMINUM SHEETS BY ULTRASONIC VIBRATION AND ITS APPLICATION TO CLINCHING

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Takashi Sato — NONK

Hiroya Murakami — Tokyo institute of technology

Naoto Ohtake — Tokyo Institute of Technology

Increasing demands of low weldabiligy material and combination of dissimilar materials are leading remarks on solid-state welding process, e.g. friction stir welding, ultrasonic welding and electromagnetic welding. On the other hand, one of mechanical fastening method clinching has still advantages in productivity, cost and less requirement of surface conditions of materials. However, it is difficult for clinching to satisfy recent greatly sophisticated demands because of its limitation of joint-strength. To develop a novel joining process which has advantages of both conventional methods, the authors have considered several methods combining solid-state welding and clinching. In this paper, two types of ultrasonic vibration modes were applied during clinching process for aluminum sheets. In one of them, materials were located on maximum displacement area. On the other hand, materials were located on maximum stress area in the other type of vibration system. These vibrations were applied through clinching tools perpendicularly against materials. As a result, 60 % higher cross-tension strength was obtained. And grain refinement effect was also observed. Moreover, it was revealed that the

application of the latter mode of ultrasonic vibration generates unique vortical flows in the applied material. These vortical flows lead stirring phenomenon in the material and aluminum sheets are unified. In the discussion, this stirring phenomenon was considered as prospective effect for further improvement of joint strength, joining method for dissimilar material and new grain size refinement method.

ICMP2011-51035

IMPROVEMENT OF MECHANICAL PROPERTY OF WC - CERMET COATINGS PREPARED BY HIGH VELOCITY AIR FUEL SPRAYING (INFLUENCE OF POWDER COMPOSITION AND SPRAY CONDITION ON THE MECHANICAL PROPERTY OF HVAF SPRAYED W

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Hidenori Miyajima — Shinshu Univ.

Junya Kitamura — Fujimi Incorporated

Kazuto Satou — Fujimi Incorporated

The wear properties of WC-Co and WC-Co-Cr cermet coatings prepared by high velocity air fuel (HVAF) spraying have been investigated. The influence of the binding metal, the WC particle size (0.2 and 2 ?m) and the pre-heating temperature of the mild steel substrate on abrasive wear resistance, micro hardness and coating structure were studied, in detail. It has been found that increasing the preheating substrate temperature, the use of coarser WC particle and a lower melting point binding metal, such as Co-Cr are effective in producing hard and highly wear resistant coating. Using longer nozzle is also beneficial in making a coating with good mechanical properties. As a result, the HVAF sprayed coating made from WC (2?m)-10mass%Co-4Cr with a powder size of -35+5?m has the best mechanical properties found in this study. This coating has a high density with slightly much pores compared to conventional the high-velocity oxyfuel (HVOF) sprayed coatings. The abrasive wear resistance of the HVAF sprayed coating, investigated using a Suga-abrasion tester, was almost comparable to a HVOF sprayed WC (2?m)-12mass%Cocoating. Microstructural analysis suggests that further improvement of coating uniformity by a decrease of small pores below 1 micron in size and a homogeneous dispersion of WC grains in the Co-Cr matrix is required to further improve the mechanical properties.

ICMP2011-51036

ADVANCED ACCELERATED TESTING METHODOLOGY FOR LIFE PREDICTION OF CFRP LAMINATES FOR MARINE USE

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Yasushi Miyano — Kanazawa Institute of Technology

The advanced accelerated testing methodology (Advanced ATM) for the long-term life prediction of polymer composites exposed to an actual loading having general stress and temperature history is proposed in this paper. First, three conditions as the basis of Advanced ATM are introduced with the scientific bases. One of these conditions is the concept of viscoelastic compliance to describe the effect of load and temperature history. Second, the formulations of creep compliance and time-temperature shift factors of matrix resin are carried out. The creep compliance of matrix resin performs an important role for time and temperature dependence of long-term life of polymer composites. And the formulations of long-term life of polymer composites under an actual loading are carried out based on the three conditions. Third, the advanced ATM is applied to the long-term fatigue life of CFRP laminates for marine use.

ICMP2011-51037

IN-SITU HRTEM STUDIES OF BRAZING PROCESS

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Brazing is one of the important ceramics joining techniques and several brazing alloy was developed to obtain high strength joints. There are several factors to obtain the fine joints such as wettability or reaction phase at the interface formed after the brazing. However, reactions which control the wettability occur just at the solid/liquid interface on an atomic scale during wetting. In this report, we applied in situ HRTEM technique to various ceramics brazing. During the brazing the reaction processes between ceramics substrates and brazing molten alloy were directly observed on an atomic scale. Discussion about kinds of information obtained from this experiment was also included in this report. Substrates used were SiC, Si3N4, Si wafers. Ti-containing Ag-Cu eutectic alloy foil used as brazing alloy was placed on the substrate and the combined specimen mounted on the heating holder of an HRTEM and heated in the microscope to melt the alloy foil. In the case of SiC, Si3N4, the molten alloy spreading on the substrates were observed after melting of the alloy. SiC and Si3N4 were dissociated along the specific plane during the reaction. In the case of the SiC substrate, reaction phase formation was also observed at the atomic scale. In contrast, Si reaction with the molten alloy produced big holes at the contacted area and molten alloy spreading was not observed.

Depending on the spreading speed of the molten alloy on the substrate, several morphology of the molten alloy spreading on the substrate was observed. From this experiment, we could obtain the reaction process during the brazing, crystallographic effect on the dissolution of the ceramic substrate, crystallographic orientation relationship between substrate and reaction phase, atomic scale morphology of the spreading molten alloy front and growth mechanism of the reaction phase.

ICMP2011-51038

CASTING OF ALUMINUM ALLOY STRIP BY SINGLE ROLL CASTER EQUIPPED WITH A SCRAPER

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Toshio Haga — Osaka Institute of Technology

Shinji Kumai — Tokyo Institute of Technology

Hisaki Watari — Gunma University

The reduction of the weight of the automobile is very important problem to be solved immediately from the view point of the environment of the earth. The use of the aluminum alloy instead of steel is most useful way to solve this problem. Aluminum alloy sheet for the body of the automobile is very expensive. The low cost of the aluminum alloy sheet must be realized. A Twin Roll Casting (TRC) is one of economical process which can make casting of aluminum alloy sheet metal at low cost. The TRC for aluminum alloy has several advantages, including rapid solidification, low cost equipment, and low running cost. However, centerline-porosity occurs in the strip cast by TRC. Centerline-porosity leads to deterioration of mechanical properties. Therefore, in this study, focusing on a Single Roll Caster (SRC) of centerline -porosity does not occur. The SRC is superior to the TRC at the points of energy saving and low cost equipment. However, the SRC has disadvantage, too. It was unsoundness of the free solidified surface of the strip. If the procedure to improve the free solidified surface was devised, the SRC may become useful process. The SRC can be used for casting of the strip with no centerline-porosity. In the previous reports which described about the strip casting by the SRC, there were few reports about the equipment to improve the free solidified surface. In the present study, the scraper was devised and tried as a way to improve the free solidified surface. The simplicity of the single roll caster was not influenced by the use of the scraper. The scraper was made from the mild steel plate, and the plate was coated by the insulator paper. The insulator paper was used to prevent the decrease of the temperature of the molten metal. Moreover, the insulator paper was useful to prevent the reactance between the scraper and the free solidified surface. The melt pool was mounted on the top of the roll. Therefore, the scraper was easily operated to attain the proper condition. The scraper pushed the strip to the roll, and the contact condition between the strip and the roll became better than the conventional SRC. In this study, the strip casting of AA5182 was tried using a Single Roll Caster Equipped with a Scraper (SRCES). The free solidified surface of the strip cast by SRCES was improved by the scraper.

ICMP2011-51040

HIGH STRAIN-RATE COMPRESSIVE BEHAVIOR OF BULK STRUCTURAL ADHESIVES: EPOXY DP-460 AND METHACRYLATE MA560-1

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Kenji Nakai — Okayama University of Science

Norfazrina Hayati Mohd Yatim — Okayama University of Science

The high strain-rate compressive stress-strain loops for bulk specimens of epoxy resin and methacylate structural adhesives are determined on the standard split Hopkinson pressure bar. The compressive stress-strain data including unloading curves are obtained over a wide strain-rate range of 10-3 to 103/s. The effects of strain rate on the initial (secant) modulus, flow stress, dissipation energy and hysteresis loss ratio are discussed. The experimental results show that the two types of bulk structural adhesives exhibit dynamic viscoelastic behavior like polymers.

ICMP2011-51041

IMPROVEMENT OF DEPOSITION EFFICIENCY AND CONTROL OF HARDNESS FOR COLD SPRAYED COATINGS USING HIGH CARBON STEEL / MILD STEEL MIXTURE POWDER

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Satoshi Amao — Tohoku University

Nobuyuki Yokoyama — East Japan Railway Company

Kousuke Ootaki — East Japan Railway Company

In the case of cold spraying, small particles are accelerated to subsonic or supersonic velocity by high temperature and supersonic gas flow, and then impact onto a substrate. When particles impact onto a substrate, kinetic energy of the particles is converted to plastic deformation energy, namely plastic deformation is required for deposition. Because of requirement of plastic deformation, hard materials, such as high carbon steels, can be difficult to deposit on the substrate. And also, due to large plastic deformation, work hardening can be occurred. In this study, in order to develop an innovative repairing technique for high carbon steel by cold spraying, microstructures and hardness property of cold sprayed high carbon steel coatings using high carbon steel powders were evaluated. In order to improve the deposition efficiency and to control the hardness of the cold

sprayed steel coating, spray conditions were optimized and mixed powders of high carbon and mild steels were used. By applying mixed powders, a dense and thick coating with appropriate hardness was obtained.

ICMP2011-51042

DEVELOPMAENT OF THIRD GENERATION SELF-HEALING CERAMICS

Wataru Nakao — Yokohama National University

Roadmap of the development on the next generation self-healing ceramics was proposed. Two next generation self-healing ceramics was included in the roadmap. The second generation self-healing ceramics is to enhance the self-healing ability by modifying and substituting the healing argent. The third generation self-healing ceramics is to fuse the self-healing ability with the other function. As an example of the third generation self-healing ceramics, the continuous fiber reinforced ceramics having self-healing ability was developed. For the development, the materials design of the self-healing ceramics was discussed. The prototype third generation self-healing ceramics was prepared based on the mentioned materials design, and was characterized.

ICMP2011-51043

MEASUREMENT OF DIE DEFORMATION IN COLD FORGING BY THE COMBINATION OF LASER DISPLACEMENT SENSOR AND STRAIN GAUGE METHOD

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Takuro Yoshihira — Meiji University

Takuya Takahashi — Meiji University

The combination of laser displacement sensor and strain gauge method is newly devised to measure the elastic deformation of the tool-workpiece interface in cold forging. A deep hole is bored close to the inside surface of the die container. A steel pin is placed in the hole to detect the minute displacement near the die-workpiece interface. The movement of the pin is measured by laser displacement sensor. The displacement of the installation position of the laser sensor is measured simultaneously by the strain gauge method to adjust the measurement obtained from the laser sensor. This method is applied to the measurement of die deformation in the backward extrusion process. The displacement distribution over the die-workpiece interface under various conditions is obtained. It is proved that the newly developed method is effective for the measurement of die deformation in forging.

ICMP2011-51045

MOTION STUDY OF THE EXPERT CONCERNING SHEET METAL WORKING OF AUTOMOBILE PARTS BY ALL HANDS

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Mio Arai — Kyoto Institute of Technology

Masaki Sakata — Kyoto Institute of Technology

Natsumi Sasaoka — Kyoto Institute of Technology

Masashi Kume — Kyoto Bunkyo Junior College

Akihiko Goto — Osaka Sangyo University

Hiroyuki Hamada — Kyoto Institute of Technology

Recently, the worker who makes the form by using the sheet metal technology that is the manual work before the car is mass-produced has decreased sharply due to aging and successor's problems. Therefore, it is thought that to clarify the "intuition" and "technique" of the experts in such a manual work is imperative. Then, in this study, the expert involved in the car making of the prototype by all hands was targeted. The expert has made automobile parts by good use of the sheet metal technology for about 60 years. It was assumed that taking a video of the each stage of work of the sheet metal was executed to the workman while seeing the video image in addition, and the operating analysis was advanced on the site. As a result, it aimed to find a sense knack concerning using the method of the grasp or the tool properly and Caen to the warp degree of the material. In this report, it first paid attention to the process study of work, and the clarification of Takumi's technique was tried. Three digital video cameras were used to record the subject's behavior and set up to be able to record each work clearly. The video recording was continued from at time from the start to the end of subject working. An analytical object was work to produce the fender part installed in the front of the body. The fender was composed of three metal sheets of upper part, center part and lower part. Consequently, the targeted working process was divided roughly into six processes. First of all, the shape making process is performed with the upper part, the lower side, and the center part. The three parts were united by welding, and the shape making in the left side part is finished. After that, finishing process was carried out.

ICMP2011-51048

FAST AND SLOW RELAXATION MODES IN SHRUNKEN PHASE OF THERMORESPONSIBLE N-ISOPROPYLACRILAMIDE GELS STUDIED WITH SCANNING MICROSCOPIC LIGHT SCATTERING (SMILS)

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Ruri Hidema — Yamagata University

Kazuyuki Horie — Tokyo University of Agriculture and Technology

Shunsuke Hirotsu — Tokyo Institute of Technology

Dynamics in Poly(N-isopropylacrylamide) gels below and above their volume phase transition temperature have been investigated with scanning microscopic light scattering, with particular attention to the shrunken phase. While the static inhomogeneities due to frozen concentration-fluctuation tends to be suppressed by shrinking, the position dependence of the relaxation process due to thermal fluctuation becomes strong by shrinking and then a multiple-relaxation feature clearly appears in the shrunken gels. At least two distinct relaxation modes, fast and slow modes, in the shrunken phase were characterized separately, and their temperature dependences were determined. The similarity between the dynamics in shrunken gels and that in concentrated polymer solutions is indicated.

ICMP2011-51049

NOVEL OPTICAL DEVICES DEVELOPED WITH HIGH-STRENGTH GELS

Tomohiro Yokoo — Yamagata University

Ruri Hidema — Yamagata University

Hidemitsu Furukawa — Yamagata University

Double network (DN) gels are the strongest in the world whose maximum stress in compression reaches 30MPa. The DN gels have not only high strength, but low friction, shock absorbency and biocompatibility. Thus we hope that the DN gels will be used to artificial joints, artificial cartilages and artificial blood vessels. In this study we focused on both high transparency and large transformation of the DN gels and we tried to develop novel optical devices. Our purpose is to apply it to a deformable lens system. If we succeed in developing a new focus controlling system by imitating eyes, we will realize further miniaturization and simplification of various optical products containing optical lens.

ICMP2011-51050

DEVELOPMENT OF ULTRAHIGH DUCTILE GELS

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Ruri Hidema — Yamagata University

Hidemitsu Furukawa — Yamagata University

After 2001, several methods were devised to improve the mechanical strength of gels extraordinary. Therefore it is expected that gels will be used as new industrial materials. The purpose of this study is to create a novel high-strength gels, which realizes the ultrahigh ductility of gels by adding multi-functional polymer as a new type of crosslinker to the gels. We analyzed the mechanical properties of the gels, containing different amounts of the polymer and discussed the reffect of the polymer on the mechanical properties of the gels.

ICMP2011-51057

CASTING OF ALUMINUM ALLOY CLAD STRIP USING A ROLL CASTER

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Toshio Haga — Osaka Institute of Technology

Shinji Kumai — Tokyo Institute of Technology

Hisaki Watari — Gunma University

A roll caster has an advantage of the energy saving. Therefore, many researches of the roll caster have been done. However, the report of the roll caster to cast the clad strip is few. In this study, two kinds of the roll casters to make the clad strip was devised and assembled, and the fabrication of the clad strip was tried by the roll casters. One of the roll casters is a vertical type tandem twin roll caster. In this process, two twin roll casters were set at the vertical tandem position. Three layers clad strip can be cast directly from molten metals only by this caster. The base strip is cast by the upper caster. The overlay strips are cast by the lower caster. The fabrication process of the three layers clad strip of the vertical type tandem twin roll caster is as below. The base strip was cast by the upper caster. This strip was drawn into the lower caster. When the base strip went into the roll-bite of the lower caster, the melt of the overlay strips was poured to the lower caster. The three layers of clad strip can be cast by the vertical type tandem twin roll caster of the present study. The other of the roll casters is an unequal diameter twin roll caster. The unequal diameter twin roll caster is assembled from a small roll and a large roll. The small roll was amounted on the large roll. A scraper plate was used to prevent the mixture of the different kinds of melts. The scraper rounds around the pivot, and this traces the solidified metal. The

clad strip can be cast directly from molten metals only by this unequal diameter twin roll caster. The fabricated process of the clad strip of the unequal diameter twin roll caster is as below. The large roll cast the first layer. The small roll cast the third layer. The molten metal of the second layer is poured between the first and the third layer. The three layers clad strip can be cast by this caster. Two kinds of the roll casters could cast the three layers clad strips. The interfaces of the three layers clad strip were clear. The three layers clad strip could be cold rolled.

ICMP2011-51059

HYDROTHERMALLY SYNTHESIZED AND SPARK PLASMA SINTERED MULTI WALL CARBON NANOTUBE (MWCNT) REINFORCED BOEHMITE (ALOOH) DERIVED ALUMINA CERAMICS

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Multi wall carbon nanotube (MWCNT) reinforced alumina ceramics were fabricated by means of hydrothermal synthesis of MWCNT/boehmite (AlOOH) and subsequently by spark plasma sintering. Aluminum acete mono hydride ((HO)2AlC2H3O2) and MWCNTs (1 wt. % of alumina, 20 nm in diameter and 10 to 25 μm in length) were mixed in water with ammonia (NH3) and alpha alumina was added as a seed to lower the sintering temperature and the process took place at 200°C for 2 h. in a teflon lined autoclave. SPS conditions was 1600°C, 5 min. and 50MPa. FT-IR analysis of hydrothermally processed MWCNT/AlOOH was used to investigate the presence of COOH functional groups which are necessary for nanotubes. Nanotubes should be decorated with functional groups for homogeneous dispersion in the matrix and also to provide interaction with the oppositely charged boehmite particles. . After the sintering process the obtained samples were analyzed by XRD. SEM and TEM analysis of hydrothermal synthesized powders and SPSed powders were performed in order to assess the state of aggregation and the integrity of MWCNTs. SEM analysis of MWCNT/ AlOOH revelas fiber reinforcing affects which are fiber pull out and bridging when advancing cracks were observed. Besides, it is clearly shown that nanotubes made interactions with boehmite particles. TEM analysis of MWCNT/ AlOOH reveals that the synthesized boehmite particles having cubic shapes and 40 nm in length and it is clearly shown that MWCNTs' surfaces are covered with boehmite particles. The high magnification TEM images of nanotubes sidewalls also show that nanotubes are intact. According to the SEM analysis of polished surfaces, the grain size of Al2O3 is 3.25 μm and it is 2.42 μm for MWCNT/ Al2O3. SEM images of fractured surface of monolithic Al2O3 and MWCNT/ Al2O3 samples showing the presence of mixed mode of fracture for pure alumina and inter-granular fracture for MWCNT/Al2O3. Nanotubes tend to locate between the grains creating continious networks. The electrical conductivity values are 10-8 S/m for alpha alumina and 10-4 S/m for MWCNTs/alumina. The relative densities and hardness values of the samples were 98.19%, 17.99 GPa and 99.96%, 17.28 GPa for Al2O3 and MWCNT/ Al2O3, respectively. In summary, carbon nanotube reinforced hydrothermally synthesized boehmite derived alumina ceramics was produced by means of SPS with nearly full density.

ICMP2011-51060

EFFECT OF TEMPERATURE ON FATIGUE CRACK GROWTH BEHAVIOR OF EPOXY RESIN REINFORCED BY SILICA PARTICLES

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Epoxy resin composites reinforced by silica particles have been applied for encapsulate materials for semiconductor device because of their excellent electrical insulation, formability and adhesion to other materials. However, thermal stresses generated during on-off cycles attributed by heat expansion coefficient difference between resin and device led to crack initiation, finally resulted in failure. Moreover, as the resins at near glass transition temperature, show typical deformations such as softening, creep deformation and viscoelastic behavior, which may change crack growth behavior. Effects of temperature on fatigue crack growth behavior of epoxy resin reinforced by silica particles was then observed in this study. Crack growth test was carried out at the temperatures of 22oC, 50oC and 80oC. In addition, two different frequencies were also used to investigate time dependent effects. Crack growth curve relating dK to da/dN showed decreases in crack growth resistance with temperature elevation and frequency dropping. On the other hand, crack growth curve related dJ to da/dt showed two separated bands that depend not on frequencies, but only on temperatures. Upper band corresponds with ambient temperature (22oC) and lower band corresponds with elevated temperature (50,80oC). Fracture surface observation revealed two different crack growth mechanisms corresponding to these bands. Crack propagated straightly breaking silica particles at ambient temperature, whereas crack propagated along silica particles at elevated temperatures. These variations can be explained in term of

transition from breaking of silica particles at low temperatures to cracking on interfaces between silica and epoxy resins at elevated temperatures.

ICMP2011-51061

STRAIN SENSORS MADE FROM POLYMER NANOCOMPOSITES WITH TWO KINDS OF MWNTS

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Extensive numerical simulation and experimental measurements have been conducted to understand the piezoresistivity characteristics and the working mechanisms of highly sensitive strain sensors made from carbon nanotubes (CNTs) embedded polymer nanocomposites. When using two kinds of multi-walled carbon nanotubes (MWNTs), it was identified that the piezoresistivity characteristics of two sensors are different. When using comparatively straight MWNTs of a large diameter, named as MWNT-7, the fundamental working mechanism of this sensor is the tunneling resistance change among CNTs due to the distance change caused by applied strains. However, for another type of MWNTs, which is of a very small diameter and seriously curved shapes, and named as LMWNT-10, the main working mechanism of the sensor may be the piezoresistivity of MWNTs themselves due to deformation of MWNTs. Furthermore, for the sensors made from MWNT-7/epoxy, further numerical and experimental investigations have been carried out to explore the effects of processing parameters and material properties on sensor sensitivity. Both numerical and experimental results indicate that a higher tunneling resistance or higher ratio of the tunneling resistance to the total resistance of the sensor leads to a higher sensor sensitivity. Processing conditions and material properties play a role in determining the sensor sensitivity.

ICMP2011-51062

STRATEGY FOR ADVANCED FABRICATION OF METALLIC MICRO/NANO MATERIALS USING ATOMIC DIFFUSION PHENOMENON

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Metallic micro and nano materials are particularly attractive for use in MEMS applications, which are considered to be a key technological development with outstanding potential in modern industry. Especially, Al, Ag and Cu are the most popular materials for the metallization of integrated circuits, and these materials have big potential applications in MEMS and small-scale devices. Two kinds of atomic diffusion, i.e., electromigration (EM) and stress-migration (SM), based on physical approach were developed for fabricating metallic micro and nano materials by our recent research. Al thin wires, micro-spheres, and micro-belts can be fabricated by utilizing EM mechanism in passivated films. In addition, Cu and Ag nano-wires can be successfully synthesized by utilizing SM mechanism. In this study, a strategy for advanced fabrication of metallic micro and nano materials is proposed. Four ways based on a formula of atomic flux divergence (AFD), which is number of atoms decreasing or increasing per unit volume and unit time, are suggested for enhancement of atom accumulation.

ICMP2011-51063

DELAYED FRACTURE OF GFRP LAMINATES UNDER CONSTANT TENSILE LOAD IN HYDROCHLORIC ACID SOLUTION

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The aim of this research is to investigate the effects of the environment on the creep behavior of woven glass fiber reinforced plastics (GFRP) and to investigate the mechanism of its delayed fracture. The GFRP under study is consisted by plain NCR-glass cloth and vinylester resin, which both possesses high corrosion resistance. Experimental conditions discussed in this paper are in air, deionized water, and in hydrochloric acid at 40 °C. Immersion tests of woven GFRP were conducted in deionized water and hydrochloric acid in order to investigate its water absorption properties; the swelling strain and the weight gain. The swelling strain of woven GFRP were negligible within all environments, and the weight gain showed a similar increasing behavior between deionized water and hydrochloric acid, which both follows the typical Fickian behavior. Tensile tests of woven GFRP were conducted in air, in deionized water, and in hydrochloric acid to evaluate the mechanical properties, and to determine the experimental conditions of constant tensile load tests. The mechanical properties of woven GFRP decreased with the immersion into deionized water, and moreover by the immersion into hydrochloric acid. Constant tensile load tests of woven GFRP were conducted in order to investigate the creep behavior and the fracture time in various solutions: in air, deionized water and hydrochloric acid. The strain and the strain rate increased with the immersion into deionized water and hydrochloric acid. In addition, fracture occurred in deionized water and in hydrochloric acid within the range of this research. The fracture time in hydrochloric acid was shorter than that of in deionized water. Besides, the decrease of the resin adhesion was observed with the increase of immersion time from fracture observation, which is an evidence of the degradation of fiber/matrix interface adhesion. The fracture surface of the glass fiber flattened and the mirror zone enlarged with the decrease of the applied stress.

These experimental results suggest that the delayed fracture of woven GFRP under constant tensile load in corrosive environment is dominated by the degradation of its fiber reinforcement and fiber/matrix interface.

ICMP2011-51064

SHAPE MEMORY CHARACTERISTICS OF NI-RICH TI-NI SHAPE MEMORY ALLOYS BY POWDER-METALLURGICAL PROCESS

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Ni-rich Ti-50.8at%Ni shape memory alloys (SMAs) were fabricated by mixed elemental powders using a pulse-current pressure sintering equipment. The effects of solution treatment and aging treatment conditions on the shape memory properties and the critical stress for slip deformation of sintered alloy were investigated. It was found that the aged alloy showed the R-phase transformation induced by precipitation of Ti3Ni4. As a result, the aging treatment improves the critical stress for slip deformation of the sintered alloy, and the alloy aged for 36 ks showed the highest critical stress for slip deformation. The conventional solution-treated alloys had a lower critical stress for slip deformation of less than 200 MPa, which is lower than that of the wrought Ni-rich SMA. Therefore, in order to improve the critical stress for slip deformation of the alloy, the effect of the solution treatment under external stress was investigated. It was found that the solution-treatment under external stress also improves the critical stress for slip deformation, and the alloy aged for 36 ks after solution-treatment under external stress showed a superelesticity and over 350 MPa in the critical stress for slip deformation.

ICMP2011-51065

FABRICATION OF FUNCTIONALLY GRADED TINI SHAPE MEMORY ALLOY WIRE

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The martensitic and the reverse transformation temperatures are directly related to the bending rigidity of the TiNi shape memory alloy (SMA) wire. In this paper, aiming at obtaining a functionally graded TiNi shape memory alloy wire that varies in bending rigidity from high to low along the wire axis, a new fabrication process of combined powder metallurgy and plastic working is proposed. First, a multi-layered TiNi green compact, where Ti-Ni compositions varied layer by layer, was sintered by means of pulse current pressure sintering technique, and then it was hot-extruded and cold drawn into a wire. The functionally graded properties of transformation temperatures, texture morphologies and deformation properties of the extruded wires were investigated. According to differential scanning calorimetry measurements, it was found that functionally graded properties of transformation temperatures still retain even in the hot-extruded wire. Therefore, the wire having both shape memory effect and superelasticity was successfully fabricated

ICMP2011-51066

POLYMER EFFECTS ON TURBULENCE IN FLOWING SOAP FILMS STUDIED WITH FILM INTERFERENCE FLOW IMAGING METHOD.

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Thin liquid layer exists between bone and bone in joint of human body, and also, thin tear film covers cornea. These thin liquid layers contain biopolymer such as hyaluronic acid and mucin. These thin liquids make it possible that smooth movement of the joint and smooth blinks. In this research, effects of polymer in thin liquid layer are studied by using flowing soap films. Soap films consist of about 4x10^-6 m thickness water layer inside and surfactant mono-layer in the surface. Interference patterns of the soap films are affected by the thickness of the water layer. Thus the interference pattern reflects the behavior of the water layer. In this study, turbulence was made in flowing soap films, the effects of long flexible polymer Polyethylene oxide (Mw=4x10^6) to the turbulence was observed by the interference pattern. This technique is proposed as Film Interference Flow Imaging method (FIFI). Thickness and velocity information of the turbulence were observed by FIFI. Inside of the water layer in the soap film was observed by Scanning Microscopic Light Scattering (SMILS). Investigations of the polymer effects in thin liquid layer are useful for the development of polymer drag for joint pain or dry eyes.

ICMP2011-51067

FABRICATION OF TEXTURED DLC FILMS USING THREE-DIMENSIONAL MASKING SYSTEM

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Diamond-like carbon (DLC) film have high hardness among the amorphous carbon film, and have many excellent characteristics as low friction coefficient, wear resistance, gas barrier property and biocompatibility. These many positive characteristics enable DLC coatings to be applied to a lot of materials from metallic materials to polymer materials for overcoatings. However, when the DLC film is distorted with the deformation of a soft substrate, the fragile DLC film is considerably damaged and peeled-off or delaminated. Segment-structured DLC (S-DLC) coating has been developed to improve these weak points of DLC films. The S-DLC coating is a technique to separate the DLC film into small segments using metal masks. The S-DLC film can cope with the deformation of the substrate flexibility and can avoid the abrasive wear as well as the cracks or the delamination of the DLC film. Meanwhile, the S-DLC deposition by conventional methods using metal mesh as masks is difficult to apply to the three-dimensional substrates which have complicate curves. The purpose of this study is to develop coating methods for S-DLC deposition on the three-dimensional substrates like an aspect of the cylinder and a ball surface. In this study, we report the coating method using a robot employing six degrees of freedom (MOTOMAN-MH6: Yaskawa electric corporation) and a micro ink jet system (IJHB-1000 and IJHB-30: Microjet corporation). By adjusting the parameters applied to the piezoelectric element, the ink droplet was stable discharged. Then, small grid patterns were drawn on the plate. The substrate temperature is also controlled in order to make the drawn line thinner, because the resin ink is thermosetting material. Then, the DLC film was deposited onto the ink drawn substrate by a micro-pulse plasma CVD method using acetylene gas for 40 minutes. After the liftoff and the Raman spectroscopy measurement, we found that the resin ink could play a role as a mask material. Finally, grid patterns were successfully drawn on the aspect of the cylinder and a ball surface. In conclusion, it could be thought that this masking method could be used to various shape by complicating the robot programming in the future.

ICMP2011-51069

STRAIN RATE DEPENDENCY ON THE STRENGTH OF E-GLASS FIBERS

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It is well know that the strength of glass fibers increases with increasing the strain rate. Consequently, the energy absorption property of glass fibers is better than that of carbon fibers, though the static strength and elastic modulus of glass fibers are lower that those of carbon fiber. Therefore, it is expected to design the transport vehicles by glass-fiber reinforced plastics, since they have high specific strength, high impact energy absorption characteristics, and low material cost. However, the strengthen mechanism of glass fibers with increasing strain rate is not yet cleared. The propose of out research is to the answer the reason of the strain rate dependency on the strength of glass fibers. An analytical model considering the particular property of glass fibers was developed. It is reported that the crack growth of glass fibers show unique behavior. Slow-crack growth area named subcritical crack growth might affect on the strain dependency of glass fiber. The crack developing during the tensile test reducing the strength of glass fiber. We considered the crack growth during the tensile test, and the analytical model was presented considering the subcritical crack growth. The analytical results show the same tendency with the results reported other papers. It was calculated that the strength of glass fiber increased with increasing the strain rate. To discuss the validity of this analysis, we conducted the static and dynamic tensile test with the E-glass fiber bundle. The fracture behavior of static and dynamic test was completely different. Experimental results showed the results that strength of E-glass fiber increased with increasing the strain rate. On the other hand, the elastic modulus did not change with various strain rate. Furthermore, we confirmed that the analytical results showed good agreement with the experimental results. The strain dependency for the strength of glass fibers was successfully predicted by considering the subcritical crack growth during the tensile test.

ICMP2011-51070

ELECTRIC DISCHARGE MACHINED SURFACE OF THE INSULATING ZRO2 CERAMICS

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Several insulating ceramic materials, have been machined by electrical discharge machining (EDM) using the assisting electrode method that has been proposed by the authors' group. In this machining process, the carbide products that have electrical conductivity are made on the surface of workpiece. The adhered products became to the electrical conductive layer during the generation of the discharges. The physical and mechanical characteristic of the layer was affected by the electrical machining conditions and by the physical characteristics of the workpiece. In this paper, to investigate the dependence of the machining properties on the amount of Al2O3 additives and tool electrode materials. Two types of insulating Si3N4 ceramics were prepared as the workpiece and three types of tool electrode material of copper , copper- tungsten and graphite. Some electrical conductive material was adhered or coated on the workpiece as the assisting electrode and they were machined by the refinement sinking EDM machine. The material removal rate and the surface roughness were estimated on the EDMed workpiece, and the discharge waveforms were analyzed using the digital oscilloscope. The machining properties depended on the adhesion phenomenon of the electrical conductive layer which was made from the dissociated working oil element of carbon and electrode component.

ICMP2011-51071

ADHESIVE STRENGTH EVALUATION OF THERMAL SPRAYED COATING BY TORSION PIN-TEST METHOD

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Adhesive strength of thermal sprayed coating is evaluated experimentally by the newly established torsion pin-test method. The new method makes it possible to get a very accurate adhesive strength of thermal sprayed coating under combined shear and tensile stresses. Also, stress distributions at stress singular points on fractured surfaces by Finite Element Method. Finally, the adhesive strength criteria of WC-Co thermal sprayed coating could be found.

ICMP2011-51072

THE TIGHTENING CHARACTERISTICS AND EFFECTIVENESS OF MAGNESIUM ALLOY BOLTS

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In recent years, due to the rapid progress of lightweight technology, the demand for lightweight mechanical and electronic parts has been increasing. Industrial manufacturers are focusing on nonferrous bolts such as aluminum alloy bolts because of their lightness and strength. Incidentally, a bolt made from magnesium alloy which is considered the lightest metal for structures has recently been developed. But the magnesium alloy bolts are not widely used yet because the strength of the magnesium alloy bolts is considered to be insufficient. In this study, tensile tests and tightening tests for magnesium alloy bolts and aluminum alloy bolts have been conducted to investigate the effectiveness of magnesium alloy bolts. The magnesium alloy bolts used in the tests were made of AZ31 and AZX912 magnesium alloy, and the aluminum alloy bolts were made of A5056 aluminum alloy. Test results showed that the tensile strength of the aluminum alloy bolts was higher than that of the magnesium alloy bolts. However the results of the tightening tests indicated that the tightening strength of the magnesium alloy bolts was higher than that of the aluminum alloy bolts. These results are very interesting, and they may result in an increased use of magnesium alloy bolts. The reason the results were different in each test comes down to whether a twisting torque occurs or not. When a bolt is tightened to a specific clamping force, the bolt receives not only a tensile force but also a twisting torque. In general, the friction coefficient of the aluminum alloy is larger than that of the magnesium alloy. Hence an equivalent stress on the aluminum alloy bolt becomes larger than the same stress on the magnesium alloy bolt because the tightening torque while the aluminum alloy bolt is tightened, becomes larger than that of the magnesium alloy bolt. Accordingly the ultimate clamping force of an aluminum alloy bolt turns out to be less than that of a magnesium alloy bolt.

ICMP2011-51073

A STUDY ON THE CUTTING RATE PERFORMANCE OF A NOVEL SAGITTAL BONE SAW

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Conventional sagittal saws have been shown to generate significant heat at the cutting interface due to high friction and slow cutting rates. To investigate means of reducing sawing temperatures, a new sagittal sawing mechanism was developed to experiment with cutting parameters such as blade speed, stroke length, and thrust force. A unique aspect of the new mechanism is the ability to create blade movement in a direction normal to the oscillating motion. This enables the user to generate a thrust force by mechanical means, rather than through the application of a thrust force by hand. For this initial study, the new mechanism was characterized as a conventional sagittal saw, with cutting rates measured as a function of blade speed for a constant externally applied thrust force. The relationship between cutting rate and oscillatory blade speed was not linear in the region tested. At lower blade speeds, the cutting rate leveled off. As blade speed increased beyond an apparent threshold, cutting rates increased significantly for a relatively small change in blade speed.

ICMP2011-51074

SYNTHESIS OF VIRLTICAL ALIGNED CNT AND EFFECTS OF CNT LENGTH ON ITS POLYMER COMPOSITE PROPERTIES

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Carbon nanotubes (CNTs) has outstanding properties such as high thermal conductivity, high tensile strength and high electric conductivity compared with conventional carbon fiber, hence they are expected that they are used as fillers of composite material. However, according to the recent reports mechanical properties, such as Young's modulus and tensile strength, of CNT/polymer composite could not be improved as expected. It indicates that the length of CNTs is not longer than its critical length for reinforcement. In fact, in the case that CNT of 150 nm in diameter and 20 micrometer in length was used as fillers of CNT/polymer composite, the tensile strength was not improved. In this study, the effect of CNT length on its polymer composite properties was investigated. First, CNTs aligned along the vertical direction were synthesized by rf-plasma CVD method to obtain the longer and also uniform length CNTs. The length of the in-house CNT could be easily changed by changing synthesising time. CNTs of 10nm in diameter and 90, 150, 330 and 620 micrometer long CNTs could be synthesized. Then in-house CNTs were dispersed into Polycarbonate (PC) by a melt mixing. CNT/PC composites of 1 and 4 weight percent CNT loaded were fabricated by hot press in vacuum chamber then effects of CNTs length on electric, thermal and mechanical properties of CNT/PC composite were investigated. It was found that the length of CNTs highly affected on its composite properties and also the properties could be greatly improved with longer CNT. The volume resistivity of in-house CNT/PC composite with 620 micrometer long CNT had 2.4 times lower than that with 90 micrometer long CNTs on the condition of 1 weight percent concentration. Young's modulus of the in-house CNT/PC with 620 micro meter long CNTs was much stronger than those with shorter CNTs on the condition of 1 weight percent concentration. The tensile strength of 1 weight percent CNT loaded increase by about 50 percent. Finally the thermal conductivity of the in-house CNT/PC with longer CNTs showed slightly higher than those with shorter CNTs.

ICMP2011-51075

ANALYSIS OF MICRO PUNCH PENETRATION USING SCALE-UP EXPERIMENT

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A micro nozzle is an important part of fuel burners and ink-jet printers etc. The micro hole of the nozzle is efficiently manufactured by micro piercing a sheet. Besides, the micro-punch penetration is another forming process to make a dimple hole. While the micro punch is penetrating a sheet on a side, a small region rises into protrusion on the other side. It should be ground off to complete a hole. Accordingly, the punch penetration is not more efficient than piercing. However, it yields smoother surface and more precise diameter than piercing. In addition, it does not need a small clearance between a punch and a die, whereas the precise piercing definitely needs the small clearance. The punch penetration has these three advantages, so it must be an effective process. Industrially the punch life is also important. Properly, mechanical conditions such as the penetrating load, pulling force, bending load, and deformation behavior are essential to increase in punch life directly. Since it is an unknown process in macro-scale manufactures, they have never been measured except numerical simulation. In this paper, the mechanical conditions are evaluated in micro- and macro-scale experiments. For punch life, we should note the behavior that the punch was subjected to large bending moment at the onset of punch pulling from a hole under a poor-lubricated condition and hard material.

ICMP2011-51078

SUCCESS CONDITIONS OF WELDING ULTRATHIN PT WIRES BY JOULE HEAT

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Recently, the welding of micro/nanomaterials (MNMs) has attracted considerable attention because it is an indispensable technique for creating functional fine structures. Several welding techniques for MNMs have been reported, including electron beam heating, nanoscale soldering, cold welding and Joule heat welding. Among the available techniques, the Joule heat welding method is one of the suitable techniques for conductive, MNMs because the technique only requires the current supply for welding, and the welding of two objects are achieved in self-completed manner under a constant current supply. Up to now we have adapted the Joule heat welding method to welding the ultrathin Pt wires with the diameter of 600 to 800nm in air and a scanning electron microscope, and realized the tip to tip welding of ultrathin wires in both environments, where the tips of wires were contacted each other. Moreover, the tip to side welding of the ultrathin wires, where the tip of one wire was in contact with the side of the other, was also achieved by the Joule heat welding method. In this paper, we gather the successful data for welding two ultrathin wires performed under different environments and welding positions, and discuss the successful welding condition for ultrathin Pt wires. Here a parameter governing the melting phenomenon at the contact of two wires is used for discussion. The parameter was proposed previously and depends on the current, the length and cross-sectional area of the wires and comprises a function with respect to the thermal boundary conditions. Although the heat transfer properties around the wire system depended on the environments, the successful welding condition was independent of the environments. Also the welding condition derived from the tip to tip welding of wires was applicable for the tip to side welding of wires. Note that the successful welding condition was independent of both the environments and the welding positions.

ICMP2011-51079

FRACTURE BEHAVIOR OF STAMPABLE SHEETS COMPOSITES

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Recently, owning to the increasing concerns on the environment, lightweight materials representative by composite are being considered to be used in primary structure components in particular in vehicle instead of metal. In order to enhance the mechanical property in particularly impact property, at current study, stampanle sheets (glass mat which were fabricated by punch knitted technology) were adopt to make glass mat reinforced thermoplastic PP (GMT). In the paper, three kinds of specimens including two GMT which have glass fiber volume fractions (Vf) as 40% and 30% respectively and a LFT (normal long fiber reinforced thermoplastics PP) which has a Vf of glass fiber 40% were fabricated and tested in drop impact. The specimens have a size of 300X300 mm and a thickness of 3mm. The impactor fell down freely from certain heights to get a impact speed at 1 and 34 km/h. It is found that no matter of which impact speed, the maximum load and energy absorption value is increased with the increase of glass fiber volume from 30 to 40 % for GMT specimens. Additionally both GMT specimens have better impact property than LFT specimens. In the case of same glass Vf i.e. 40%, GMT had 2.5 times higher value that LFT in both maximum load and energy absorption. The observation on the fracture area was carried out to examine the difference fracture mechanics which has a small fracture area and fewer fragments in GMT while a big fracture area and more fragments in LFT specimens. It is found that the fiber architecture in GMT was 3D by the punch knitting which is considered to be the main reason to an enhanced performance. Furthermore, the effect of hole and testing temperature on the impact property of GMT were also investigated and discussed.

ICMP2011-51081

IMAGING THE NANO-STRUCTURE MATERIALS UTILIZING MICROWAVE-AFM

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With the development of nanotechnology, the measurement of electrical properties of materials and devices on nano scale has become a great needing. Though many kinds of scanning probe microscopes have been developed for satisfying the requirement of nanotechnology, a microscopy which can determine electrical properties on nano scale is still under developing. On the other hand, many researchers have been interested in microwave microscopy, because of the potential of microwave microscopy in evaluation of electrical properties of materials and devices. The advantage of microwave is that the response of materials is directly relative to the electromagnetic properties of materials. Recently, a microwave-AFM (M-AFM) has been developed, which is expected to be able to realize the evaluation of electrical properties and the measurement of topography of materials in nano scale, simultaneously. In this paper, some special samples with nano-structures were measured by the M-AFM. The electrical properties of the nano-structure materials were discussed in details.

ICMP2011-51082

SUPERPLASTIC NANOFORMING OF ZR-BASED METALLIC GLASS AT HIGH STRAIN RATE UNDER RAPID HEATING

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The Glass transition and crystallization phenomena were studied on ZrAlCuNi bulk metallic glass under rapid heating. Cylindrical specimens of 2 mm in diameter were heated by induction heating at a rate of up to 100 K/s. During the heating, glass transition temperature Tg and the crystallization temperature Tx increase with increasing heating rate. Furthermore, the temperature range of the supercooled liquid state becomes wider. In addition, deformation behavior during heating was studied under a compressive load. The material exhibits a Newtonian viscous flow in the temperature range of the supercooled liquid state, and the normal viscosity decreases with increasing heating rate. The normal viscosity is 5x104 Pas at a heating rate of 100 K/s. As an application of this phenomenon, characteristic nanoforming should be performed at very high strain rates during rapid heating. In the present study, the new nanoforming system was developed. The system consists of a rapid heating unit by resistance heating, a unit of detecting the glass transition phenomenon by measuring the straining behavior of pre-loaded specimen and an electromagnetic linear actuator for driving a forming tool and their control circuit. Temperatures of the tools, timing of specimen heating and tool driving affect the forming behavior because the thermal capacity of the specimen is so small. FEM simulation was carried out on heat transfer among specimen and tools during the forming. With these apparatus, specimen was heated at a rate of 103K/s and in optimum condition, diffraction grating was formed on the surface of the specimen within 0.5 seconds. The nanoforming system for metallic glasses is effective for mass production of micro parts for MEMS.

ICMP2011-51083

FABRICATION OF COMPOSITE MATERIAL USING COAL ASH AND ALUMINUM SLUDGE BY SPARK PLASMA SINTERING

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Coal ash and aluminum sludge are industrial wastes discharged in large amounts by electric power plants and aluminum sash factories. In this research, aluminum sludge was heat treated at a temperature of 1573K for 2 hours to change the ?-alumina crystal structure. The silica contained in coal ash and the alumina contained in aluminum sludge were combined to synthesize mullite by using a spark plasma sintering apparatus. While varying the composition ratio of the fly ash and ?-alumina sludge, the mechanical properties were investigated. As a result, the bending strength of the composite material (composition weight ratio of coal ash and sludge 2:3) showed an extremely high value of 270MPa at a sintering temperature of 1573K and holding pressure of 40MPa. Using X ray analysis, the existence of mullite structures in this material was confirmed.

ICMP2011-51085

ADVANCED SELF-HEALING AGENT FOR NEXT GENERATION SELF-HEALING CERAMICS

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Wataru Nakao — Yokohama National University

Advanced self-healing argents instead of SiC were investigated in the present study. Mo-Al, Nb-Al, Ti-Al alloys were determined to be suitable for self-healing material, based on Clarke number, melting point and oxidation behavior obtained from many references. The oxidation kinetics of Mo-Al, Nb-Al, Ti-Al alloys were also estimated by means of TG-DTA analysis. All the peak-temperatures of the alloy's oxidations were ~300 K lower than that of SiC. Furthermore, Ti-Al particle and Nb-Al particle exhibited lower activation energy of its oxidation than SiC particle. Thus, Ti-Al and Nb-Al alloys particles were determined to be the most attractive candidate for advanced healing argent.

ICMP2011-51086

SPLAT FORMATION MECHANISM IN THERMAL SPRAYING

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Thermal sprayed particle shows transition phenomenon from splash type to disk one in flattening on collision onto substrate surface according to both substrate temperature and ambient pressure change. That is, transition temperature, Tt and transition pressure, Pt can be difined as critical values for the transition. Splat formation mechanism relating to transition is discussed in the paper based on the observation on single splat behavior.

ICMP2011-51089

ALUMINIUM ALLOY WHEEL PRODUCTION AND FATIGUE EVALUATIONS

Murathan Soner — Olguncelik

Aluminium alloy wheels are used as safety part on light commercial vehicles. They are carrying complete vehicle. Primarily, aluminium wheel endurance must be ensured. The main advantages of aluminium wheels are being lighter than steel wheels which positively effects vehicle weight . Aluminium wheels are also used as a visual part and adds value on complete vehicle aesthetically. One of the most important advantages of aluminium wheel rather than steel wheel is behaving like the form of powder dispersion during a crash accident while steel wheel behaves like a blade. In this study, fatigue strength of aluminium alloy wheel, different aluminium alloy compositions and heat treatment effects on fatigue , fatigue strength values of different aluminium alloys, advanced gravity casting and gravity casting tool experiences, wheel spokes machining operation experiences related to casting quality and fatigue, endurance test experiences comparison with finite element solutions have been detailed and summarised. Aluminium alloy wheels main critical fatigue test of bending moment has been taken as reference. Bending moment test theoretical calculations and static linear finite element methodology have been summarised. Static linear finite element analysis results have been compared with rig tests. Besides bending moment test, impact test which performed with tyre is determining the endurance of aluminium alloy wheels. Impact test, dynamic non linear finite element analysis methodology will be summarised in another article. This paper present a precise method based on, finite element analyse solutions by evaluating the effects of the aluminium alloy material, the variations in the characteristics of the material, production parameters, heat treatment effects which correlates the real life conditions. Aluminium alloy wheel producers can take reference this numerical approach to obtain the fatigue life and the wheel geometry against the environmental condition on the base of material properties.

ICMP2011-51090

A STUDY ON STRUCTURAL STIFFNESS, STRENGTH AND TOUGHNESS OF KENAF RANDOM SHORT-FIBER REINFORCED POLYLACTIDE COMPOSITES

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In this study, composite flat sheets of poly(lactic acid), PLA or polylactide, reinforced with randomly oriented short-fibers of kenaf (Hibiscus cannabinus L.) was molded through a twin-screw kneading process followed by hot-pressing and rapid cooling. The weight fraction of the fibers to the composites was varied up to 20wt% by 5wt% increment. No chemical treatment was applied during the present composite processing for future references. Quasi-static tensile test and single-edge-notched three-point bend test for fracture toughness were respectively conducted to the present composites. From the tensile test results, any benefit of kenaf fiber loading into the polylactide in terms of the tensile strength (ultimate tensile stress at break) and tensile strain at break was not found when compared to those of neat polylactide. This is probably because the interfacial bonding of the present composites may be relatively weak and fiber length that will be reduced during the kneading process may be not sufficiently large to efficiently utilize the fiber strength especially at the very final stage of break. On the other hand,

structural stiffness (initial Young's modulus and degraded stiffness up to 30MPa of applied stress) and fracture toughness were certainly improved via kenaf fiber loading. In addition to the carefully acquired test data mentioned above, for the purpose of elucidating some sources of the experimental results on static structural performance of the present composites and verifying feasibility for applying the linear fracture mechanics to the present composites, numerical stress analysis using the general-purpose finite element analysis (FEA) code (ANSYS ver.11) was applied to the single-edge-notched three-point bend specimens, and it was, if partly, shown that relaxation of stress concentration around the crack-tip could play an important role in reinforcement mechanisms of the present random short-fiber reinforced composites.

ICMP2011-51092

EFFECT OF LOADING RATE IN THREE POINT BENDING TESTS FOR ROCK ON ITS FRACTURE BEHAVIOUR AND ACCOMPANYING ELECTROMAGNETIC PHENOMENON

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A series of three-point bending tests for two kinds of rocks, granite and gabbro, which have different content of quartz, were carried out at quasi-static and dynamic rates to examine the relation between their mechanical properties and electromagnetic phenomena during their fracture. Not only the strength of the rocks but also the output of ferrite-core antenna located close to the specimens in a shielding box made of Permalloy plates were measured through a band-pass filter. The dynamic bending strengths were larger than the static ones, i.e. the strain-rate dependence was observed in their strength of both rocks. It was also found that the intensity of electromagnetic waves measured in dynamic tests for granite was much greater than that observed in static tests, this means that the electromagnetic phenomenon strongly depends on loading rates, too.

ICMP2011-51093

ACCURATE QUANTITATIVE EVALUATION OF OXIDATION RATE OF SIC UNDER ELEVATED TEMEPERATURES

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Silicon carbide (SiC) exhibits high melting point, high thermal conductivity, high hardness, and excellent high-temperature oxidation performance. In light of this advantage, a number of investigators have studied the oxidation behavior of SiC aiming at applications in thermal protection system (TPS) for aerospace structures used at ultra-high-temperature. SiC is known to have excellent resistance against high-temperature oxidation in the passive oxidation regime, in which a protective SiO2 layer prevents further oxidation. However, under low oxygen partial pressure, SiC evaporates by the formulation of gaseous SiO and CO in the active oxidation regime. Of cource it is predicated that SiC is used for applying TPS at Passive oxidation regime. Therefore, it is important to understand how SiC oxidizes depending on oxygen partial pressure at high-temperatures. Although many researchers reported the transition conditions of active-to-passive oxidation and active oxidation rate of SiC, reported these values scattered quite widely. In order to clarify the reason for the large scattering, numerical calculations were carried out to simulate flow, diffusion, and oxidation reaction occurring near SiC samples of various oxidation-rate evaluation systems under the active oxidation regime using analytical software "ANSYS FLUENT". By these simulations, it was found that even if the input partial pressure of oxygen is the same, the oxygen partial pressure on the surface of SiC varies widely, approximately one order of magnitude variation. Since the oxidation rate should be controlled by the partial pressure of oxygen, this result indicates that the large scattering in terms of oxidation rates and transition conditions of active-to-passive oxidation regimes is very likely due to misevaluation of the partial pressure of oxygen PO2; input PO2 in the present case is 5~60 times as high as PO2 on SiC surface. In these calculations, Arrhenius parameters, i.e., the pre-exponential factor and activation energy were estimated by applying collision theory and from standard free energy of equilibrium vapor pressure of SiO, respectively.

ICMP2011-51094

IMPROVEMENT OF OUTPUT BAR SUPPORT WITH A POLYTETRAFLUOROETHYLENE COLLAR ON HIGH VELOCITY TENSILE TEST FOR STEEL PLATE

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As mentioned in the introduction of ISO 26203-1:2010(E), "Metallic materials -Tensile testing at high strain rate- Part 1: Elastic-bar-type systems," during a crash event, the maximum strain rate often reaches 1000 /s, at which the strength of the material can be significantly higher than that under quasi-static loading condition. Thus, the reliability of crash simulation depends on the accuracy of the input data specifying the strain-rate sensitivity of the materials. The accuracy of dynamic stress-strain behavior for steel plate depends on how experimental technique is utilized properly. In the one bar method, one of the high velocity tensile testing techniques, unfortunately, there is an apparent effect of the output bar supporting method on high strain rate tensile behavior of steel plate. If there is a little misalignment of the loading end of the output bar, lateral vibration of the end leads to an extraordinary-high initial stress peak on dynamic stress-strain curve. The author have been tried to find the optimum supporting condition of the metallic output bar end. Briefly speaking, at least one end of the plate specimen should be designed to be able to rotate in order to release inplane bending due to the misalignment of the bar, and no support or simple support with a V-shaped metallic support should be installed in the testing machine. However, these conditions were not enough to satisfy reproducibility of the shape of dynamic stress-strain curves for the same specimen material. To improve this situation, several kinds of tight supporting stand were installed. Between the cylindrical output bar and the metallic support, there were several contact points, i.e., three or four points. Consequently, the contact points should be limited two, because the area of an obtained stress-strain curve is enlarged by sliding energy in axial direction at the supporting points. In this study, with a collar and a sheet made of polytetrafluoroethylene, the sliding energy at the contact area between the output bar and the supporting stand is tried to reduce. Satisfied reproducibility has not been accomplished yet. Obtained experimental results suggest that some amount of contact pre-load should be introduced on the collar to reduce the lateral vibration of the output bar.

ICMP2011-51096

SURFACE ROLLING CHARACTERISTICS AND LOAD BEARING CAPACITY OF 1.5CR-0.2MO HIGH DENSITY SINTERED STEEL ROLLERS AND GEARS

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Surface rolling experiments were carried out using P/M rollers and gears made from 1.5Cr-0.2Mo 1P1S (Single Press Single Sinter) very high density (7.55 g/cm3) sintered steel. The P/M test specimens were machined from sintered packs. A high precision CNC form rolling machine of two roller dies transverse type was employed. In fundamental rolling experiments of rollers, the densification properties of this P/M material are examined and the porosity becomes almost zero at the surface and to a depth of approximately 0.5 mm when the amount of decrease in roller radius is more than 0.15 mm. The rolling process of P/M spur gears was designed and optimized to get good surface layer densification and enough accuracy on the gear tooth profile. The FEM simulation results agree well with the experimental ones and gears with good tooth profile accuracy and fully densified surface layer at least 0.5 mm on the gear flank can be obtained. The load bearing capacity of this P/M gear was tested and analyzed using a power re-circulating type gear testing rig with a counter pinion gear made of Ni-Cr-Mo wrought steel. Both of P/M gears and counter pinions were case carburized and finished by grinding under the same condition. The test results confirm that the high density P/M gears with or without surface densification have high enough surface durability to replace gears made of typical Cr-Mo wrought steel.

ICMP2011-51097

EFFECT OF CNT SIZE ON WEAR PROPERTY OF CU-BASED CNT COMPOSITE ELECTRODES IN EDM

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The effect of carbon nanotube (CNT) size on the wear properties of Cu-based CNT composite electrode in electrical discharge machining (EDM) was studied. Cu-based CNT electrodes were fabricated by electroplating using a copper sulfate plating bath containing three kinds of CNTs. EDM was performed on stainless steel to evaluate the wear properties of the electrodes. Single pulse discharge was performed to evaluate the craters generated on the electrode surface. The wear ratios of Cu-based CNT composite electrodes decreased by 50–72% in relation to those of electrolytic Cu electrodes. The wear resistance of the composite electrodes was dependent on CNT size. It increased as the length and thickness of CNTs increased. The mechanisms of wear resistance in Cu-based CNT composite electrodes are discussed through observation and analysis of craters formed by single pulse discharge. The diameters of the craters are almost identical and largely independent of the size and presence of CNTs, indicating that CNT addition does not improve the thermal conductivities of the electrodes. Hence, the increase in wear resistance is independent of thermal conductivity. Exposed CNTs observed in craters on electrodes containing large CNTs with high wear-resistance properties do not decrease in diameter via electrical discharge, indicating that large CNTs can be resistant to pyrolysis at the melting points for Cu and Fe. It is suggested that the carbon layer with exposed CNTs on the electrode surface prevents the electrode from spark erosion in a manner identical to that of turbostratic carbon.

ICMP2011-51098

PVDF RESONATING DIAPHRAGM ACTUATOR FOR FATIGUE TEST OF MICROSPECIMENS

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This paper presents modeling, fabrication and testing of a Poly VinyliDene Fluoride (PVDF) piezoelectric unimorph diaphragm actuator. This actuator is considered for fatigue testing of microspecimens of metals or alloys. A microspecimen is stamped on the top of a diaphragm actuator and the actuator applies cyclic loading to the microspecimen through the bending motion of the diaphragm and the stress increases in the specimen until the fatigue failure occurs. The dimension of this diaphragm is 5mm×3mm. In the experiment, maximum out-of-plane vibration amplitude of around 12 μm at the center of diaphragm is achieved at driving voltage of 50V at the first resonance frequency of the actuator which is about 8kHz. A finite element model of the actuator is created. The vibration amplitude at the resonance frequency from this model is around 3 times of that of experiment. Next, model of specimens made of Copper or Nickel are added to the model of actuator to simulate the vibration of the specimen for fatigue test. Stress analysis of the specimen at different driving voltages of actuator at the first resonance frequency of the actuator shows that the vibration of this actuator can increase the stress in Copper and Nickel specimens to hundreds of MPa which is high enough for the fatigue test of those specimens.

ICMP2011-51099

SEARCH FOR NI-NB-ZR-X AMORPHOUS ALLOYS FOR GLASS LENS MOLDING DIE MATERIALS

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As mold material for glass lens with grating, it requires not only excellent mechanical properties, high thermal stability and oxidation resistance, but also satisfying machinability. Our research on Ni-Nb-Zr alloy system found out that one amorphous alloy composition (Ni35Nb60Zr25at.%) met almost all the requirements for glass lens mold material. Unfortunately, when fabricating grating on the mold, the

immense wear of bit which was caused by high hardness (10GPa) made it impossible to fabricate precise grating. Consequently the forth element X in Ni-Nb-Zr-X was considered to be added to decrease the hardness. Al, Si and Ti were selected as candidates for X. However, during cutting test, Ni-Nb-Zr-Al and Ni-Nb-Zr-Si samples even can't be cut at start point, not mention to the capability to be precision-machined. As a result, the search was focused on Ni-Nb-Zr-Ti alloy system. Several samples were deposited and evaluated. Finally Ni28Nb32Zr25Ti15at.% and Ni25Nb30Zr25Ti20at.% with lower hardness presented the ability for precision machining.

ICMP2011-51102

EVALUATION OF FIBER/MATRIX INTERFACIAL PROPERTIES OF C/C USING MODEL MATERIAL

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Carbon fiber reinforced carbon composites (C/Cs) have been used for structural material in aerospace field, because of their high specific strength and specific elastic modulus at very high temperatures. Crystal structures of fiber and matrix were considered as an influential factor for characteristics of fiber/matrix interface, which mainly affect the mechanical properties of C/Cs. There are various types of atomic array in carbon fibers, such as amorphous structure, onion-type or radial-type crystal structures. These different structures may affect the bonding strength between the fiber and the matrix. Clarifying the effect of surface structure of carbon fiber and matrix may lead to a better understanding of the interfacial properties. Two different kinds of model materials were made in the present study. In both cases, glassy carbon was used to imitate the amorphous structures of the fiber. For the matrix, phenol resin or polyimide resin was used and after adhesion, they were carbonized at high temperature. In the above, phenol-based carbon represents amorphous structures and polyimide-based carbon is most likely graphite like structures. For the evaluation of the fiber/matrix interface, optical microscope and SEM observation of the interface and shear strength measurement by means of the plunger test method were carried out. The above two model materials showed about the same shear strength and it was higher than the ILSS of C/Cs.

ICMP2011-51103

DEVELOPMENT OF ACOUSTIC EMISSION CLUSTERING METHOD TO DETECT DEGRADATION OF LITHIUM ION BATTERIES

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Lithium ion batteries are widely used for electrical devices. However, their degradation causes serious accidents such as fires or explosions. In order to detect the degradation of a lithium ion battery during charging and discharging in real time, an acoustic emission (AE) technique was applied and a clustering method was developed to extract AE signals caused by battery degradation. In this study, highly oriented pyrolytic graphite (HOPG) and a lithium metal were used as working and counter electrodes, respectively, and a glass fiber sheet was used as a separator. An ethylene carbonate / diethyl carbonate (EC/DEC) solution, which was used as the electrolyte solution, was sealed in a metallic shell. Degradation of this type of battery mainly occurred by gas evolution and fracture or exfoliation of the graphite electrode. During the first charging and discharging cycle, 499 AE signals were detected. AE signals were clustered by a method that was developed based on the waveform polarity, frequency spectrum, and enveloped waveform. These features were first clustered by correlation coefficients. AE signals for which the Euclidean distance of each feature was close were clustered into the same cluster. AE signals were clustered into 43 clusters by this method. In order to characterize clustered AE signals from a degrading battery, the clustered signals were compared to artificial AE signals created by simulating degradation behavior in the battery. Gas evolution on an electrode in the battery was simulated by electrolysis of water. AE signals due to graphite fracture were simulated by mechanically fracturing the graphite in a Vickers indentation test. As a result, AE signals characterizing gas evolution were detected continuously during the cycle. This result constituted gas evolution phenomena in the battery. Fracture-related AE signals due to graphite electrode exfoliation tended to occur when the lithium intercalation rate changed. Thus, fracture or exfoliation of graphite was attributed to the formation of a solid electrolyte interface (SEI) or volume expansion/contraction due to lithium intercalation, respectively. Other classes AE signals were also discussed, of which some were attributed to the distortion of graphite.

ICMP2011-51104

NON-DESTRUCTIVE EVALUATION FOR C/C COMPOSITES USING ELECTRICAL MEASUREMENT METHOD

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C/C composites are lightweight materials with high mechanical properties and they are expected to be applied to aerospace field, etc. However, C/C has generally low reliability, because of inherent and nonuniform defects such as void, crack and debonding. Especially, the effect of interfacial debonding on mechanical properties has been reported to be serious. The purpose of this study is the establishment of non-destructive evaluation technique using electrical method in C/C. The main idea of the present method is to estimate mechanical properties from electrical data using correlativity of interfacial condition, mechanical properties, and electrical data. Interfacial debonding is detected indirectly by impedance measurement. This study assumes that C/C is composed of a parallel RC circuit and interfacial debonding works as a capacitor. Electrostatic field analysis was also done whether the interfacial debonding works as a capacitor. As a result, it was suggested that a quantitative forecast of the mechanical properties is possible from the electrical data.

ICMP2011-51105

MONITORING OF ROBOT ASSISTED POLISHING THROUGH PARAMETERS OF ACOUSTIC EMISSION

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The polishing process is essential for the surface generation of machine tooling components in advanced manufacturing. While robot assisted polishing is faster and more consistent than manual polishing, it can still consume a significant part of machining time and operator presence time. The determination of the point in time to change a polishing media or stop the process is needed for computer controlled functional surface generation. During the last years, several research works have been done in order to build grinding/polishing monitoring systems to determine process characteristics, the duration of each process stage and predict the end of process in a precise and unmanned way. This paper presents and analyses the utilization of acoustic emission for generation of control signals in the stone polishing process for achieving these control objectives in an industrial set-up prototype.

ICMP2011-51106

DETECTION OF IMPACT STRAIN WAVE IN COMPOSITES BY FBG SENSOR SYSTEM WITH AWG FILTER

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In our previous study, an ultrasonic propagation system using fiber Bragg grating (FBG) sensors as ultrasonic receivers has been developed for damage detection in composite structures. This system uses an arrayed waveguide gratings (AWG) filter as a Bragg wavelength filter to detect really small strain change of ultrasonic waves. In this research, the authors extended the function of this system to detection of large strain waves caused by the impact loads. First, tensile tests were conducted to obtain the relations between the strain and the outputs from multiple ports of the AWG filter that the reflection spectra of FBG sensors passed through. Then the relationship equations between the Bragg wavelength of the FBG sensors and the output ratios of the AWG filter were obtained. Then, an impact test was carried out to a carbon fiber reinforced plastic (CFRP) quasi-isotropic laminate on which an FBG sensor was bonded. After that, inverse analysis was applied to the measured output ratios of multiple ports of the AWG using the relationship equations obtained from the tensile tests. As a result, the strain wave caused by the impact load was able to be detected with a higher degree of accuracy than the results by a commercial device that measures Bragg wavelength at the sampling rate of 2.6 kHz. Furthermore, in order to confirm the availability of this method for simultaneous multipoint measurement, three multiplexed FBG sensors with different Bragg wavelengths were boned at three different locations on a surface of an acrylic plate. Since the stiffness of this plate was smaller than that of the CFRP plate, much larger strains were occurred under an impact load. Hence the Bragg wavelengths shifted over multiple ports of the AWG filter. However, the strain waves received in the three FBG sensors could be reconstructed precisely through the same automatic inverse analysis. The merits of this method to detect impact strain waves are as follows. First, since the ratio of multiple port outputs are used, the Bragg wavelength can be estimated independent of the variation of optical power caused by some disturbances. Secondly, this method can detect impact behavior at really high sampling rate, because the measurement speed depends on the performance of the data recorder. Thirdly, this system can detect not only really small strain of ultrasonic waves but also large strain waves caused by impact loads.

ICMP2011-51107

SIMULATION OF LOW-PRESSURE INFILTRATION FOR FABRICATION PROCESS OF ALUMINUM ALLOY MATRIX COMPOSITES

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Infiltration simulation of molten alloy to porous preform by low-pressure in order to fabricate metal matrix composites was developed. This simulation was made by Darcy's low and direct finite deference method, mainly. Furthermore, the effect of the increase of volume fraction of solid caused by the solidification of molten metal and the degradation of the permeability of molten metal by temperature degradation was considered in this simulation. Assumed preform, volume fraction of fiber, molten alloy and applied pressure for calculation are FeCrSi fiber, 20vol%, AAA332.0 and 0.5MPa, respectively. Simulation results denoted the temperature and pressure distribution of molten metal in preform during infiltration. Molten alloy infiltrate from preform surface to air vent, smoothly. Before applying a pressure, molten alloy infiltrated to half of preform because of vacuum at air vent. Infiltration to preform finished 0.571s later for applying pressure of 0.5MPa.

ICMP2011-51112

FRETTING CREEP, A MATERIAL DEGRADATION PROCESS

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Greater care must be taken in the choice of materials for components and structures subjected to either creep or fretting. In practice, there are many components and structures which are subjected to creep in the presence of fretting. This gives rise to fretting creep, a new material degradation process which has been ignored by scientists and engineers. Fretting creep may be defined as the degradation of material by the conjoint action of creep and fretting. Many examples of fretting creep cases which may be found in practice have been given. For this reason, it is important in any new design that fretting creep should be taken into consideration, and steps have to be taken to avoid its serious consequences. Thus, intensive studies are required to explore this material degradation process. It is hoped from such studies to supply the designers with the necessary design data. Also, it is important to find out the mechanisms involved in the fretting creep process, therefore remedies could be recommended. A rig has been constructed to carry out fretting creep tests. The rig has the facilities of changing the normal contact load between the fretting couple, the applied creep stress, testing temperature, fretting frequency and slip amplitude. Tests have been conducted on stainless steel 316 L at 600°C. The fretting couple was cylinder on flat, and the normal contact load between the couple was 2 N. The applied creep stresses were 420 and 330 MNm-2. Fretting frequencies of 50 and 500 Hz have been used. The results show that fretting affects the creep properties of the material. Fretting has a pronounced effect on the steady-state strain rate. As the fretting frequency increases, the steady state-strain rate decreases. Also, increasing the frequency results in a reduction in both the time to fracture and the creep ductility.

ICMP2011-51113

DEVELOPMENT OF SIMULATION OF NANOSTRUCTURE PRODUCTION DUE TO ELECTROMIGRATION CONSIDERING SPECIMEN'S DAMAGE

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Al nanowires have been successfully formed utilizing electromigration(EM) in a passivated Al thin film specimen. It is important for investigation of effective condition in the production of nanostructure(NS) such as nanowire to understand the production mechanism. Therefore, there is an attempt to understand the mechanism through numerical simulation. Recently, a numerical simulation of NS production was developed from the viewpoint of collection of metallic atoms, by improving the numerical simulation for the EM reliability of electronic devices. In the NS production, a direct current is supplied to the specimen until the disconnection caused by specimen's failure. However, the simulation of NS production covers until damage initiation in the specimen, not specimen's failure. So, the simulation is insufficient for understanding the mechanism of NS production covering process of specimen's failure. Therefore, in this study we develop a numerical simulation method covering process of specimen's failure. On the other hand, it is known that two failure modes of the specimen appear depending on condition of electric current and temperature. This paper shows that the developed method can simulate both the failure modes, and is useful for understanding the mechanism of NS production.

ICMP2011-51114

A ESR STUDY OF UV POLYMERIZED FULLERENE NANO WHISKER

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The fullerenes electronics have been prevented by its instability and inability of performance in ambient atmosphere. It is important to archive air tolerability of the fullerene devices for applying broad applications such as solar cells, electron luminescence devices, field effect transistors, and gas sensors. We have been making a study on polymerization of fullerene due to UV irradiation. Because the way is easy and freely area selectable method, it is needed to elucidate the detail of UV induced polymerization and the effect for air tolerability. Recently, it was described that UV irradiation into the fullerene nano whisker field effect transistor (FNW-FET) could read air tolerable FNW-FET1). FNW is fine crystalline nano wire consisting of C60 molecules made by liquid-liquid interfacial precipitation method2). FNW was obtained as solvate crystal with good solvent for C60, such as m-xylene or toluene. However large degradation was still observed when FNW-FET was exposing ambient atmosphere. To elucidate more detail of electron behavior and polymerization effect, we applied the ESR measurement to FNW. As well known, a C60 molecule has closed shell electron structure which means that no electron spins are in C60. However, C60 thin film has a thermal excited conductive feature with 0.22 eV of excitation energy3) and the electron can behave like a conductive electron at room temperature. The crystal structure of FNW was clarified and FNW has structural defects after evaporation of crystal solvent. The ESR magnetic susceptibility of FNW indicated that temperature independent behavior in vacuum which illustrated that electronic structure of FNW is almost metallic. New ESR spectrum was appeared when UV light was irradiated into FNW placed in ESR cavity. At the beginning, the new spectrum appeared and disappeared subserviently with UV irradiation, however stable signal was remained for 8 to 12 hour irradiation. The remained spectrum had broad and weak temperature dependent peak width, and can be considered to be from electronic structure of polymeric phase. The metallic behavior of pristine FNW was suddenly vanished when air was introduced. Furthermore, air exposure effect against UV polymerized FNW will be discussed to obtain air stable FNW as a n-type organic semiconductor.
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ICMP2011-51115

FRICTION STIR SPOT WELDING BETWEEN A5052 AND PET

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The application of light metals such as aluminum or magnesium alloy in automotive parts is very effective for the weight reduction purposes. On the other hand, plastic has been used in the automotive parts due to good physical properties such as excellent corrosion resistance, durability, insulation and lightweight. The both dissimilar materials are suitable to be couple in the production of automotive parts. Unfortunately, welding between them is difficult due to unlike material properties. Mechanical fastening or adhesive has been mainly applied to join between a metal and a plastic. However these techniques have limitations, for example it is difficult to join a product with intricate shape, longer assembly time, and required much consumable. Hence an appropriate joining technique should be proposed to improve quality, assembly time and reliability of the dissimilar materials joint. In this study, a new direct joining method for dissimilar materials between a metal and a plastic by using friction stir spot welding (FSSW) technique is introduced. A5052 and polyethylene terephthalate (PET) were used as materials used in the present work. Effects of joining parameters, such as plunge depth and plunge speed on the strength and joining mechanism are discussed. The joining strength was evaluated under tensile shear loading. Fracture surface and cross section of the joined specimens were observed in order to understand characteristics of the joints. The results show that A5052 and PET were successfully welded by the FSSW. In case of lower plunge speed conditions, welded area decreased with increasing plunge speed. In the conditions, welded area obtained with the deeper plunge depth was larger than that obtained with the shallow plunge depth. On the contrast, in case of higher plunge speed conditions, welded area size became almost constant regardless of plunge speed and depth. Tensile shear load decreased with increasing plunge speed when the joining was conducted with the conditions of the deeper plunge depth and lower plunge seeds. This decreasing might be due to difference in welded area. In case of the specimen joined with the shallow plunge depth condition, failure loads were almost constant. Apparent joining strength was evaluated by the failure load and welded area. The joining strength obtained in this study was almost constant regardless of welding conditions and it was fall between 0.5 MPa – 0.8 MPa. Formation of bubbles was observed at the interface of PET side. Size and distribution of the bubbles might affect the strength of the joints.

ICMP2011-51116

DEVELOPMENT OF CYLINDRICAL AE PROBES USING OPTICAL FIBER INTERFEROMETRIC SENSORS

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A low-cost and high-sensitive fiber optic AE sensor has been developed for health monitoring in an electromagnetically noisy environment. The sensor was composed of an epoxy cylinder and a wound optical fiber on its surface. A Mach-Zehnder fiber optic interferometer was used for measuring the circumferential strain of the sensor. In the present study, three experimental set-ups of direct input, longitudinal wave and plate wave measurements. Sinusoidal continuous waves, a pulse wave and sweep waves were generated by a transducer for low-frequency input signals. From the experimental results, it appeared that the sensor could monitor small continuous and pulse waves with low noise at the all experimental conditions. The results of sweep wave measurement showed that the sensor has resonant frequencies. The frequency responses by FEM analysis agreed very well with experimental results and it was found that the frequency characteristics were predictable.

ICMP2011-51118

INPROVEMENT OF TORSIONAL FRETTING FATIGUE STRENGTH OF SPLINED SHAFT USED FOR CAR AIR CONDITIONING COMPRESSORS BY HYBRID JOINT

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Tatsuro Aoki — Kyushu University

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Masato Miwa — Sanden Corporation

To improve the fatigue strength of the splined shaft used for a car's air conditioning compressor, press fit was combined to the spline. A torsional fretting fatigue test was performed focusing on the effect of the amount of interference on the fatigue strength. The fatigue strength of the splined shaft was drastically increased by the hybrid joint. The improvement was achieved by sharing the torque between the press fit and the spline. The fatigue strength of the hybrid joint was at most 8 times higher than that of the conventional spline-joint shaft. The fatigue strength as well as the failure mode of the hybrid-jointed specimens were changed depending on the amount of interference. The reason was that the relative slip was significantly reduced with an increase in the amount of interference. The specimen consisted of a shaft, a boss and a bolt. The hybrid joint prevented loosening of the bolt, while loosening of the bolt was found to occur in the conventional spline-joint shaft.

ICMP2011-51119

HIGH RESOLUTION TRANSMISSION ELECTRON MICROSCOPY OF ALUMINUM/GLASS SUBSTRATE INTERFACE BONDED BY ULTRASONIC WIRE WELDING

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Tomoyuki Nishinaka — Toshiba Mitsubishi-electric Industrial Systems Corporation

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Ultrasonic welding is an attractive joining method, because bonding is quickly obtained without extra heat or welding metal. Thus far, there have been several researches about the bonded interface structure and process of the ultrasonic welding. However, atomic structure analysis of the bonded interface was limited and sometimes controversial results were obtained. Besides, there were only few studies about the application of ultrasonic welding to the Al/Glass substrate and detailed bonding mechanism was unclear. In this report, ultrasonic bonded interface between an Al wire and a Mo coated glass substrate was observed by high resolution transmission electron microscopy and bonding mechanism was discussed. The bonded sample was cut perpendicular to the interface and, the atomic structure and chemical composition of the cross-section of the sample were analyzed. Mo grains on the glass observed before bonding extended perpendicular to the glass substrate and terminated with a nano sized pyramid at their surface. Structure of Mo grains remained unchanged after bonding. Around the interface between Al and Mo, several dislocations and Al sub-grains were produced in Al and no intermetallic compounds were observed. Al and Mo lattices were directly connected at the interface. This indicates that dislocations generated at the interface moved to form low angle grain boundaries during a recovery process without intermetallic formation. During the ultrasonic welding process, the pyramid of Mo surface was considered to work effectively to break the native oxide and produce the bonded interface.

ICMP2011-51120

EFFECT OF FILM THICKNESS ON HELICAL FORMATION OF COATED NANOWIRES IN AN ENHANCED-BENDING TECHNIQUE

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Various methods have been proposed for fabricating nanocoils in order to extend the range of elements for building nanodevices. Most of these methods are based on self-assembly technique, i. e., a specific crystallization. We have previously proposed an alternative method based on a mechanical process, where a straight nanowire is bent by depositing a thin film with a circumferentially nonuniform thickness on the nanowire. The bending is due to the misfit strain of the coated film. In order to enhance the bending, we also adopted a heat treatment that induces a creep flow only in the nanowire and thereby released the constraint of the nanowire on elastic bending due to film strain. However, the coils that were obtained by the heat treatment often had an irregular shape, and an efficiency of coil formation was 40 %. In present study, we investigated effects of the film thickness on the coil formation. We obtained the improved shape and efficiency (almost 100 %).

ICMP2011-51123

PREDICTION OF FREE SURFACE ROUGHENING BY 2D AND 3D FE MODEL CONSIDERING MATERIAL INHOMOGENEITY

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FE model considering mesoscopic material inhomogeneity due to different flow stresses for each crystal grain to predict free surface roughening was suggested. The effect of standard deviation of material inhomogeneity and grain size was investigated by 2D FE model. In addition, to verify the model considering material inhomogeneity, the free surface roughening behavior is predicted under other stress state such as bi-axial stretch stress state using 3D FE model. Furthermore, by comparison with experimental results, the validity of the FE model considering material inhomogeneity and its determination method is discussed. The standard deviation of material inhomogeneout parameter in the model has a strong correlation with the gradient of increasing in the surface roughness. The gradient of increasing in free surface roughening increases with increasing grain size, which is same as conventional empirical equation. The surface roughness of bi-axial tension state is larger than that of uni-axial tension state. In addition, the experimental results are in good agreement with the simulation results. From these conclusions, we can verify the fundamental behavior and the validity of this model considering material inhomogeneity for prediction of free surface roughening.

ICMP2011-51128

CRACK GROWTH BEHAVIOR OF SEALING RUBBER UNDER STATIC STRAIN IN HIGH-PRESSURE HYDROGEN GAS

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Fuel-cell systems that use energy derived from hydrogen have received a considerable amount of attention recently as a solution to the issue of the exhaustion of fossil fuels and the problems associated with global warming. To achieve widespread acceptance by society of hydrogen-based energy, it is necessary to clarify the influence of hydrogen on the mechanical, physical and chemical properties of the materials used for hydrogen energy systems. In the case of rubbers, there is a particular danger of mechanical damage resulting from internal fracture, which occurs when high-pressure hydrogen gas is suddenly decompressed. We have been studying the mechanism of internal fracture and the influence of fillers on internal fracture using cylindrical rubber specimens with a diameter of 29.0 mm and a thickness of 12.5 mm. Ethylene-propylene-diene-methylene linkage (EPDM) rubbers and acrylonitrile-butadiene rubbers (NBR) were employed for the evaluation, as these rubbers are conventional sealing materials. While?our previous studies focused on fractures and deformation caused by high-pressure hydrogen decompression, the cause of fractures and deformation of rubber materials under pressurize has not been studied. On a related point, as sealing rubber O-rings are used under compression conditions, tensile stress is generated near the center core of the O-rings. Cracks sometimes grow under static (constant) strain in rubber materials; therefore, crack growth behavior under static strain (static crack growth behavior) influences the durability of O-rings. However, it has not yet been clarified whether a hydrogen environment influences the crack growth behavior of sealing rubber O-rings. From this viewpoint, static crack growth tests of an unfilled sulfur-crosslinked EPDM rubber were conducted using hydrogen gas at 10 MPa at room temperature (around 25 degrees Celsius). A high-pressure hydrogen vessel with glass viewing ports was developed, and measurements of crack length and deformation were made. Hydrogen permeation tests of the rubber were also conducted using a hydrogen permeation tester. Deformation of the rubber by hydrogen exposure was hardly seen at 10 MPa, although hydrostatic pressure was applied and hydrogen gas penetrated into the rubber. The static crack growth rate for hydrogen gas at 10 MPa was consistent with that in air (0.1 MPa). The fracture surface of the rubber in hydrogen gas at

10 MPa was the same as that in air. From these results, it was clarified that a hydrogen environment at 10 MPa did not influence the static crack growth characteristic of the rubber.

ICMP2011-51129

NON-DESTRUCTIVE TESTING FOR CFRP BY USING PULSE-PHASE THERMOGRAPHY

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In order to increase the detectable defect depth by thermographic testing, pulse-phase thermographic technique (PPT) was examined. It was expected from the results of one-dimensional calculations and experiments for CFRP plate having artificial defects that PPT can detect deeper defects by obtaining phase data in lower frequency range. In addition, the relationship between defect size and obtained phase data by PPT was studied by using numerical simulations.

ICMP2011-51130

MAGNETIC PROPERTIES OF INJETION MOLDED PERMALLOYS (FE-50%NI)

Hideshi Miura

Soft magnetic materials are used for electromagnetic applications such as motors, transformers, sensors and so on because of high magnetic induction with small magnetic field. Recently, these parts are required to have small size, high output and high efficiency. In order to realize these properties, soft magnetic materials need to have the iron loss minimized in the high frequencies. A permalloy (Fe-50%Ni) is one of attractive materials in the ferromagnetic industrial. For MIM process of permalloy, mixed elemental powder or prealloyed powder is used as the raw materials. In the case of mixed elemental powder, obtaining high relative density is difficult because sintering is progressed in the area of austenite which the diffusion rate is few low. Relatively, high relative density could be expected with prealloyed powder because sintering is progressed in the area of ferrite, however; there is some possibility of heterogeneous microstructure derived from not enough diffusion of Ni. Therefore in the last section, the effect of mixed elemental and prealloyed powder on magnetic properties of MIM parts will be discussed.

ICMP2011-51131

AE MONITORING OF DAMAGE ACCUMULATION IN TRANSPARENT CONDUCTIVE OXIDE FILM UNDER THE MECHANICAL STRAIN

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Recently, development of solar cells has been required for expanding the utilization of sustainable energy. Especially, dye-sensitized solar cells (DSCs) was focused because of its low cost in production. However, the lifetime of DSCs has been limited due to the damage accumulation in service. Therefore, it is necessary to understand the damage mechanism and the influence of damages on the degradation in electric performance. In this paper, tensile test of transparent conductive oxide (TCO) deposited on polyerhylene naphthalate (PEN) film (TCO + PEN film, Peccel Technologies, PFCF) was carried out. And PEN film (TCO was removed by 17.5% acidum hydrechloricum) was prepared to discriminate AE signals from PEN and TCO. The result of tensile test showed that many AE signals were detected in TCO + PEN film, while few AE signals in PEN film. On the other hand, electric resistance of TCO also measured during tensile test. AE event rate began to increase at the strain of 0.63%, and electric resistance increased rapidly at the strain of 0.68%.These results suggested that critical damage in TCO was detected by measurement of AE signals sensitively than electric resistance. To identify AE sources, in-situ observation of specimen during tensile test with AE measurement was carried out. During tensile test, cracks transverse to the loading direction in the TCO were found at the strain of ~0.67%, and then saturated at the strain of 9.63%. Cracks parallel to the loading direction in TCO were found at the strain of 9.63%. On the other hand, AE event rate began to increase at the strain of ~0.7% and reached a peak at the strain of ~3%, then decreased, and increased again at the strain of ~10%. It was emphasized that AE signals correspond to the cracks in TCO. Damage in TCO under mechanical strain was successfully monitored by AE technique. Consequently, it was suggested that AE technique will be a powerful technique for degradation of generating efficiency of DSCs.

ICMP2011-51132

SHEAR STRENGTH OF BRAZED JOINT BETWEEN TITANIUM AND C/C COMPOSITES WITH VARIOUS CROSS-PLY ANGLES

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There are difficulties to obtain the sound joint by brazing of the carbon-fiber-reinforced carbon composites (C/C Composites)and refractory metals. Those difficulties are caused by the C/C composites' strong anisotropy in mechanical properties, especially in the thermal expansion coefficient. In this research, the proper orientation of C/C composites to the brazing interface is investigated. A cross-ply laminate C/C composites plate was cut with various angles to the fiber direction. Their end faces were perpendicular to the laminate direction. The end face was brazed to pure titanium disk in the vacuum. The active brazing filler of Ag-32.25Cu-1.75Ti (Cusil-ABA®, Wesgo Metals) was used. The brazing temperature was at 830ºC, and the keeping time was 300s. For the brazed joint, the shear strength and the shear were measured. All obtained joints were fractured at the bulk C/C composites. On the case of [0º/90º] cross-ply laminated C/C composites, the shear strength reached to the maximum value up to 24 MPa. The cross sections of the brazed joints were observed by optically and through SEM. The brazing filler was infiltrated along the fiber. The infiltrated brazing filler was not acted as anchors but the crack initiation points.

ICMP2011-51133

EFFECTS OF ELECTRON BEAM IRRADIATION (EBI) ON ADHESIVE STRENGTH BETWEEN DIFFERENT POLYMERS FOR BIOMEDICAL APPLICATION.

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Adhesions between different polymers were successfully dzzeveloped. Composite polymers have been prepared by adhesion by both heating and glue. However, these methods often degrade the adhesive force and chemical properties, thereby affecting human health for biomedical applications. Development of rapid adhesion without heating and glue would solve this problem. Electron beam irradiation (EBI) improves the mist resistance and wetting of inorganic materials. This improvement is mainly caused by the irradiation with the formation of dangling bonds. Dangling bonds have also been formed in polymers.?Dangling bonds enhance surface energy, which is probably a tool for joining the different polymers. Thus, rapid and safe adhesion between different polymers may be possible by using EBI. Therefore, the effects of EBI on the adhesive strength of different polymers composites films of PDMS and PP without glue but with sterilization were investigated. Composite samples were prepared for the tensile test to evaluate the influence of EBI on the adhesive strength. EBI enhanced the adhesive strength between most of different polymers. Additional EBI reduces the adhesive strength, as usual radiation damages by large amount of irradiation dose with high electric potential of electron beam. In order to investigate the influence of EBI on adhesive strength, electron spin resonance (ESR) signals related to dangling bonds were observed. When EBI generated dangling bonds in different polymers, the dangling bonds probably served as reactive and bonding sites for each polymer at the interface. Results indicated that the optimum dose of EBI enhanced the adhesive strength of the composites, therefore, it was concluded that EBI was probably a useful tool for quickly joining the different polymers films for the biomedical application.

ICMP2011-51134

STRENGTHENING OF TRANSPARENT SILICATE GLASSES TREATED BY DISSOLUTION IN WATER

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In recent years, the transparent silicate glasses have been utilized for the electronics articles, computer and information technology. However, the low fracture toughness of the glass has been a serious problem in production process, when the broad thin glass sheet is used as the substrate glass for large-area liquid-crystal displays (LCD). Thus, strengthening of transparent thin sheet glass is an important technique in manufacturing large-area liquid-crystal displays. If the crack-origins are annihilated, the improvement of the brittleness for the transparent silicate glasses can be expected. Both soda and borosilicate glasses contain the alkali metal element, which dissolution phenomenon is a serious problem for wide LCD display with long life. In addition, the dissolution phenomenon of the alkali metal element is reported for the soda and borosilicate glasses. Also, soda and borosilicate glasses exhibit chemical weak bonding energies to oxygen of Na-O (252 kJmol-1). When the stress concentration at the crack tip is relaxed by dissolution phenomenon of the alkali metal element, the brittleness improvement can be expected. Effects of dissolution treatment on the impact value of the

transparent silicate glasses have been investigated. Both borosilicate glass (Kobayashi Tokushu Glass Co., Ltd., Tokyo, Japan) and soda glass samples (Matsunami Glass Ind., Co., Ltd., Osaka, Japan) were selected to be transparent silicate glasses in this study. The sizes of soda and borosilicate glassy samples were 24 mm x 24 mm x 0.15 (+-0.0050) mm and 20 mm x 10 mm x 1.0 mm, respectively. Dissolution treatment was processed under 0.18 MPa at 390 K in the distilled water at each dissolution time. To evaluate the impact fracture toughness, the Charpy impact values of the glasses with and without dissolution treatment were measured using a standard impact fracture energy measurement system (JIS K 7077-1991). To obtain more precise information on chemical composition in the glass, the composition of the elements was obtained using an electron probe microanalyzer (EPMA, EPMA-1610, SHIMADZU CORP., Kyoto, JAPAN) As a result, the dissolution linearly reduces the mass of the glass.The dissolution treatment for short time raises the impact value, whereas the dissolution treatment for long time reduces the impact value.

ICMP2011-51135

EVALUATION OF WELDING PROPERTIES OF METALLIC FOIL WITH AN ELECTRON BEAM

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For the fabrication of MEMS or microscale devices, joining of small parts is a critical issue. In this study, thin metal foils were welded using electron beam welding to investigate the weldability of the foils. In the welding of thin foils, the heat-affected zone and welding state are strongly dependent on the energy density of the irradiation beam, and size effects, such as heat capacity and stiffness, are important as the thickness of the material becomes small. Two materials, stainless steel and titanium with thickness values of 10 ?m and 20 ?m, were used as workpieces. An electron beam with several incident energies was applied, and the surfaces and cross-sections of the weld zones of the workpieces were examined. The experimental results show that the weldability of foil welding strongly depends on the material properties and the thickness of the workpieces. It becomes more difficult to weld two overlapping foils with smaller thickness and lower thermal conductivity.

ICMP2011-51136

PHOTO-POLYMERIZATION OF FULLERENE THIN FILM USING OPTICAL VORTEX IRRADIATION

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A state of the art photo-polymerization method of a fullerene thin film has been studied using an optical vortex irradiation [1]. Since the beam has a herical wavefront and a rotation of angular momentum, some different effects from a conventional light source can be expected; e.g. a confinement force due to the photo pressure toward the center of the beam. Therefore, a highly-packed and uniform photo-polymerization or one-dimensional polymerization having concentric-ring structure might be realized in a fullerene thin film. Fullerene molecules are expected for future ubiquitous device applications such flexible field effect transistors, solar cells, and so on. However, realizations of such devices suffer from the difficulty of the use in air since the performance is easily degraded by absorption of oxygen and water molecules. One of the promising solutions for the problems is a polymerization of fullerene molecules, where chemical bonds between the molecules could protect an intercalation of oxygen atoms. Some kinds of beam irradiations, such as visible laser light, ultra-violet light, low energy electron beam, have been performed so far for the polymerization. However, a shrink of inter-molecule distance due to the chemical bond formation brings an introduction of many cracks into the thin film [2]. And then, the film is divided into a lot of domains of a size of several ?m^2. Consequently, a mobility of the film decreases a few orders of magnitude after the irradiation, although a good transport characteristic can be expected for within each domain. In our trial of irradiation of a focused optical vortex beam on a fullerene thin film, a clear concentric ring structure was successfully observed after a few second irradiations. Since the pattern does not have servility in toluene, the structure must be composed of polymerized C60. Also a disk shape of the polymerized region was formed after a few minutes irradiation, where much uniform polymerization can be expected since no crack have been observed by SEM observation so far. The characteristics will be discussed with the Raman analysis and the electrical properties. 1) T. Omatsu et al., Optics Express, vol.18, p.17967 (2010). 2) Y. Chiba et al., J. Phys: Conf. Ser. vol.159, p.012017 (2009).

ICMP2011-51137

CFRP/LIGHT METALS JOINING REINFORCED BY CARBON FIBERS

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A joining method using impregnated Ni-coated carbon fiber has been successfully developed in joining CFRP and light materials of Ti and Al to prevent the impact force of bird strike. Strengthening the joint by Ni-coated carbon fiber reinforced interface (CFRI) were investigated.. Both pre-stressed and stress free Ti/CFRI/CFRP exhibited the high strength (11.4 +/- 0.1 MPa), which were larger than that (1.86MPa) of adhesive sample (Ti/Glue/CFRP). On the other hand, both pre-stressed and stress free Al/CFRI/CFRP exhibited the high strength (12.5 MPa), which were larger than that (2.91 MPa) of adhesive sample (Al/Glue/CFRP). Both pre-stressing of Ti/CFRI/CFRP and Al/CFRI/CFRP reduced the discontinuous stress relaxation of stress-strain curves. In addition, the pre-stressed Al/CFRI/CFRP exhibits the charpy impact value (13.61kJm-2) at mid fracture probability (Pf) of 0.5 is about 10% higher than that of non-pre-stressed Al/CFRI/CFRP, which was 10 times higher than that (1.03 kJm-2) of adhesive sample (Al/Glue/CFRP).

ICMP2011-51138

EFFECT OF HYDROGEN ON FRETTING FATIGUE STRENGTH OF SUS304 AND SUS316L AUSTENITIC STAINLESS STEELS

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Fretting fatigue test of SUS304 and SUS316L austenitic stainless steels were performed for the evaluation of the effect of hydrogen as well as the understanding of mechanism. One of the causes of the reduction of fretting fatigue strength of hydrogen charged specimen made of SUS304 was the reduction of threshold stress intensity factor of crack propagation due to absorbed hydrogen. Adhesion between contacting surfaces involving formation of small cracks has an important role to reduce fretting fatigue strength in hydrogen gas. The adhesion occurred in both materials, but the amount of reduction was greater in SUS304 than SUS316L. Thus, in SUS304 the adhesion was not the sole cause of the reduction. In addition, the effect of pre-strain on the reduction of fretting fatigue strength due to hydrogen was examined. In SUS304, the reduction of fretting fatigue strength was much greater in the pre-strained material than in the solution heat-treated material.

ICMP2011-51139

HIGH RESPONSIVENESS OF RECOVERY MOTION OF HYDROGEN STORAGE FILM DRIVEN BY DIRECT RESISTANCE HEATING FOR MICRO ACTUATOR

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Haru-Hisa Uchida — Tokai University

Yoshitake Nishi — Tokai University

The various types of articles have been used to be miniaturized in Japan, because the fine machining process has been developed. However, it is difficult to make the complex structure of micro robotic arm using the motor in the mover devices of actuators. Since a bimetal is one of concepts to generate the motion, it is possible to make micro robotic arm using bimetal structure. The bimetal structure is easy to control the motion of the arms. On the other hand, since hydrogen storage alloy, such as LaNi5 indicate as much as 24% of volume change in the course of H2 absorption and desorption, the mover device of La-Ni film deposited on polyimide sheet has been developed. Its motion strain is controlled by both changes in H2 pressure and temperature. On the other hand, the amount of hydrogen in LaNi5 can be controlled by changes in H2 pressure and temperature. If mover composite device can be controlled by electric current power, robot arm structure could be simplified. Since the motion of La-Ni film deposited on polyimide sheet (125 ?m thick) by electric current has been recently investigated, it is possible that the direct resistance heating in La-Ni hydrogen storage alloy film effectively elevates the temperature with high responsiveness. In this study, the influence of the direct resistance heating on the recovery speed of a bimetal of Pd vapor deposited La-Ni hydrogen storage alloy film on enamel coated copper foil has been investigated. In order to get the basic knowledge related to high responsiveness of recovery motion, the direct heating system of electric power as well as a bimetal of Pd coated La-Ni hydrogen storage alloy film on enamel coated copper thin foil has been developed to accelerate the degassing rate. Consequently, it was confirmed that the direct resistance heating was an effective method for improvement of the recovery speed.

ICMP2011-51142

RESEARCH OF DUCTILITY INCREASE OF MAGNESIUM ALLOY ON FORMING BY TEMPERATURE CONTROL

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Magnesium alloys are known for its light weight. Magnesium alloys are being expected as an alternative for the next generation materials in fields of variety. However, magnesium alloys has few slip lines with close-packed hexagonal lattice, and generally poor ductility at room temperature. The major problem for forging of magnesium alloy is the lack of process ductility at the low temperature. The Mg96Zn2Y2 is a high strength magnesium alloy material developed by Mr. Kawamura in Japan. Mg96Zn2Y2, a newly developed high strength magnesium alloy material is expected as forged parts of the automobile and materials for aerospace applications. It is necessary to clarify forging process characteristics of this material. The purpose of the present study examined increasing of ductility of forging process for the Mg96Zn2Y2 material. For this purpose, cylinder upsetting tests of were performed by this method of two stages by temperature control. In addition, the deformation resistance and ductility of the material were examined. The two stages forging process is effective for an increase of ductility of the material.

ICMP2011-51144

EFFECTS OF TEMPERATURES, OPERATING POTENTIALS AND HCL ON RECOVERING WC FROM CEMENTED TUNGSTEN CARBIDE SCRAPS

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Abstract: This paper reports the result of a study on recycling of WC powder from cemented carbides by electrolysis with hydrothermal (EHT) process, The dissolution rate of cemented carbide was found to depend on operating potential, temperature and hydrochloric acid (HCl) concentration. The operating potential of 0.4 volt yielded maximum dissolution rate. At 7N HCl concentration and temperature 80°C, it was found that the particles were almost 100% of tungsten carbide powder with a small amount of cobalt (Co). The cobalt can be reduced by ball milling, leaching, and drying of WC particles. Recovered WC is of sufficient purity and can be used as raw material for the manufacture of high quality hard metal products. Keyword: EHT process, Recycling, Cemented Carbide

ICMP2011-51147

MICROSCOPIC DETERMINATION OF STRESS-STRAIN RELATIONSHIP BY CONTINUOUS MULTIPLE NANO-INDENTATION TECHNIQUE

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In the fields of science and engineering, there are growing demands for measuring materials properties of small-sized materials and thin films used for Micro-Electro-Mechanical-Systems (MEMS) as well as many other industrial products. In particular, mechanical properties which are directly related to the elastic and plastic behaviors of materials are strongly required to be measured because accurate values of such properties are indispensable to ensure higher reliability in making better machine design and CAE applications. In this work, a nanoindentation technique with spherical indenter is applied to the evaluation of stress-strain relationships of industrial materials such as alloy steels. Since conventional single cycle load/unload method can't be used to determine stress-strain curve, and multiple indentations method takes up too much time and effort, a continuous multiple loading method is employed. A series of 21 loading/unloading sequences with increasing terminal load from 0.1 mN to 100 mN are performed with a spherical indenter, and load-displacement curves from each sequence are then continuously obtained and converted to a stress-strain curve. Some factors such as work hardening characteristics related to pile-up/sink-in behavior, contact radius of indenter tip, and residual stress on the material surface have been examined for making proper and accurate determination of the stress-strain relationship. Based on the examinations, stress-strain curves have been estimated for alloy steels of different mechanical properties. The stress-strain curves determined by nanoindentation are compared with those measured by tensile or compression tests to verify the similarity and dissimilarity between them. In addition, some issues affecting the results are also discussed.

ICMP2011-51148

NON-CONTACT TECHNIQUES FOR PROFILING SURFACE TEMPERATURE DISTRIBUTIONS BY LASER-ULTRASOUND

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In the various fields of materials science and engineering, it is often required to measure surface temperatures of heated materials. This is basically because surface temperatures of heated materials may give us any information on internal temperature which is relating to the mechanical properties and behavior of the materials. Although conventional techniques such as infrared radiations are already used for measuring surface temperature, they are not always acceptable for some applications because of the limitation in their ability. Therefore, an alternative technique is strongly required to be developed. In this work, a simple ultrasound method for measuring surface temperature distributions of a material being heated is presented. A laser ultrasound scanning technique has been employed for non-contact measurements of surface temperature distributions. The principle of the methods is based on the temperature dependence of a surface acoustic wave (SAW). SAWs are generated at different positions on a material surface consecutively by pulsed laser irradiation scanning (Nd:YAG, wavelength=1064 nm, energy 200 mJ/pulse, pulse width 3 ns) using a one-dimensional galvanometer scanner, and each SAW is detected at a certain position using a laser interferometer based on photorefractive two-wave mixing (Nd:YAG, wavelength=532 nm, energy 200 mW). The ultrasonic method has been applied to the surface temperature measurement of an aluminum plate whose single side is being heated. The surface temperature distributions determined by the ultrasonic method almost agree with those measured using an infrared camera.

ICMP2011-51149

MATERIAL MODELING OF 980 MPA HIGH STRENGTH STEEL SHEET BASED ON BIAXIAL STRESS TESTS

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Uniaxial and biaxial stress experiments of high strength steel sheet with a tensile strength of 980MPa have been carried out. Detailed measurements were made of the contours of plastic work and the directions of plastic strain rate at different levels of work-hardening for linear loading paths in the first, second and fourth quadrant and shear stress component of the principal stress space. The geometry of the entire family of the work contours and the directions of plastic strain rates have been compared with those calculated using selected anisotropic yield functions: Hill's quadratic [Hill, R., 1948. A Theory of the Yielding and Plastic Flow of Anisotropic Metals. Proc. Royal Soc. London A193, 281-297] and Yld2000-2d [Barlat et al., Plane stress yield function for aluminum alloy sheets - Part 1: Theory. Int. J. Plasticity 19 (2003), 1297-1319] yield functions. In-plane compression tests have also been carried out using comb-shaped dies proposed by one of the authors [Kuwabara, T., Kumano, Y., Ziegelheim, J., Kurosaki, I, Tension-Compression Asymmetry of Phosphor Bronze for Electronic Parts and its Effect on Bending Behavior, Int. J. Plasticity, 25 (2009), 1759-1776]. The measured work contours and the directions of plastic strain rates have been in good agreement with those predicted by the Yld2000-2d yield function with an exponent of 4. Consequently, we conclude that the plastic deformation behavior of the 980 MPa steel sheet under biaxial stress states can be well reproduced by the Yld2000-2d with an exponents of 4 with less than 2.5 % error.

ICMP2011-51150

INFLUENCE OF TEMPERATURE FLUCTUATION ON CREEP CRACK GROWTH RATES OF ADHESIVELY BONDED JOINTS

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Influences of temperature histories on the creep strength of adhesively bonded joints were experimentally investigated. Stress relaxation tests of double cantilever beam (DCB) specimens bonded with epoxy adhesive were carried out keeping the displacement of load applying points and measuring the fluctuation of loads at several temperatures in terms of fracture mechanics. The measured loads decreased with the temperature increased. Energy release rates of the joints were calculated from the crack lengths obtained by the beam theory. The values of energy release rates signify critical energies for fracture, i.e. fracture toughness. The relations between crack growth rates and the obtained fracture toughness were examined, and could be approximated with a power equation at each temperature under the condition of stable crack growth. The same tests were also conducted increasing the temperature in incremental steps, and the crack growth was predicted with the power equation. The prediction shows fairly good agreements with the experimental result.

ICMP2011-51151

INFLUENCES OF LOADING RATES ON STRESS-STRAIN RELATIONS OF CURED BULKS OF BRITTLE AND DUCTILE ADHESIVES

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Influences of loading rates on stress-strain relations of adhesive cured bulk were experimentally investigated. A brittle epoxy adhesive and a ductile epoxy adhesive modified wit h rubber particles were examined. Concave specimens of cured bulks of the adhesives were made, and strain gages for very large strain were adhered to the specimens. The specimens were tested in static conditions with a mechanical testing machine and in dynamic condition with a drop-weight impact testing machine. The influences of loading rates on the stress-strain relations of the adhesives were identified. For the brittle adhesive, the modulus was constant in both the static and dynamic condition, and the maximum stress and strains increased with increase of loading rates. For the ductile adhesive, large plastic deformation occurred in the static condition, and the maximum stress was small and the maximum strain was very large. In contrast, in the condition of high loading rate, the ductile adhesive became brittle, and the maximum stress increased and the maximum strain decreased.

ICMP2011-51153

MECHANICAL PROPERTIES OF CNF REINFORCED CERAMIC COMPOSITES SINTERED WITH SPS TECHNIQUE

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Ceramic materials have attractive properties, such as high strength, high hardness, high wear and corrosion resistance. However, ceramics is a typical brittle material so that it has low reliability for structural materials. A lot of efforts to enhance the toughness using fiber, whisker and nanofiber have been reported. Carbon nanofibers (CNFs) are also candidates to be used as a reinforcement to toughen ceramic matrix, because of their high strength and high aspect ratio. Using CNFs for ceramic composites, toughening mechanisms involving pull-out, crack deflection and bridging can be expected to improve the fracture toughness. In previous studies, however, the composites with high CNF content often show very poor mechanical performance, which might be resulted from the poor sinterability caused by the agglomeration of CNFs. On the other hand, spark plasma sintering (SPS) is a well known technique which enables sufficient densification, especially in the case of electrically conductive ceramic powders. Since ceramic powders containing a large amount of CNFs have high electric conductivity, they would be suitable for the sintering by SPS technique. The purposes of this study are the fabrication of ceramic composites with uniformly dispersed CNFs and the characterization of their mechanical properties. In order to obtain the uniform dispersion of CNFs, the fabrication procedures are schemed as follows: First, CNFs are dispersed in a water based solution containing surfactant using ultrasonic agitation. Second, a large amount of CNFs coated with ceramic powders are prepared with adjusting the zeta potential to be minus for CNFs and plus for ceramic powders in a water based solution. Finally, ceramic composites were sintered with SPS technique. By using the CNFs coated with ceramic powders, the uniform dispersion of CNFs in ceramic matrix were accomplished. The structural analysis using X-ray diffraction and the measurements of mechanical properties, such as bending strength, elastic modulus and fracture toughness, of the composites were carried out. A large number of pull-out and bridging of CNFs are observed on the fracture surface. Therefore, the improvement of fracture toughness of composites could be related to the pull-out and bridging of CNFs. Consequently, ceramic composites with high CNF content were successfully fabricated by SPS technique and the fundamental knowledge for the development of ceramics with high toughness is obtained in the present paper.

ICMP2011-51154

FAILURE BEHAVIOR OF SENSITIZED SUS304 STAINLESS STEEL WITH SMALL SURFACE PRE-CRACKS IN 288 DEGREE CELSIUS PURE WATER

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Small surface intergranular cracks similar to those detected in the heat affected or sensitized zone of the welded nuclear power components were introduced in the sensitized SUS304 stainless steel by using a fretting fatigue technique in 288 degree Celsius pure water. Multiple parallel surface cracks were nucleated in the localized fretting slip region. Constant load tests at various initial stress intensity factors (Ki) were then carried out to investigate failure behavior of sensitized SUS304 stainless steel with small surface cracks under

constant load in 288 degree Celsius pure water. From the results, it was speculated that the KISCC for small surface crack was lower than 5.06MPa.m1/2 , which was significantly lower than that for long crack (10-20 MPa.m1/2).

ICMP2011-51155

EFFECT OF LAYER THICKNESS ON THE IMPACT DAMAGES OF HOOP-WRAPPED COMPOSITE VESSELS

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The purpose of this study is to evaluate effects of stacking thickness on the microscopic damage behaviors in filament wound carbon fiber reinforced plastics (FW-CFRP) composite vessels subjected to out-of-plane loading. After impact and quasi-static tests, surface and inside microscopic damages were observed with an optical microscope. Residual burst strength was also measured for damaged specimen.
Initial stiffness of the specimen under out-of-plane loading increased with increasing CFRP thickness. The successive loading caused fiber breakages and delamination in the all specimens. The absorbed energy and residual deflection of liner became smaller with increasing laminate thickness. The damages of the composite vessels were localized with thicker CFRP layer.

ICMP2011-51157

EFFECT OF FORMING CONDITIONS ON CRYSTALLIZATION IN LASER FORMING OF PALLADIUM BASED THIN FILM METALLIC GLASS

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Pd77Cu6Si17 thin film metallic glasses which thicknesses were 10, 20 and 28 um were bent by laser forming. The working conditions were changed and crystallization of thin films was investigated. When the laser power was changed under fixing the scanning velocity to 40 mm/s and the Q-switch frequency to 3 kHz, crystallization was observed at laser irradiated surface and/or the reverse side to the laser irradiation. In a case of changing the scanning velocity under fixing the Q-switch frequency to 3 kHz and the laser power to 2.0 W for 20 um thickness, 3.0 W for 28 um thickness, the working conditions without crystallization were found at high scanning velocity. When the Q-switch frequency was changed under fixing the scanning velocity to 40 mm/s and the laser power to 2.0 W for 20 um and 3.0 W for 28 um, the working conditions without crystallization were found at low Q-switch frequency.

ICMP2011-51158

EFFECT OF WELDING SPEED ON TENSILE PROPERTIES AND FRACTURE BEHAVIOR OF FRICTION STIR WELDED AA6061-T6 JOINTS

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The effect of welding speed on the tensile properties and fracture behavior of friction stir welded AA6061-T6 joints was examined. AA6061-T6 sheets of 4.95 mm in thickness were friction stir welded in the butt joint configuration. The friction stir welding (or FSW) parameters were varied by altering a welding (or traverse) speed of a cylindrical tool, keeping its rotational speed constant. Dumbbell-shaped specimens machined from the base material and the FS welded joints were used in the transverse tension tests. The Ramberg-Osgood equation was used to describe the experimental true tensile stress-strain curves. It is demonstrated that the FS welds exhibit reduced strength and ductility compared with the base material. This reduction is discussed from a microstructure point of view.

ICMP2011-51159

BACKWARD EXTRUSION METHOD WITH PULSATING LUBRICANT SUPPLY ON SERVO PRESS

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To prevent galling of products with deep holes in backward extrusion by reducing friction, an extrusion method utilizing a punch having an internal channel for supplying liquid lubricant to the punch nose is proposed using a servo press. On the servo press, the punch is pushed into the billet in a manner combining pulsed and stepwise modes. The liquid lubricant is sucked through the internal channel during the retreat motion of the punch and is pulsating supplied to the cavity formed at the bottom of the hole. Appropriate punch ram motions for preventing galling are determined from the surface observation of the formed hole. The maximum aspect ratio of the hole attained by the proposed method is discussed on the viewpoints of buckling and strength of the punch.

ICMP2011-51160

POWDER MAGNETIC CORE STRENGTHENED BY RESIN BINDER

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Improvement of the mechanical strength of powder magnetic cores is an important subject to increase applicable items. In this study, improvement of mechanical strength was attempted by using organic resins as binder. Some of resins show advantageous effect on increasing mechanical strength as well as electrical resistivity. Developed powder magnetic core exhibits high strength from room temperature to 473K.

ICMP2011-51163

EVALUATION OF PRE BENDING PROCESS OF BAMBOO BEAM IN KYO-CHOCHIN (JAPANESE LANTERN) MAKING PROCESS

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Japanese lantern that is made and used in Kyoto is called “Kyo-Chochin”, which is one of traditional crafts in Kyoto. Kyo-Chochin is made by craftsman one by one and made of bamboo framework and Japanese paper. In fabricating process, there is “Hone-tame” process that craftsman applies load to a bunch of bamboo circles. In this study, in order to investigate the influence of Hone-tame process to bamboo properties, mechanical test and form measurement of bamboo were performed. Specimens treated in Hone-tame process different amount of time were prepared. As a result, the Hone-tame process have effects which tensile strength of bamboo beam is evened up and bamboo hoop become true circle.

ICMP2011-51164

REVIEW OF IONIC POLYMER METAL COMPOSITES (IPMCS)

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To be announced

ICMP2011-51165

INFLUENCE OF INTERLAYER ON WEAR AND CORROSION RESISTANCE OF DLC FILM

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Diamond-like carbon (DLC) films have many excellent characteristics as low friction coefficient, wear resistance, gas barrier property and biocompatibility. These many positive characteristics enable DLC coatings to be applied to a lot of fields from metallic materials to polymer materials for overcoatings. However, usual DLC film has a lot of micro-pores or pinholes, and those defects become problems that DLC film is not able to make the best use of abrasion resistance effectively due to the substrate corrosion. In addition, the DLC films deposited directly on the steel substrates often encountered the problem of poor adhesion. It has been tried to overcome the negative effect by means of multilayer structure using metal and ceramic layers. In this study, we aim to deposit DLC films satisfied with both antiwear and anticorrosion characteristics. This time, we focused on Si modified DLC (Si-DLC) interlayer deposited by using Tetra Methyl Silane: TMS gas and Cr interlayer deposited with magnetron sputtering method. DLC films were deposited on austenite stainless steel substrates. DLC films with Si-C:H and/or Cr interlayer were deposited by a pulse plasma CVD method using C2H2 gas. Three kinds of coatings: ?substrate/Si-C:H/DLC, ?substrate/Cr/DLC and ?substrate/Cr/Si-C:H/DLC had been done. As a fundamental test, Raman spectroscopy, nano indentation, X-ray reflectometer and scratch tests were carried out to reveal both mechanical and anticorrosion characteristics. Then, ball-on-disk (BoD) tests and electrochemical measurements also had been running. These measurements lead us to conclusion that the effects of the DLC coating had been confirmed and an optimal structure to improve both tribological property and anticorrosion property was substrate/Si-C:H/DLC. Moreover, in the case of emphasizing tribological property, substrate/Cr/Si-C:H/DLC structure is recommended.

ICMP2011-51166

EFFECT OF PREPREG CUT ON THE MECHANICAL PROPERTIES IN CFRP LAMINATES

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In fabricating complicated laminated composite structure by using prepregs, there may be fiber discontinuity in the structure which may influence the mechanical response of the structure. The fiber discontinuity also may become a source of stress concentration and damage. Therefore, it is very important to understand the effect of fiber discontinuity on the mechanical properties of laminated structure in order to establish an efficient design methodology of laminated composite structure which uses prepregs. In the present study, the effect of fiber discontinuity size on the mechanical properties in CFRP laminate is investigated experimentally. The damage initiation and progress around the fiber discontinuity are also discussed.

ICMP2011-51167

A STUDY ON THE MECHANICAL PROPERTY OF INJECTION MOLDED NATURAL FIBER HYBRID SANDWICH COMPOSITES

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In this study, the jute and glass fiber were used as hybrid reinforcements in polypropylene to fabricate the hybrid composite. The effects of sandwich construction on the mechanical properties of the hybrid composites were investigated. The different skin and core materials were examined comparing with normal injection moldings for the hybrid composite. With normal injection molded specimen, the incorporation of glass fiber with jute fiber increase both tensile strength and bending strength as compared the one reinforced by jute fiber only. The jute fiber skin–glass fiber core construction exhibits better tensile strength than the glass fiber skin-jute fiber core construction but the all sandwich injection molded hybrid composite exhibits lower tensile strength than normal injection molded hybrid composite. The tensile modulus and bending modulus of sandwich hybrid construction did not show the significant change as compared with normal injection molded hybrid composite.

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Northwest NanoNet™

ONAMI's first-class materials characterization and fabrication laboratories offer industry access to high-cost capital equipment and technical expertise to help you make the smartest use of always-scarce resources. We understand time-critical needs and provide rapid results for industry. Clients include biotech, semiconductor, solar, wood products, defense and advanced materials companies and universities.

Materials Characterization equipment includes: TEM, SEM, DualBeam (FIB/SEM), AFM, XPS, ToFSIMS, MALD/ESI Mass spectrometer, NMR, XRD and e-beam lithography.

Prototyping and Fabrication facilities at the MBI support the design, fabrication, testing and pilot production of microchannel process technology (MPT), nanomaterials, nanofluids and nanostructured films.

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We can Help Your Nano Company Grow in the Silicon Forest

If you'd like to build your high-growth "small tech" company in Oregon, ONAMI's Commercialization Gap Fund can connect you with talent, facilities – see above – investors and funding (up to $250K) to cross the critical gaps: from science result to practical process, and from technology push to market pull.

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University of Oregon · Portland State University · Pacific Northwest National Laboratory · Oregon Health & Science University · Oregon State University

Call for Technical Session Proposals

2012 International Symposium on Flexible Automation (ISFA 2012)
June 18 - 20, 2012
St. Louis, MO

Proposals for technical sessions, including panel sessions, are being solicited for the 2012 International Symposium on Flexible Automation (ISFA 2012). The symposium will be hosted by Missouri University of Science and Technology, and it will be held June 18-20, 2012 in St. Louis, MO.

ISFA, which has been sponsored by American Society of Mechanical Engineers (ASME) and the Institute of Systems, Control and Information Engineers (ISCIE) in Japan, was initiated in 1986 and the title "Flexible Automation" was selected as a general term referring to automation technologies essential to meet the increasing requirements of modern manufacturing. While many of these requirements were identified over more than two decades ago, such as flexibility, intelligence, lead-time reduction, and lean manufacturing, they continue to pose major challenges. In addition, requirements such as agility, reconfigurability, networked CAD/CAM, virtual prototyping, freeform fabrication, ERP, PDM, SCM, cell production, e-manufacturing, intelligent automation, RFID, health monitoring, security, sensor and actuator technologies, MEMS, haptics, mechatronics, automotive systems, intelligent control for automobiles, virtual environments for development of vehicle control systems, precision systems, systems integration and the protection of the environment, have broadened the research agenda and thus the scope of this symposium.

Those interested in organizing technical sessions in their fields of interest are urged to submit session proposals for ISFA 2012 to the Program Chair: Prof. Yong Huang, Clemson University, +1-864-656-5643, yongh@clemson.edu or the Program Co-chair: Prof. Nobuhiro Sugimura, Osaka Prefectural University, +81-72-254-9207, sugimura@me.osakafu-u.ac.jp. The tentative deadline for receipt of technical session proposals is **Thursday, June 30, 2011** (see below for other important dates). For more information, please contact the above Program Chair and Co-chair, as well as the Organizing Committee Chair and Co-chair: Prof. Ming C. Leu, Missouri University of Science and Technology, mleu@mst.edu, and Prof. Toshiya Kaihara, Kobe University, kaihara@kobe-u.ac.jp. The complete paper submission and review process and the symposium website information will be provided in the near future.

Important Dates (tentative):

- Publication of Calls for Papers starts: Wednesday, June 1, 2011
- Submission of session proposals: Thursday, June 30, 2011
- Submission of full-length manuscript for review: Wednesday, November 16, 2011
- Acceptance notification to authors: Monday, March 5, 2012
- Camera-ready manuscript due: Monday, April 2, 2012
- Author registration deadline: Friday, April 20, 2012
- Symposium: Monday-Wednesday, June 18-20, 2012