MSEC 2008 ASME International Conference on Manufacturing Science and Engineering

3rd JSME/ASME International Conference on Materials and Processing ICM&P

October 7-10, 2008 • Evanston, IL, USA

Program and Abstracts

ASME SETTING THE STANDARD

NORTHWESTERN UNIVERSITY

JSME

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for their Financial Sponsorships

Welcome from the Hosts

On behalf of the MSEC/ICM&P Organizing Committee and Northwestern University, we would like to extend our warm welcome to you to the Chicago area for the 2008 ASME International Manufacturing Science and Engineering Conference (MSEC) and the 3rd JSME/ASME International Conference on Materials and Processing (ICM&P).

Northwestern University was established in Evanston in 1851 to benefit the residents of the former Northwest Territory. Since then, Northwestern has expanded to lakefront campuses in both Evanston and Chicago and consists of a total of nine schools: Weinberg College of Arts and Sciences, McCormick School of Engineering and Applied Science, Kellogg School of Management, School of Communication, Feinberg School of Medicine, Medill School of Journalism, School of Law, Bienen School of Music, School of Education and Social Policy. The McCormick School of Engineering will celebrate its 100th anniversary in 2009. Today, McCormick has 180 faculty, 1382 undergraduate students and 726 graduate students. The engineering school has a long standing tradition of diverse and innovative research programs, just one of which is manufacturing. The spirit of collaboration between departments as well as internationally is strong and is an important factor in the commitment to excellence. With this spirit and through the diligent efforts of the organizing committee, guidance from both MED and JSME executive committees, and many nights of hard work from our Program Chairs, we are here to welcome you to the co-located MSEC 2008 and ICM&P 2008 conferences.

Thanks are due to Ms. Mariela Huber and the Student Organizing Committee co-chaired by Ms. Tiffany Davis and Mr. Numpon Mahayotsanun for their critical assistance, creative thoughts and hard work that have made this event possible.

Our sincere appreciations also go to the sponsorship from Illinois Tool Works Inc., Los Alamos National Laboratory, Cummins Inc., Ford Motor Company, General Electric Company, General Motors Corporation, JTEKT Corporation, Meidoh Company, TechSolve, Toyota Motor Corporation, Chiyoda Montrow Die Manufacturing, Inc., and Sugino Corp., without which the conference could not succeed.

Finally, we would like to thank all of you for showing your support by attending the conference. We sincerely wish all of you a very enjoyable stay at Northwestern and hope you find inspiration and excitement in this stimulating manufacturing environment.

Jian Cao
Fellow, ASME
Professor
Northwestern University
Organizing Chair

Kuniaki Dohda
Professor
Nagoya Institute of Technology
Organizing Co-Chair

Kornel Ehmann
Fellow, ASME
James N. and Nancy J. Farley
Professor in Manufacturing and Entrepreneurship
Northwestern University
Organizing Co-Chair

Greetings from the ASME/MED Chair

On behalf of the ASME Manufacturing Engineering Division (MED) Executive Committee whose members include Dr. Bin Wei from General Electric, Prof. Lawrence Yao from Columbia University, Dr. Matt Berment from Los Alamos National Lab, Dr. Cedric Xia from Ford and myself from Northwestern University, I would like to extend our sincere welcome to you to the ASME International Manufacturing Science and Engineering Conference (MSEC) co-located with the 3rd JSME/ASME International Conference of Materials and Processing.

Manufacturing as the means to generate products is essential to the accumulation of wealth and to the enhancement of living standards. By working together, we can advance the science and technology of manufacturing at a much faster pace. This conference has a unique position in the history of MED as it is the first division conference that is co-located with another major international society. As a result of this joint effort, we have grown more than double the size of our past conferences, with attendees from 19 countries.

Manufacturing fosters innovations and has an undisputable link to energy, environment, stability and economy. The advance of manufacturing science and technology requires fundamental research in many basic domains, technology innovation and the intrinsic partnership between industry, academia and government labs. This division will continue to offer technical leadership and partnership opportunities to the manufacturing community. Currently, we have seven technical committees: Manufacturing Processes, Manufacturing Equipment, Manufacturing Systems, Quality & Reliability, Life Cycle Engineering, Nano/Micro/Meso Manufacturing and Biomanufacturing. We are looking forward to partnerships from our international counterparts or from other societies or ASME divisions.

We hope you will take advantage of this international conference setting to meet old friends, make new acquaintances, find talents for your firm, and establish new collaborations.

None of this technical-stimulating and social rich gathering would be possible without the hard work of our Program Chairs, Prof. John Roth of Penn State, Prof. Naoto Ohtake of Nagoya University and Prof. Brad Kinsey of the University of New Hampshire at Durham, the kind financial sponsorships of more than 12 corporations and a government lab, and the contribution of the local organizing committee. Last, but most importantly, I would like to thank all of you, who contribute to the success of this conference via paper/poster submissions, reviewers, panelists, symposium organizers, session chairs and registrants.

Enjoy the conference and I look forward to your continuous active involvement with the division. See you at MSEC 2009 at Purdue University if not before.

With my best wishes,

Jian Cao, Ph.D., FASME
Northwestern University
Chair – ASME Manufacturing Engineering Division, 2008-2009

Greetings from the JSME/ICM&P Chair

On behalf of the steering committee of MPD (Materials and Processing Division) of JSME (Japan Society of Mechanical Engineers), I am very pleased to introduce ICM&P2008 (International Conference on Materials and Processing 2008) held in Norris University Center at Northwestern University, Evanston, IL, USA, on October 7-10, 2008, in collaboration with MSEC2008 (Manufacturing Science and Engineering Conference 2008). MPD, founded in 1991, has contributed to the development of engineering materials and processing technology in Japan and organizes the Materials and Processing Conference annually. This conference has been recognized as the premier meeting on current topics in materials and processing technology in Japan. ICM&P2008 is also held as the sixteenth annual JSME Materials and Processing Conference.

ICM&P2008 is the third international conference sponsored by MPD along with the Manufacturing Engineering Division of ASME (The American Society of Mechanical Engineers). The first international conference (M&P2002) was organized by Professor Hiroyuki Kawada (Waseda University) and held in Honolulu from October 15-18, 2002. The second international conference (M&P2005) was held in Seattle from June 19-22, 2005, organized by Professor Nobuo Takeda (The University of Tokyo). Based on the great success of these two international conferences, Professor Kuniaki Dohda (Nagoya Institute of Technology) has organized the third international conference (ICM&P2008) aiming at the further technical interchanges between JSME and ASME and the development of the related fields. In most symposia of this conference, both JSME (ICM&P2008) papers and ASME (MSEC2008) papers will be presented in the same session. Fruitful and enjoyable discussions are greatly expected in each symposium.

I would like to thank the members of the organizing committee, the programming committee, the international coordinating committee, the scientific committee, the honorary committee and the local steering committee as well as the secretaries and JSME staff for their cooperation and contribution toward the success of the conference. I would also like to express many thanks to the chairs of each symposium and all the participants of the conference.

October, 2008

Koji Fujimoto
Materials and Processing Division, JSME

Foreword from the MSEC/ICM&P Program Chairs

This proceeding contains the papers and posters presented at the joint International Manufacturing Science and Engineering Conference (MSEC) and International Conference of Materials and Processing (ICM&P), co-located at Northwestern University in Evanston, IL, from October 7-10, 2008. This first joint conference is the flagship forum in the Manufacturing, Materials and Processing fields, in fact, as well as, in name. We are indeed proud to recognize the fact that 336 presentations will be made at this joint conference. The details of the presentations are: 4 plenary talks, 155 ASME technical presentations, 129 JSME technical presentations, 18 ASME poster presentations, 22 JSME poster presentations, and 8 ASME student activities.

MSEC and ICM&P each have their own activities and research fields. MSEC covers manufacturing in areas such as cutting, manufacturing systems, laser processing, bio engineering, etc. In contrast, ICM&P deals with engineering materials such as polymer and polymer matrix composites, metals, ceramics, powders, etc. Both conferences simultaneously have significant activities on metallic deformation, welding, surface and micro/nano engineering, etc. Thus, by co-locating these two conferences, some content overlaps and some content is unique to each. This conjunction should derive an active and creative environment for all the participants.

We are proud to circulate these excellent papers representing researchers residing in 22 countries around the world. A new addition of this joint conference is the ASME/JSME Poster Session and we anticipate fruitful discussions at each poster booth, as well as, within each session room.

Each paper submitted to the conference was put through a rigorous peer review planned by the respective track and symposium organizers. We would like to thank the track chairs and the symposium organizers for their management of the symposiums and presentations. Thanks are also due to the reviewers for the critical review of the large number of submitted papers and posters.

October 7th, 2008

John T. Roth, Program Co-Chair

Naoto Ohtake, Program Co-Chair

Brad L. Kinsey, Program Vice-Chair

Committees

MED Executive Committee

Jian Cao (Chair), Northwestern University, USA
Bin Wei (Vice-Chair), General Electric Global Research, USA
Lawrence Yao (Program Chair), Columbia University, USA
Matt Berment (Secretary), Los Alamos National Laboratory, USA
Cedric Xia (Member), Ford Motor Company, USA

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Naoto Ohtake (Co-Chair), Nagoya University, Japan
Brad Kinsey (Vice-Chair), University of New Hampshire, Durham, USA
Yong Huang, Clemson University, USA
Yuan-Shin Lee, North Carolina State University, USA
Xiaochun Li, University of Wisconsin, USA
Burak Ozdoganlar, Carnegie Mellon University, USA
Steven Skerlos, University of Michigan, Ann Arbor, USA
Wei Sun, Drexel University, USA

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Kuniaki Dohda (Co-Chair), Nagoya Institute of Technology, Japan
Kornel Ehmann (Co-Chair), Northwestern University, USA
Hideki Kyogoku, Kinki University, Japan
Mariela Huber, Northwestern University, USA
Ying Huang, Northwestern University, USA

Student Organizing Committee

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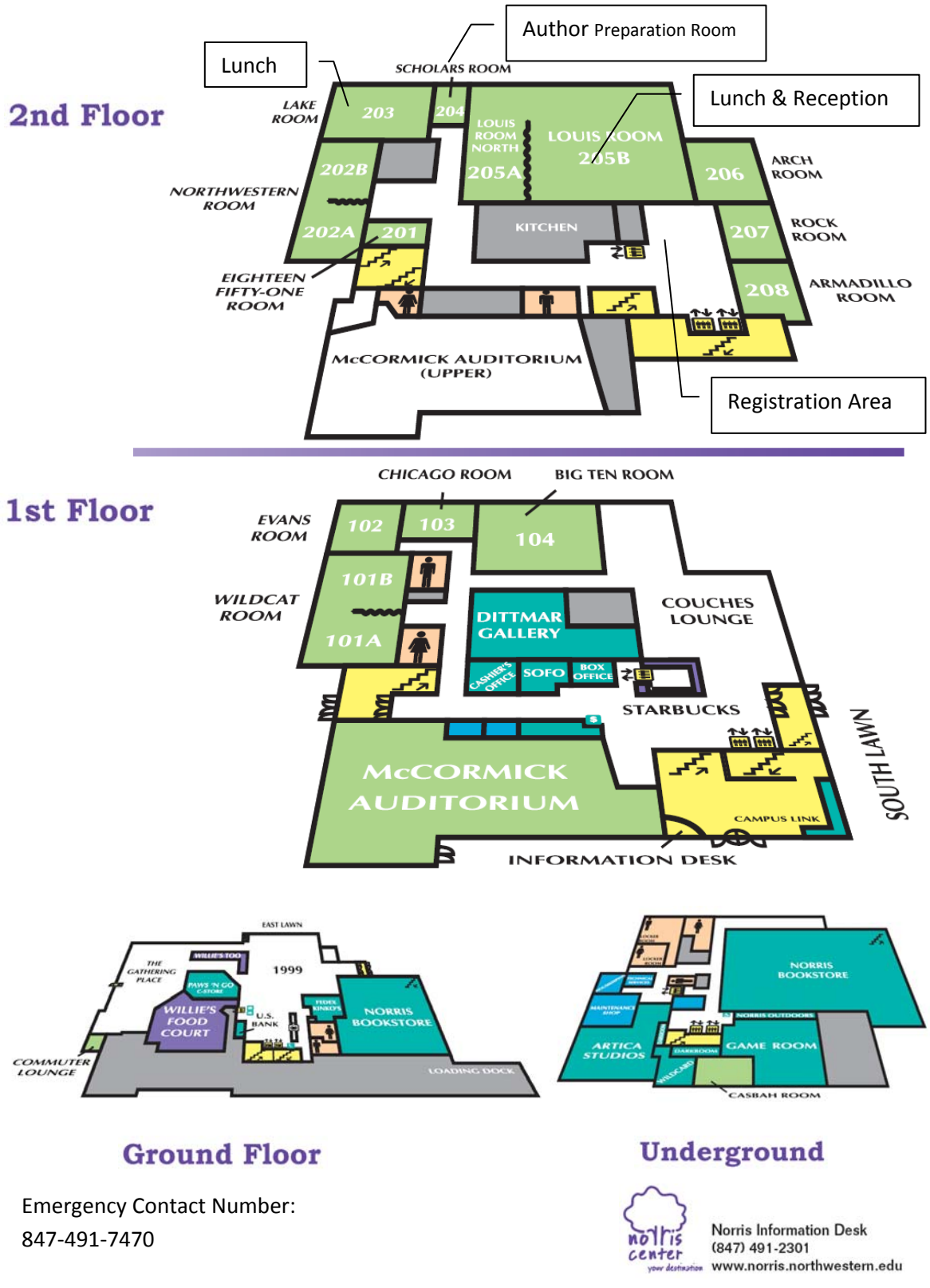
Kumar Pallav, Northwestern University, USA
Hyung Suk Yoon, Northwestern University, USA
Rui (Ray) Zhou, Northwestern University, USA
Yan-Jin Zhu, Northwestern University, USA

Conference Venue Map



Emergency Contact Number:
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Program-at-a-Glance

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Oct. 7,
2008</th><th>Wednesday
Oct. 8, 2008</th><th>Thursday
Oct. 9, 2008</th><th>Friday
Oct. 10, 2008</th><th>Saturday
Oct. 11, 2008</th></tr>
<tr><td>7:30am</td><td></td><td>Registration and Breakfast</td><td>Registration and Breakfast</td><td>Registration and Breakfast</td><td>Breakfast</td></tr>
<tr><td>8:30am</td><td></td><td>Welcome and opening remarks</td><td rowspan="2">7 Technical Sessions +Career Planning Panel for Students</td><td rowspan="2">7 Technical Sessions</td><td rowspan="6">NSF Short Course
Fundamentals and New Opportunities of Materials
Metal : Prof. Fine
Shape Memory Alloys: Prof. Brinson
Metallic Foam: Prof. Dunand
Ceramics: Prof. Faber

Students, Post-docs: $30
Others: $100</td></tr>
<tr><td>9:00am</td><td></td><td rowspan="2">Plenary Talks:

Dr. Maughan
Dr. Somiya</td></tr>
<tr><td>10:00am</td><td></td><td>Coffee Break</td><td>Coffee Break</td></tr>
<tr><td>10:30am</td><td></td><td>Coffee Break</td><td rowspan="2">8 Technical Sessions + ASME mfg group meeting</td><td rowspan="2">8 Concurrent Technical Sessions</td></tr>
<tr><td>10:50am</td><td></td><td>6 Technical Sessions + NAMRI Board Meeting</td></tr>
<tr><td>12:00pm</td><td></td><td>Lunch + ASME Fellow Recognition</td><td>Lunch + Invited Talk - Dr. Danno</td><td>Merchant Medal Recipient Award
Lunch</td><td></td></tr>
<tr><td>1:30pm</td><td></td><td>5 Technical Sessions +Posters+Student Mfg Design Competition + JMSE Associate Editors Meeting</td><td>6 Technical Sessions + One Panel</td><td>8 Technical Sessions</td><td></td></tr>
<tr><td>3:00pm</td><td></td><td>Coffee Break</td><td>Coffee Break</td><td>Coffee Break</td><td></td></tr>
<tr><td>3:30pm</td><td></td><td>5 Technical Sessions +Posters +Student Mfg Design Competition</td><td>8 Technical Sessions + MED EC Meeting</td><td>7 Technical Sessions</td><td></td></tr>
<tr><td>5:00pm</td><td rowspan="6">Registration and Reception</td><td rowspan="2">Transportation to Dinner Cruise</td><td></td><td></td><td></td></tr>
<tr><td>5:30pm</td><td rowspan="2">ASME Membership Meeting + JSME Membership Meeting</td><td></td><td></td></tr>
<tr><td>6:00pm</td><td rowspan="4">Spirit of Chicago Dinner Cruise
+Awards Ceremony

(return at 9:30pm)</td><td></td><td></td></tr>
<tr><td>6:30pm</td><td rowspan="2">Light Reception</td><td></td><td></td></tr>
<tr><td>7:00pm</td><td></td><td></td></tr>
<tr><td>7:30pm</td><td></td><td></td><td></td></tr>
<tr><td>8:00pm</td><td></td><td></td><td></td><td></td></tr>
</table>

Program Overview

Wednesday, October 08, 2008

08:30 AM to 10:30 AM

6-2-6	Opening Remarks and Plenary Talks *(Plenary Session)*	No.of Papers: 2

10:50 AM to 12:00 PM

1-4-1	Adhesion and Interfaces I (ASME and JSME Technical Papers) *(Technical Session)*	No.of Papers: 3
2-3-1	Advanced Powder Processing Technique I (ASME & JSME Technical Papers) *(Technical Session)*	No.of Papers: 3
2-13-1	Energy Field Method featured processes (ASME Technical Papers) *(Technical Session)*	No.of Papers: 3
3-6-2	Advances in Nondestructive Evaluation and Monitoring Techniques II (JSME Technical Papers) *(Technical Session)*	No.of Papers: 3
4-7-1	New Developments in Nanomanufacturing, Nanometrology and Applications (ASME Technical Papers) *(Technical Session)*	No.of Papers: 3
4-8-1	Ultra-Precision and Micro/Nano Forming of Materials I (ASME & JSME Technical Papers) *(Technical Session)*	No.of Papers: 3
6-2-5	NAMRI Board Meeting *(Meeting Session)*	No.of Papers: 0

01:30 PM to 03:00 PM

1-4-2	Adhesion and Interfaces II (JSME Technical Papers) *(Technical Session)*	No.of Papers: 3
2-3-2	Advanced Powder Processing Technique II (JSME Technical Papers) *(Technical Session)*	No.of Papers: 3
2-13-2	Nano-related new processes (ASME Technical Papers) *(Technical Session)*	No.of Papers: 3
3-6-1	Advances in Nondestructive Evaluation and Monitoring Techniques I (JSME Technical Papers) *(Technical Session)*	No.of Papers: 4
4-8-2	Ultra-Precision and Micro/Nano Forming of Materials II (ASME & JSME Technical Papers) *(Technical Session)*	No.of Papers: 3
6-2-8	JMSE AE Meeting *(Technical Session)*	No.of Papers: 0
6-3-1	Student Design Manufacturing Competition I *(Technical Session)*	No.of Papers: 4

01:30 PM to 05:00 PM

6-1-1 MSEC and ICM&P Poster Session *(Poster Session)* No.of Papers: 41

03:30 PM to 05:00 PM

1-7-1 Material Selection, Processing, Reuse and Recycle for Sustainable Manufacturing (ASME & JSME Technical Papers) *(Technical Session)* No.of Papers: 4

2-3-3 Advanced Powder Processing Technique III (JSME Technical Papers) *(Technical Session)* No.of Papers: 4

2-13-3 Laser shock peening (ASME & JSME Technical Papers) *(Technical Session)* No.of Papers: 3

4-2-1 Advances in Mechanical Micromachining (ASME Technical Papers) *(Technical Session)* No.of Papers: 5

4-8-3 Ultra-Precision and Micro/Nano Forming of Materials III (ASME & JSME Technical Papers) *(Technical Session)* No.of Papers: 3

6-3-2 Student Design Manufacturing Competition II *(Technical Session)* No.of Papers: 4

Thursday, October 09, 2008

08:30 AM to 10:00 AM

1-1-1	Polymer and Polymer Matrix Composites I (ASME Technical Papers) *(Technical Session)*	No.of Papers: 4
2-5-1	Coating and Thermal Spraying I (ASME & JSME Technical Papers) *(Technical Session)*	No.of Papers: 4
2-9-1	Tool Wear and Process Monitoring (ASME Technical Papers) *(Technical Session)*	No.of Papers: 4
3-3-1	Contact Surface Mechanics, Fracture and Fracture Reliability I (ASME & JSME Technical Papers) *(Technical Session)*	No.of Papers: 5
3-4-1	Manufacturing Process and Surface Modification (ASME & JSME Technical Papers) *(Technical Session)*	No.of Papers: 3
4-6-1	Development and Applications of Micro Manufacturing Equipment I (ASME Technical Papers) *(Technical Session)*	No.of Papers: 4
5-2-1	Advanced Manufacturing Processes for Biomedical Applications (ASME Technical Papers) *(Technical Session)*	No.of Papers: 4
6-3-3	Career Planning Panel for Students *(Technical Session)*	No.of Papers: 0

10:30 AM to 12:00 PM

1-1-2	Polymer and Polymer Matrix Composites II (JSME Technical Papers) *(Technical Session)*	No.of Papers: 4
2-1-1	Plastic Forming of Metals: Analytical & Experimental Modeling I (ASME Technical Papers) *(Technical Session)*	No.of Papers: 4
2-5-2	Coating and Thermal Spraying II (ASME & JSME Technical Papers) *(Technical Session)*	No.of Papers: 4
2-9-2	New Cutting Tool Technologies (ASME Technical Papers) *(Technical Session)*	No.of Papers: 4
3-3-2	Contact Surface Mechanics, Fracture and Fracture Reliability II (ASME & JSME Technical Papers) *(Technical Session)*	No.of Papers: 4
3-4-2	Thin Films and Tribology I (ASME & JSME Technical Papers) *(Technical Session)*	No.of Papers: 4
4-6-2	Development and Applications of Micro Manufacturing Equipment II (ASME Technical Papers) *(Technical Session)*	No.of Papers: 4
5-2-2	Laser-Assisted Manufacturing Processes for Biomedical Applications (ASME Technical Papers) *(Technical Session)*	No.of Papers: 3
6-2-4	ASME Manufacturing Group Meeting *(Meeting Session)*	No.of Papers: 0

12:00 PM to 01:15 PM

6-2-9	Thursday Luncheon Speaker *(Plenary Session)*	No.of Papers: 1

01:30 PM to 03:00 PM

1-1-3	Polymer and Polymer Matrix Composites III (JSME Technical Papers) *(Technical Session)*	No.of Papers: 4
2-1-5	Plastic Forming of Metals: Processing I (ASME & JSME Technical Papers) *(Technical*	No.of Papers: 4

Session)

2-5-3 Coating and Thermal Spraying III (ASME & JSME Technical Papers) *(Technical Session)* No.of Papers: 3

2-9-3 Machining Issues Relating to Tool Design (ASME & JSME Technical Papers) *(Technical Session)* No.of Papers: 4

3-4-3 Thin Films and Tribology II (ASME & JSME Technical Papers) *(Technical Session)* No.of Papers: 3

4-5-2 International Perspective of the Micro/Mesoscale Manufacturing Material Handling and Fixturing Needs *(Panel Session)* No.of Papers: 3

5-3-1 Advances in Medical Micro/Nano Manufacturing and its Applications (ASME & JSME Technical Papers) *(Technical Session)* No.of Papers: 4

03:30 PM to 05:00 PM

1-3-1 Ceramics and Ceramic Matrix Composites (JSME Technical Papers) *(Technical Session)* No.of Papers: 4

2-1-4 Plastic Forming of Metals: Processing II (ASME Technical Papers) *(Technical Session)* No.of Papers: 5

2-9-4 Process Modeling Related to Cutting Tools (ASME Technical Papers) *(Technical Session)* No.of Papers: 4

2-12-1 Emerging and Non-traditional Manufacturing Technologies I (ASME Technical Papers) *(Technical Session)* No.of Papers: 4

3-4-4 Surface Measurement and Observation (ASME & JSME Technical Papers) *(Technical Session)* No.of Papers: 3

3-7-1 Condition-Based and Predictive Maintenance for Manufacturing Equipment and Systems (ASME Technical Papers) *(Technical Session)* No.of Papers: 5

4-5-1 Micro/Mesoscale Manufacturing Challenges in Material Handling (ASME Technical Papers) *(Technical Session)* No.of Papers: 3

5-5-1 Advances in Bio Applications (ASME & JSME Technical Papers) *(Technical Session)* No.of Papers: 4

6-2-3 MED Executive Committee Meeting *(Meeting Session)* No.of Papers: 0

05:30 PM to 06:30 PM

6-2-1 ASME General Membership Meeting *(Meeting Session)* No.of Papers: 0

6-2-2 JSME Committee Meeting *(Technical Session)* No.of Papers: 0

Friday, October 10, 2008

08:30 AM to 10:00 AM

1-2-1	Metal and Metal Matrix Composites I (ASME Technical Papers) *(Technical Session)*	No.of Papers: 5
2-1-3	Plastic Forming of Metals: Process & Tool Design (ASME Technical Papers) *(Technical Session)*	No.of Papers: 4
2-6-1	Environmentally Sustainable Manufacturing Systems (ASME Technical Papers) *(Technical Session)*	No.of Papers: 4
2-12-2	Emerging and Non-traditional Manufacturing Technologies II (ASME & JSME Technical Papers) *(Technical Session)*	No.of Papers: 4
3-5-1	Dynamic Behavior of Materials and Structures I (JSME Invited Papers) *(Plenary Session)*	No.of Papers: 2
3-8-1	Quality Control in Multistage Manufacturing Systems (ASME Technical Papers) *(Technical Session)*	No.of Papers: 4
4-3-1	Laser Micromachining Technology and Its Applications (ASME Technical Papers) *(Technical Session)*	No.of Papers: 4

10:30 AM to 12:00 PM

1-2-2	Metal and Metal Matrix Composites II (JSME Technical Papers) *(Technical Session)*	No.of Papers: 5
2-1-2	Plastic Forming of Metals: Analytical & Experimental Modeling II (JSME Technical Papers) *(Technical Session)*	No.of Papers: 4
2-4-1	Advanced Welding and Bonding Technology I (ASME Technical Papers) *(Technical Session)*	No.of Papers: 4
2-8-1	Semiconductor Materials Manufacturing Processes (ASME Technical Papers) *(Technical Session)*	No.of Papers: 4
3-1-1	Mechanical Characterization and Measurement Techniques I (ASME & JSME Technical Papers) *(Technical Session)*	No.of Papers: 3
3-5-2	Dynamic Behavior of Materials and Structures II (ASME and JSME Technical Papers) *(Technical Session)*	No.of Papers: 4
4-1-1	MEMS and NEMS Applications (JSME Technical Papers) *(Technical Session)*	No.of Papers: 5
4-4-1	Miniaturization of Molding Processes for Microfabrication I (ASME & JSME Technical Papers) *(Technical Session)*	No.of Papers: 3

12:00 PM to 01:15 PM

6-2-10	Friday Luncheon Speaker *(Plenary Session)*	No.of Papers: 1

01:30 PM to 03:00 PM

1-2-3	Metal and Metal Matrix Composites III (JSME Technical Papers) *(Technical Session)*	No.of Papers: 3
2-1-6	Plastic Forming of Metals: Processing III (JSME Technical Papers) *(Technical Session)*	No.of Papers: 4
2-4-2	Advanced Welding and Bonding Technology II (ASME & JSME Technical Papers) *(Technical Session)*	No.of Papers: 4
2-7-1	Model-Based Control and Quality (ASME Technical Papers) *(Technical Session)*	No.of Papers: 5

3-1-2 Mechanical Characterization and Measurement Techniques II (ASME & JSME Technical Papers) *(Technical Session)* No.of Papers: 3

3-2-1 Advances in Sensors, Controllers, Intelligent Systems and Robotics for Material Processing and Inspection I (ASME Technical Papers) *(Technical Session)* No.of Papers: 4

3-5-3 Dynamic Behavior of Materials and Structures III (JSME Technical Papers) *(Technical Session)* No.of Papers: 4

4-4-2 Miniaturization of Molding Processes for Microfabrication II (ASME & JSME Technical Papers) *(Technical Session)* No.of Papers: 3

03:30 PM to 05:00 PM

1-6-1 Smart Materials and Structures (JSME Technical Papers) *(Technical Session)* No.of Papers: 4

2-1-7 Plastic Forming of Metals: Processing IV (JSME Technical Papers) *(Technical Session)* No.of Papers: 4

2-4-3 Advanced Welding and Bonding Technology III (ASME & JSME Technical Papers) *(Technical Session)* No.of Papers: 4

2-7-2 Process Modeling and Optimization (ASME Technical Papers) *(Technical Session)* No.of Papers: 3

3-2-2 Advances in Sensors, Controllers, Intelligent Systems and Robotics for Material Processing and Inspection II (ASME & JSME Technical Papers) *(Technical Session)* No.of Papers: 4

3-5-4 Dynamic Behavior of Materials and Structures IV (JSME Technical Papers) *(Technical Session)* No.of Papers: 4

4-4-3 Miniaturization of Molding Processes for Microfabrication III (ASME & JSME Technical Papers) *(Technical Session)* No.of Papers: 3

06:00 PM to 07:30 PM

6-2-7 ASME and JSME Planning Committee Wrap-up Meeting *(Meeting Session)* No.of Papers: 0

WEDNESDAY
OCTOBER 8, 2008

WEDNESDAY 8:30 – 10:30 AM

TK 6 Other Conference Events

Track Chair: **John T. Roth**, *Penn State Erie, The Behrend College, Erie, PA, United States*

6-2 -GENERAL MEETINGS AND PLENARY TALKS

6-2-6 -Opening Remarks and Plenary Talks

McCORMICK Auditorium 8:30am - 10:30am

Energy Technology and the Environment: Advances in Renewables
Plenary. MSEC_ICMP2008-72622
-***James Maughan***, *General Electric Corporation, Salem, MA, United States*

Estimation Theory of Creep Behavior on Fiber Reinforced Thermoplastics
Plenary. MSEC_ICMP2008-72623
-***Satoshi Somiya and Tatenobu Sakai***, *Keio University, Yokohama, Japan*

WEDNESDAY 10:50 – 12:00 PM

TK 1 Materials

Track Chair: **Hiroshi Asanuma**, *Chiba University, Chiba, Japan*

1-4 -ADHESION AND INTERFACES

1-4-1 -Adhesion and Interfaces I (ASME and JSME Technical Papers)

WildCat B (Room 101B) 10:50am - 12:00pm

Session Chair: **Chiaki Sato**, *Tokyo Institute of technology, Yokohama, Japan*
Session Co-Chair: **Kevin Chou**, *The University of Alabama, Tuscaloosa, AL, United States*

Simulation of Crack Initiation at the Interface Edge between Submicron Thick Films under Creep by Cohesive Zone Model
ASME Technical Publication. MSEC_ICMP2008-72061
-***Truong Do Van**, Kyoto University, Kyoto, Japan*

Interface Effects on Coating Failure of Diamond Coated Cutting Tools
ASME Technical Publication. MSEC_ICMP2008-72309
-***Jianwen Hu**, UA, Tuscaloosa, AL, United States*, ***Kevin Chou**, The University of Alabama, Tuscaloosa, AL, United States*, ***Raymond Thompson**, Vistae Engineering, Birmingham, AL, United States*

A Diagram for Evaluating Delamination of GFRP/Stainless-steel Adhesive Joints by Using Stress Singularity Parameters
JSME Invited Paper. MSEC_ICMP2008-72370
-***Masaaki Iwasa**, Hitachi,Ltd., Hitachinaka, Ibaraki, Japan*

TK 2 Processing

Track Chair: **Brad Kinsey**, *University of New Hampshire, Durham, NH, United States*
Track Co-Chair: **Jaime Camelio**, *Virginia Tech, Blacksburg, VA, United States*

2-3 -ADVANCED POWDER PROCESSING

2-3-1 -Advanced Powder Processing Technique I (ASME & JSME Technical Papers)

Arch (Room 206) 10:50am - 12:00pm

Session Chair: **Hideshi Miura**, *Kyushu University, Fukuoka, Japan*
Session Co-Chair: **Patrick Kwon**, *Michigan State University, East Lansing, MI, United States*

Microstructure and Mechanical Properties of ZrO2 (Y2O3)-Al2O3 Nanocomposites Prepared by Spark Plasma Sintering
ASME Technical Publication. MSEC_ICMP2008-72322
-***Shufeng Li**, Nihon University, Funabashi, Chiba, Japan*, ***Hiroshi Izui**, Nihon University, Funabashi, Chiba, Japan*, ***Michiharu Okano**, Nihon University, Chiyoda, Tokyo, Japan*, ***Weihua Zhang**, Xi'an University of Technology, Xi'an, Shaanxi,, China*, ***Taku Watanabe**, Nihon University, Funabashi, Chiba, Japan*

Processing of ZrW2O8-ZrO2 Continuous Functionally Graded Materials by Co-Sintering ZrO2 and ZrO2+WO3 Multi-Layer Compacts
ASME Technical Publication. MSEC_ICMP2008-72368
-***Li Sun, Patrick Kwon, Samuel Baldauf**, Michigan State University, East Lansing, MI, United States*

Synthesis and Characteristics of WC-Co Alloy Fabricated by Mechanical Alloying and Pressure Sintering
JSME Technical Publication. MSEC_ICMP2008-72344
-***Kazuo Isonishi**, Faculty of Education, Shiga University, Otsu, Japan*

2-13 -ENERGY FIELD MANUFACTURING

2-13-1 -Energy Field Method Processes (ASME Technical Papers)

WildCat A (Room 101A) 10:50am - 12:00pm

Session Chair: **Frank Pfefferkorn**, *University of Wisconsin-Madison, Madison, WI, United States*
Session Co-Chair: **Shuting Lei**, *Kansas State University, Manhattan, KS, United States*

Investigation on Operating Temperature in Laser Assisted Milling of Silicon Nitride Ceramics
ASME Technical Publication. MSEC_ICMP2008-72463
-***Xinwei Shen, Shuting Lei***, *Kansas State University, Manhattan, KS, United States*

Effect of Electrical Pulsing on Various Heat Treatments of 5xxx Series Aluminum Alloys
ASME Technical Publication. MSEC_ICMP2008-72512
-***Wesley A. Salandro***, *Penn State Erie, The Behrend College, Latrobe, PA, United States*, ***Joshua J. Jones***, *Penn State Erie, The Behrend College, Pittsburgh, PA, United States*, ***Timothy A. McNeal, John T. Roth***, *Penn State Erie, The Behrend College, Erie, PA, United States*, ***Sung-Tae Hong***, *University of Ulsan :School of Mechanical and Automotive Engineering, Ulsan, WA, Korea (Republic)*, ***Mark T. Smith***, *Pacific Northwest National Laboratory, Richland, WA, United States*

Review of Intelligent Energy Field Manufacturing (EFM)
ASME Technical Publication. MSEC_ICMP2008-72541
-***Wenwu Zhang***, *GE GRC, Schenectady, NY, United States*

TK 3 Properties and Applications

Track Chair: **Ikuo Ihara**, *Nagaoka University of Technology, Nagaoka, Niigata, Japan*

3-6 -ADVANCES IN NONDESTRUCTIVE EVALUATION AND MONITORING TECHNIQUES

3-6-2 -Advances in Nondestructive Evaluation and Monitoring Techniques II (JSME Technical Papers)

Armadillo (Room 208) 10:50am - 12:00pm

Session Chair: **Riichi Murayama**, *Japan/Fukuoka Institute of Technology, Fukuoka, Fukuoka, Japan*
Session Co-Chair: **Goutham Kirikera**, *Northwestern University, Evanston, IL, United States*

Visualization of Guided Wave Propagation from Defects in a Pipe
JSME Technical Publication. MSEC_ICMP2008-72465
-***Nor Salim Muhammad***, *Nagoya Institute of Technology, Nagoya, Japan*

Efficient Generation and Detection of a Guided Wave in a Pipe Using Guided Wave Reflectors
JSME Technical Publication. MSEC_ICMP2008-72477
-***Hideo Nishino, Yasuhisa Kato, Yasuhiro Tanaka, Kenichi Yoshida***, *The University of Tokushima, Tokushima, Japan*

Quantitative Evaluation of the Blocking Ratio of a Blockage inside a Pipe Utilizing Film-Type PZT Elements
JSME Technical Publication. MSEC_ICMP2008-72486
-***Hideo Cho, Takahiro Abe***, *Aoyama Gakuin University, Sagamihara, Kanagawa, Japan*, ***Takuma Matsuo***, *Aoyama Gakuin University, Sagamihara, Kanagawa, Japan*

TK 4 Micro and Nano Technologies

Track Chair: **Gloria Wiens**, *University of Florida, Gainesville, FL, United States*

4-7 -NEW DEVELOPMENTS IN NANOMANUFACTURING, NANOMETROLOGY AND APPLICATIONS

4-7-1 -New Developments in Nanomanufacturing, Nanometrology and Applications (ASME Technical Papers)

Rock (Room 207) 10:50am - 12:00pm

Session Chair: **Theodore Vorburger**, *NIST, Gaithersburg, MD, United States*
Session Co-Chair: **Kazuaki Nishiyabu**, *Osaka Prefectural College of Technology, Osaka, Japan*

Fractal Dimension and Multifractal Spectra of InGaN/GaN Self-Assembled Quantum Dots Films
ASME Technical Publication. MSEC_ICMP2008-72012
-***K.T. Lam**, Leader University, Tainan City, Taiwan*

Modeling and Simulation of Focused Ion Beam Based Single Digital Nano Hole Fabrication for DNA and Macromolecule Characterization
ASME Technical Publication. MSEC_ICMP2008-72033
-***Jack G. Zhou**, Drexel University, Philadelphia, PA, United States*, ***Guoliang Yang**, Drexel University, Philadelphia, PA, United States*

Application of Nickel Nanoparticles in Diffusion Bonding of Stainless Steel Surfaces
ASME Technical Publication. MSEC_ICMP2008-72151
-***Santosh Tiwari, Brian K. Paul**, Oregon State University, Corvallis, OR, United States*

4-8 -ULTRA-PRECISION AND MICRO/NANO FORMING OF MATERIALS

4-8-1 -Ultra-Precision and Micro/Nano Forming of Materials I (ASME & JSME Technical Papers)

Big Ten (Room 104) 10:50am - 12:00pm

Session Chair: **Jenn-Terng Gau**, *Northern Illinois University, DeKalb, IL, United States*
Session Co-Chair: **Yasunori Saotome**, *Tohoku University, Sakai, Osaka, Japan*

The Preparation and Properties of Zinc Oxide/Silver/Zinc Oxide Multilayer Transparent Conductive Oxide Thin Films Deposited by a D. C. Magnetron Sputtering System
JSME Technical Publication. MSEC_ICMP2008-72099
-***Zhiyong Qiu**, Tokyo University of Science, Noda, Chiba, Japan*, ***Pangpang Wang, Ri-ichi Murakami**, The University of Tokushima, Tokushima, Japan*

Tribological Behavior and Surface Characteristics of Metal Microtube in Flaring Test
JSME Technical Publication. MSEC_ICMP2008-72120
-***Mohammad Ali Mirzai, Kenichi Manabe**, Tokyo Metropolitan University, Tokyo, Japan*

Development of a Small Machining Center Equipped With Nanomachining and Measurement Functions
JSME Technical Publication. MSEC_ICMP2008-72106
-***Kiyonori Inagaki**, Tateyama Machine Co.,Ltd., Toyama, Toyama, Japan*, ***Noboru Morita**, Toyama University, Toyama, Toyama, Japan*, ***Kiwamu Ashida**, National Institute of Advanced Industrial Science and Technology, Tsukuba, Ibaraki, Japan*, ***Jyunji Saito**, Tateyama Machine Co.,Ltd., Toyama, Japan*

TK 6 Other Conference Events

Track Chair: **John T. Roth**, *Penn State Erie, The Behrend College, Erie, PA, United States*

6-2 -GENERAL MEETINGS AND PLENARY TALKS

6-2-5 -NAMRI Board Meeting

Evans (Room 102) 10:50am - 12:00pm

WEDNESDAY 1:30 – 3:00 PM

TK 1 Materials

Track Chair: **Hiroshi Asanuma**, *Chiba University, Chiba, Japan*

1-4 -ADHESION AND INTERFACES

1-4-2 -Adhesion and Interfaces II (JSME Technical Papers)

WildCat B (Room 101B) 1:30pm - 3:00pm

Session Chair: **Masaaki Iwasa**, *Hitachi,Ltd., Hitachinaka, Ibaraki, Japan*
Session Co-Chair: **Truong Do Van**, *Kyoto University, Kyoto, Japan*

Simplified Method to Predict the Strength of Double Lap Adhesively Bonded Joints Subjected to Bending Moment
JSME Technical Publication. MSEC_ICMP2008-72360
-***Chiaki Sato***, *Tokyo Institute of technology, Yokohama, Japan*

Application of High Homogenization Technique to Fabrication of Electric Testing Prove Disk Using Micro-Fibrillated Bacteria Cellulose
JSME Technical Publication. MSEC_ICMP2008-72473
-***Kaho Matsuoka , Kazuya Okubo, Toru Fujii***, *Doshisha University, Kyo-Tanabe, Japan*

Stress Analysis and Strength Evaluation of Scarf Adhesive Joints Subjected to Impact Tensile Loadings
JSME Technical Publication. MSEC_ICMP2008-72410
-***He Dan, Toshiyuki Sawa, Takeshi Iwamoto, Toshimasa Nagai***, *Hiroshima University, Higashi Hiroshima, Japan*

TK 2 Processing

Track Chair: **Brad Kinsey**, *University of New Hampshire, Durham, NH, United States*
Track Co-Chair: **Jaime Camelio**, *Virginia Tech, Blacksburg, VA, United States*

2-3 -ADVANCED POWDER PROCESSING

2-3-2 -Advanced Powder Processing Technique II (JSME Technical Papers)

Arch (Room 206) 1:30pm - 3:00pm

Session Chair: **Katsuyoshi Kondoh**, *Osaka University, Ibaragi, Japan*
Session Co-Chair: **Shufeng Li**, *Nihon University, Funabashi, Chiba, Japan*

Mechanical Properties of Composite Material Using Coal Ash and Clay
JSME Technical Publication. MSEC_ICMP2008-72150
-***Isao Fukumoto, Yasuyuki Kanda***, *University of the Ryukyus, Nishihara-cho Okinawa, Japan*

Resin/Metal Extrusion for Fabricating Porous Aluminum
JSME Technical Publication. MSEC_ICMP2008-72305
-***Masato Hirai, Kazunari Shinagawa, Yutaka Mihara***, *Kagawa University, Takamatsu, Japan*

Experimental Analysis of Metal Flow and Strain Distribution in Rolling of Sn-Pb Powder
JSME Technical Publication. MSEC_ICMP2008-72102
-***Yoshimi Murata***, *Meiji University, Kawasaki, Japan,* ***Eiji Yuasa***, *Musashi Inst. Tech., Tokyo, Japan*, ***Masahito Tanaka***, *Meiji University, Kawasaki, Japan*

2-13 -ENERGY FIELD MANUFACTURING

2-13-2 -Nano-Related New Processes (ASME Technical Papers)

WildCat A (Room 101A) 1:30pm - 3:00pm

Session Chair: **Gary Cheng**, *Purdue University, West Lafayette, IN, United States*
Session Co-Chair: **Tao Deng**, *GE, Niskayuna, NY, United States*

Structural Modification of Amorphous Fused Silica under Femtosecond Laser Irradiation
ASME Technical Publication. MSEC_ICMP2008-72210
-***Sinisa Vukelic, B. Robert Gao, Sunmin Ryu, Y. Lawrence Yao***, *Columbia University, New York, NY, United States*

Manipulating Shape and Size of Nanoparticles with Plasma Field
ASME Technical Publication. MSEC_ICMP2008-72293
-***Tao Deng, James Cournoyer, James Schermerhorn, Joleyn Balch, Margaret Blohm***, *GE, Niskayuna, NY, United States*

Numerical Investigation of Temperature Field during Sintering of Bioceramic Nanoparticles by Pulse Lasers
ASME Technical Publication. MSEC_ICMP2008-72426
-***Chang Ye***, *Purdue University, West Lafayette, IN, United States*, ***Gary Cheng***, *Purdue University, West Lafayette, IN, United States*

TK 3 Properties and Applications

Track Chair: **Ikuo Ihara**, *Nagaoka University of Technology, Nagaoka, Niigata, Japan*

3-6 -ADVANCES IN NONDESTRUCTIVE EVALUATION AND MONITORING TECHNIQUES

3-6-1 -Advances in Nondestructive Evaluation and Monitoring Techniques I (JSME Technical Papers)

Armadillo (Room 208) 1:30pm - 3:00pm

Session Chair: **Hideo Nishino**, *The University of Tokushima, Tokushima, Japan*
Session Co-Chair: **Goutham Kirikera**, *Northwestern University, Evanston, IL, United States*

Damage Degree Evaluation of Iron and nickel thin Fatigue Specimens using EMAT for an S0-Lamb Wave and an SH0-Plate wave
JSME Technical Publication. MSEC_ICMP2008-72421
-***Riichi Murayama***, *Fukuoka Institute of Technology, Fukuoka, Japan*, ***Yusuke Okawa, Yuta Ito, Tomoaki Nagai***, *Fukuoka Institute of Technology, Fukuoka, Japan*

Ultrasonic In-Situ Monitoring of Temperature Gradient inside Materials during Heating and Cooling
JSME Technical Publication. MSEC_ICMP2008-72455
-***Manabu Takahashi, Ikuo Ihara***, *Nagaoka University of Technology, Nagaoka, Niigata, Japan*

Evaluation of Bond Strength of Ni-P-SiC Electronic Plating by Laser Spallation Technique
JSME Technical Publication. MSEC_ICMP2008-72487
-***Tomonari Uchiyama***, *Aoyama Gakuin Univ., Sagamihara, Japan*, ***Hideo Cho***, *Aoyama Gakuin University, Sagamihara, Kanagawa, Japan*, ***Takeshi Ogawa***, *Aoyama Gakuin Univ., Sagamihara, Kanagawa, Japan*

Tool Wear Monitoring Using Time Series Analysis
JSME Technical Publication. MSEC_ICMP2008-72526
-***DongYeul Song***, *Gunma Industrial Technology Center, Maebashi, Japan*, ***Yasuhiro Ohara***, *Kuramae Industries Co. Ltd, Maebashi, Japan*, ***Haruo Tamaki, Masanobu Suga***, *Mathematical Assistance Design Laboratory, Maebashi, Japan*

TK 4 Micro and Nano Technologies

Track Chair: **Gloria Wiens**, *University of Florida, Gainesville, FL, United States*

4-8 -ULTRA-PRECISION AND MICRO/NANO FORMING OF MATERIALS

4-8-2 -Ultra-Precision and Micro/Nano Forming of Materials II (ASME & JSME Technical Papers)

Big Ten (Room 104) 1:30pm - 3:00pm

Session Chair: **Jenn-Terng Gau**, *Northern Illinois University, DeKalb, IL, United States*
Session Co-Chair: **Masaaki Otsu**, *Kumamoto University, Kumamoto, Japan*

Microscale Flanging Using Quasi-Static and Electromagnetic Forming Processes
ASME Technical Publication. MSEC_ICMP2008-72135
-***Brad Kinsey, Reid VanBenthysen, Peter DiSalvo, Jonathan Michaud***, *University of New Hampshire, Durham, NH, United States*, ***Michael Blakely, Jianhui Shang***, *Hirotec America, Auburn Hills, MI, United States*

Tensile And Micro Stretch Bending Experiments For Studying Stainless Steel 304 Foil For Micro Sheet Forming
ASME Technical Publication. MSEC_ICMP2008-72273
-***Jenn-Terng Gau***, *Northern Illinois University, DeKalb, IL, United States*, ***Chi-Han Chen, Rong-Shean Lee***, *National Cheng Kung University, Tainan, Taiwan*

Influence of Surface Topographical Interaction between Tool and Material in Micro Deep Drawing
JSME Technical Publication. MSEC_ICMP2008-72488
-***Tetsuhide Shimizu, Yushiro Murashige***, *Tokyo Metropolitan University, Tokyo, Japan*, ***Kuniyoshi Ito***, *Seki Corporation, Tokyo, Japan*, ***Ken-ichi Manabe***, *Tokyo Metropolitan University, Tokyo, Japan*

TK 6 Other Conference Events

Track Chair: **John T. Roth**, *Penn State Erie, The Behrend College, Erie, PA, United States*

6-2 -GENERAL MEETINGS AND PLENARY TALKS

6-2-8 -JMSE AE Meeting

Evans (Room 102) 1:30pm - 3:00pm

6-3 -STUDENT EVENTS

6-3-1 -Student Design Manufacturing Competition I

Rock (Room 207) 1:30pm - 3:00pm

Hybrid Micro-composite E-springs for Vehicle Suspension Systems
Student Presentation. MSEC_ICMP2008-72613
-***Salah Elmoselhy***, *University of Cambridge, UK, United Kingdom*

Collapsible and Portable Bed Design
Student Presentation. MSEC_ICMP2008-72614
-***Rigoberto Hernandez***, *University of Texas, Pan American, United States*

Grain Packing Control for Near Infrared Laboratory Analysis
Student Presentation. MSEC_ICMP2008-72615
-***Lidia Agelet***, *Iowa State University, United States*

Comparison Of Quasi-Static And Electromagnetic Flanging At The Microscale
Student Presentation. MSEC_ICMP2008-72616
-***Reid VanBenthysen***, *University of New Hampshire, United States*

WEDNESDAY 1:30 – 5:00 PM

6-1 -MSEC AND ICM&P POSTERS

6-1-1 -MSEC and ICM&P Poster Session

Northwestern A & B (Room 202) 1:30pm - 5:00pm

Green Manufacturing of Electricity for Stationary Industrial Applications
ASME Poster. MSEC_ICMP2008-72510
-***Zulfiqar Ali-Qureshi***, *University of Windsor, Windsor, ON, Canada*

Application Of Envelop Analysis And Wavelet Transform For Fault Detection In Local Gearboxes Failure
ASME Poster. MSEC_ICMP2008-72546
-***Dong Sik Gu, Byeong Keun Choi***, *Gyeongsang National University, Tongyeong, Gyeongnam, Korea (Republic)*, ***Jeong Hwan Lee***, *Gyeongsang National University, Tongyoung, Gyeongnam-do, Korea (Republic)*, ***Byeong Su Kim***, *Gyeongsang National University, Tongyeong, Gyeongnamdo, Korea (Republic)*, ***Jong Duk Son, Bo Suk Yang***, *Pukyeong National University, Busan, Korea (Republic)*, ***Achmad Widodo***, *Diponegoro University, Samarang, Indonesia*

Impact of National Science Foundation Next Generation Manufacturing: Where Are We Now?
ASME Poster. MSEC_ICMP2008-72560
-***Karen Wosczyna-Birch***, *CT Comm-Tech Colleges' College of Technology Regional Ctr. for Next Gen. Mfg, Hartford, CT, United States*, ***Paola Jaramillo***, *Board of Trustees, CT Comm-Tech Colleges' College of Technology Regional Center for Next Gen. Mfg, Hartford, CT, United States*, ***Kerry Simoneau***, *CT Comm-Tech Colleges' College of Technology Regional Ctr. for Next Gen. Mfg, Hartford, CT, United States*, ***Robert Simoneau***, *Keene State College, Keene, NH, United States*

Development of the Process of Honeycomb Seal for Gas Turbine
ASME Poster. MSEC_ICMP2008-72561
-***Kyu-Taek Han***, *Pukyong National University, School of Mechanical Engineering, Busan, Korea (Republic)*

Flexible Gripper System for Small Optical Assemblies
ASME Poster. MSEC_ICMP2008-72569
-***Mikko Remes, Riku Heikkilä, Timo Prusi***, *Tampere University of Technology, Tampere, Finland*, ***Taeho Ha***, *Korea Institute of Machinery and Materials (KIMM), Daejeon, Korea (Republic)*, ***Jun Yeob Song, Chang Woo Lee***, *Intelligent Machine Systems Research Center, Korea Institute of Machinery and Materials, Daejeon, Korea (Republic)*, ***Reijo Tuokko***, *Tampere University of Technology, Tampere, Finland*

Semisolid Powder Forming For Micro Manufacturing
ASME Poster. MSEC_ICMP2008-72575
-***Yufeng Wu, Gap-Yong Kim***, *Iowa State University, Ames, IA, United States*

Force Modeling of the Micro-Grinding Process
ASME Poster. MSEC_ICMP2008-72576
-***Hyung-Wook Park***, *Korea Institute of Machinery & Materials, Daejeon, Korea (Republic)*, ***Steven Liang***, *Manufacturing Research Center (MaRC), Georgia Institute of Technology, Atlanta, GA, United States*, ***Jong-Kweon Park***, *Korea Institute of Machinery & Materials, Daejeon, Korea (Republic)*

Simulation Study of Micro Assembly Machine for Lens Module
ASME Poster. MSEC_ICMP2008-72580
-***Dug Hee Moon, Bing Lin Zhang, Jin Wook Kim***, *Department of Industrial and Systems Engineering, Changwon National University, Changwon, Gyeongnam, Korea (Republic)*, ***Jun Yeob Song, Chang Woo Lee***, *Intelligent Machine Systems Research Center, Korea Institute of Machinery and Materials, Daejeon, Korea (Republic)*

3D Hollow Polymeric Microstructures Obtained by Partial Molding for Shear-Protecting Cell Containers within Microfluidic Channel
ASME Poster. MSEC_ICMP2008-72584
-***Sung-Hoon Lee, Kahp-Yang Suh, Min-Cheol Park, Chan-Ick Park, Hong-Nam Kim***, *Seoul National University, Seoul, Korea (Republic)*

Experimental Study of Submersed Gas-Jetting EDM
ASME Poster. MSEC_ICMP2008-72591
-***Xiaoming Kang, Wansheng Zhao, C. J. Tang, L. S. Ding***, *Shanghai Jiao Tong University, Shanghai, Shanghai, China*

Deformation Machining: A New Hybrid Process
ASME Poster. MSEC_ICMP2008-72598
-***Bethany Woody***, *UNC Charlotte, Charlotte, NC, United States*, ***K. Scott Smith***, *University of North Carolina at Charlotte, Charlotte, NC, United States*, ***Jian Cao***, *Northwestern University, Evanston, IL, United States*, ***John Ziegert***, *Clemson University, Greenville, SC, United States*, ***Ted Belytschko***, *Northwestern University, Evanston, Botswana*, ***Tim Foecke***, *NIST, Gaithersburg, MD, United States*, ***Ming Li***, *Alcoa Technical Center, Pittsburgh, PA, United States*

Micromixing with 3D Porous Structure Fabricated using HIFU
ASME Poster Presentation Only. MSEC_ICMP2008-72599
-***Hai Wang, Wei Li***, *University of Washington, Seattle, WA, United States*

Lightweight Design of Automotive Chassis Using Fatigue Properties and Finite Element Analysis
ASME Poster. MSEC_ICMP2008-72605
-***Ali Bagherzadeh, Mojtaba Javaheri***, *Amirkabir University of Technology, Tehran, Iran*

The Effect of Fine Particles on Metal Surface in MCF(Magnetic Compound Fluid) Polishing
JSME Poster. MSEC_ICMP2008-72040
-***Shimada Kunio, Zheng Yaoyang***, *Fukushima University, Fukushima, Fukushima Province, Japan*

Effect of Plastic Straining on Working Life under Cyclic Loading
JSME Poster. MSEC_ICMP2008-72085
-***Kazumasa Sugai, Minoru Yamashita, Naoya Nishimura, Toshio Hattori***, *Gifu University, Gifu, Japan*, ***Joji Sato***, *Res. Inst. Machinery & Materials Gifu Pref., Seki, Japan*

Deformation Behavior of Wood in Biaxial Compression and Its Strength Evaluation
JSME Poster. MSEC_ICMP2008-72086
-***Haruhiko Mori, Minoru Yamashita, Naoya Nishimura, Toshio Hattori***, *Gifu University, Gifu, Japan*

Fabrication of High Aspect Ratio X-Ray Grating Using X-Ray Lithography
JSME Poster. MSEC_ICMP2008-72090
-***Daiji Noda, Hiroshi Tsujii***, *University of Hyogo, Kamigori, Ako, Japan*, ***Kazuma Shimada***, *University of Hyogo, Kaimigori, Ako, Japan*, ***Wataru Yashiro, Atsushi Momose***, *The University of Tokyo, Kashiwa, Japan*, ***Tadashi Hattori***, *University of Hyogo, Kamigori, Ako, Japan*

Basic Study on Usefulness of Magnetic Compound Fluid (MCF) Rubber as Material for Microwave Heating
JSME Poster. MSEC_ICMP2008-72159
-***Shimada Kunio, Zheng Yaoyang***, *Fukushima University, Fukushima, Fukushima Province, Japan*

Processing on Hot Emboss Molding for a Small Capacitive Inclination Sensor
JSME Poster. MSEC_ICMP2008-72175
-***Kazufumi Nishimoto***, *University of Hyogo, Ako-gun, Hyogo, Japan*, ***Naoya Ishizawa***, *University of Hyogo, Ako, Hyogo, Japan*, ***Hiroaki Miyake***, *University of Hyogo, Aako, Hyogo, Japan*, ***Toshiaki Sakai***, *Kamigori, Ako-gun, Japan*, ***Satoshi Nishida***, *Nanocreate Co., Ltd, Ako, Hyogo, Japan*, ***Hiroyasu Ueda, Koichi Itoigawa***, *TOKAI RIKA Co., Ltd., Niwa, Hyogo, Japan*, ***Daiji Noda, Tadashi Hattori***, *University of Hyogo, Kamigori, Ako, Japan*

Fabrication Of the 3 Dimension Resist Microstructure Using X-ray Diffraction And Applying To LIGA Process
JSME Poster. MSEC_ICMP2008-72194
-***Yoshitaka Sawa***, *Sawa Plating Co., Ltd., Himeji, Japan*, ***Kyo Tanabiki***, *University of Hyogo, Ako-gun, Hyogo, Japan*, ***Daiji Noda, Tadashi Hattori***, *University of Hyogo, Kamigori, Ako, Japan*

Interfacial Behavior of Fiber/Matrix Based on of Interphase
JSME Poster. MSEC_ICMP2008-72301
-***Chang Junjie***, *Dalian Maritime University, Dalian, China*

A Boss Forming Technique for Deep-Drawn Product
JSME Poster. MSEC_ICMP2008-72338
-***Keiichi Morishita, Zhrgang Wang***, *Gifu University, Gifu, Japan*

V-Bending of Metal Plates
JSME Poster. MSEC_ICMP2008-72343
-***Nobuhiro Kanada, Zhrgang Wang, Keiichi Morishita, Shota Ikeido***, *Gifu University, Gifu, Japan*

Development of a Method to Evaluate Tribological Performance of Lubrication Coatings for Cold Forging
JSME Poster. MSEC_ICMP2008-72357
-***Ryuichi Tokunaga, Zhrgang Wang, Shinobu Komiyama***, *Gifu University, Gifu, Japan*

Precision of FEM Simulation in Injection Molding
JSME Poster. MSEC_ICMP2008-72372
-***Shingo Ozu, Zhrgang Wang***, *Gifu University, Gifu, Japan*

Fastening Force Monitoring Systems for Bolted Joints Using Semiconductor Strain Sensors
JSME Poster. MSEC_ICMP2008-72482
-***Toshio Hattori, Kenji Nurikabe, Takashi Hayakawa**, Gifu University, Gifu, Japan*, ***Naoya Nishimura**, Meijo University, Nagoya, Aichi, Japan*, ***Minoru Yamashita**, Gifu University, Gifu, Japan*, ***Yoshimizu Iida**, Hitachi Eng. & Service Co. Ltd.,, Hitachi, Ibaraki, Japan*, ***Toshiaki Kobari**, Hitachi Eng. & Service Co. Ltd., Ibaraki, Japan*, ***Hiroyuki Ohta**, Hitachi Ltd.,, Hitachinaka, Ibaraki, Japan*

Research of Optimum Model Size for Shot Peening Simulation
JSME Poster. MSEC_ICMP2008-72565
-***Masahiro Kitamura, Katsuji Tosha**, Meiji University, Kanagawa, Kawasaki, Japan*

Effect of Characteristics of Peened Surface on Flow Resistance
JSME Poster. MSEC_ICMP2008-72566
-***Hiromitsu Kiyoto, Katsuji Tosha**, Meiji University, Kanagawa, Kawasaki, Japan*

Interfacial Strength Evaluation in Glass Fiber Reinforced Composites Using the Cruciform Specimen Method
JSME Poster. MSEC_ICMP2008-72593
-***Shinji Ogihara**, Tokyo University of Science, Noda, Japan*, ***Hajime Kato**, Tokyo University of Science, Noda, Japan*

Net Shape Processing of Micro/Meso-Scale Stem with Grooves, Steps and Threads by Cross Wedge Rolling
JSME Poster. MSEC_ICMP2008-72594
-***Isao Kuboki**, Shizuoka Institute of Science and Technology, Fukuroi, Japan*

Search for Novel MEMS Materials using A Combinatorial Method
JSME Poster. MSEC_ICMP2008-72595
-***Seiichi Hata**, Tokyo Institute of Technology, Yokohama, Kanagawa, Japan*

Reduction of Fretting Wear Using DLC Coating Shim Inserts
JSME Poster. MSEC_ICMP2008-72596
-***Mai Takashima, Tsuyoshi Kuroda, Naoto Ohtake**, Nagoya University, Nagoya, Japan*, ***Makoto Matsuo**, iMott Inc., Yokohama, Kanagawa, Japan*, ***Yoshinao Iwamoto**, iMott Inc, Yokohama, Kanagawa, Japan*, ***Masanori Saito**, Tokyo Institute of Technology, Tokyo, Japan*, ***Masao Kumagai, Makoto Kano**, Kanagawa Industrial Technology Center, Ebina, Kanagawa, Japan*, ***Hiroshi Kimoto**, Kobe Material Testing Laboratory, Hitachi, Ibaraki, Japan*, ***Masaru Shinohara**, KURITA SEISAKUSYO Co., Ltd., Tsuzuki-Gun, Kyoto, Japan*

Effect of Skew of Driving Rollers on Surface Damages under Rolling Fatigue Condition
JSME Poster. MSEC_ICMP2008-72600
-***Koji Fujimoto**, The University of Tokyo, Tokyo, Japan*, ***Akihiro Yuuki**, Isuzu Motors Limited, Tokyo, Japan*

Analysis by EELS With Aluminum Surface Film Section Generated With Chemical Polishing
JSME Poster. MSEC_ICMP2008-72603
-***Emi Shindou, Akira Yoshida, Naoki Hamamura**, **Eiji Yuasa**, Musashi Institute of Technology, Tokyo, Japan*

Ultra High-Speed Micro-Milling Spindle
ASME Poster Presentation Only. MSEC_ICMP2008-72573
-***Said Jahanmir**, Mohawk Innovative Technology, Inc., Albany, NY, United States*, ***Hooshang Heshmat**, Mohawk Innovative Technology Inc., Albany, NY, United States*, ***Zhaohui Ren**, Mohawl Innovative Technology, Inc., Albany, NY, United States*, ***Michael Tomaszewski, James Walton, II**, Mohawk Innovative Technology, Inc., Albany, NY, United States*, ***John E Lawler**, Mohawk Innovative Technology. Inc., Albany, NY, United States*

The Micro Pattern Forming on the Metal Substrate Using a Frequency Forming Process
ASME Poster. MSEC_ICMP2008-72585
-***Hye-Jin Lee**, Korea Institute of Industrial Technology (KITECH), Incheon Metropolitan City, Korea (Republic)*, ***Jong-Pil Choi**, Kangwon National University, Chunchon City, Korea (Republic)*, ***Byeong-Hee Kim**, Kangwon National University, Chuncheon City, Korea (Republic)*, ***Seongouk Kim**, Space Solution Inc., Seoul City, Korea (Republic)*, ***Junhee Shin**, Space Solution Inc., Seoul City, Korea (Republic)*, ***Andy Chu**, Space Solution Inc., Seoul City, Korea (Republic)*, ***Nak-Kyu Lee**, Korea Institute of Industrial Technology (KITECH), Inchen City, Korea (Republic)*, ***Geun-An Lee**, Korea Institute of Industrial Technology (KITECH), Incheon City, Korea (Republic)*, ***Hyoung-Wook Lee**, Chungju National University, Chungju City, Korea (Republic)*, ***Sung-Min Bae**, Hanbat National University, Daejon City, Korea (Republic)*, ***Moon-Young Hwang**, Hyechon College, Daejon City, Korea (Republic)*, ***Jung-Han Song**, Korea Institute of Industrial Technology, Incheon City, Korea (Republic)*

Fuel Cells ASAP: Automated Stack Assembly Process
ASME Poster. MSEC_ICMP2008-72601
-***Christina Laskowski, Stephen Derby**, Rensselaer Polytechnic Institute, Troy, NY, United States*

Micro Punching System Using Punch and Die Made by EDM
JSME Poster. MSEC_ICMP2008-72607
-***Toshihiko Mori**, Nagoya University, Nagoya, Aichi, Japan*, ***Mark Broomfield**, Nagoya University, Nagoya, Aichi, Japan, **Teruaki Mikuriya**, Nagoya University, Nagoya, Aichi, Japan*

On Permanent Wrinkles in a Tube-Hydroformed Automotive Part
ASME Poster Presentation Only. MSEC_ICMP2008-72612
-***Fuh-Kuo Chen**, National Taiwan University, Taipei, Taiwan*

A Study on the Tribology Characteristics and Processing of MoSi2 Composites
JSME Technical Publication. MSEC_ICMP2008-72453
-***SungHo Park**, Department of Mechanical and Precision Engineering, Graduate School, GyeongSang National University, Tongyoung, Korea (Republic)*, ***WonJo Park**, Department of Mechanical and Aerospace Engineering, Gyeongsang National University, Tongyoung, Korea (Republic)*, ***SunChul Huh**, Research Center for Aircraft parts Technology, Gyeongsang National University, Tongyoung, Korea (Republic)*, ***IlSu Han**, School of Materials , Arizona State University, Tempe, AZ, United States*

Fatigue Crack Growth Behavior of High Carbon Steel (SM53C) by Using Induction Hardening
ASME Technical Publication. MSEC_ICMP2008-72452
-***HyunBae Jeon**, GyeongSang National University, Tongyoung, Korea (Republic)*, ***TaeHoon Song**, Department of Mechanical and Precision Engineering, Gyeongsang National University, Tongyoung, Korea (Republic)*, ***SungHo Park**, Department of Mechanical and Precision Engineering, Graduate School, GyeongSang National University, Tongyoung, Korea (Republic)*, ***SunChul Huh**, Research Center for Aircraft parts Technology, Gyeongsang National University, Tongyoung, Korea (Republic)*, ***WonJo Park**, Department of Mechanical and Aerospace Engineering, Gyeongsang National University, Tongyoung, Korea (Republic)*

WEDNESDAY 3:30 – 5:00 PM

TK 1 Materials

Track Chair: **Hiroshi Asanuma**, *Chiba University, Chiba, Japan*

1-7 -MATERIAL SELECTION, PROCESSING, REUSE AND RECYCLE FOR SUSTAINABLE MANUFACTURING

1-7-1 -Material Selection, Processing, Reuse and Recycle for Sustainable Manufacturing (ASME & JSME Technical Papers)

WildCat B (Room 101B) 3:30pm - 5:00pm

Session Chair: **Fu Zhao**, *Purdue University, West Lafayette, IN, United States*
Session Co-Chair: **Andres Clarens**, *University of Virginia, Charlottesville, VA, United States*

Disassembly Planning and Timing through Petri Net Approach
ASME Technical Publication. MSEC_ICMP2008-72034
-***Han Bao, Chun Hsi Lei***, *Old Dominion University, Norfolk, VA, United States*

Production Conditions of Wood Plastic Recycled Composite (Effects of Mixing Temperature and Wood Powder Size)
JSME Technical Publication. MSEC_ICMP2008-72376
-***Tsunehisa Miki, Hiroyuki Sugimoto***, *National Institute of AIST, Nagoya, Japan*, ***Keisuke Kojiro***, *AIST, Nagoya, Japan*, ***Kozo Kanayama***, *National Institute of AIST, Nagoya, Japan*, ***Ken Yamamoto***, *Hiroshima Prefectural Technology Research Institute, Hiroshima, Japan*

Economic and Environmental Assessment of Automotive Remanufacturing: Alternator Case Study
ASME Technical Publication. MSEC_ICMP2008-72490
-***Hyung-Ju Kim, Vineet Raichur, Steve Skerlos***, *University of Michigan, Ann Arbor, MI, United States*

An Economic Model for The Maintenance of a Device Submitted to Minor And Major Repairs
ASME Technical Publication. MSEC_ICMP2008-72130
-***Hrishikesh Phadke, Han Bao, Anthony Dean***, *Old Dominion University, Norfolk, VA, United States*

TK 2 Processing

Track Chair: **Brad Kinsey**, *University of New Hampshire, Durham, NH, United States*
Track Co-Chair: **Jaime Camelio**, *Virginia Tech, Blacksburg, VA, United States*

2-3 -ADVANCED POWDER PROCESSING

2-3-3 -Advanced Powder Processing Technique III (JSME Technical Papers)

Arch (Room 206) 3:30pm - 5:00pm

Session Chair: **Kazuo Isonishi**, *Faculty of Education, Shiga University, Otsu, Shiga, Japan*
Session Co-Chair: **Patrick Kwon**, *Michigan State University, East Lansing, MI, United States*

Phase Transformation Behavior of Ti-Ni-Cu Shape Memory Alloy by P/M Process
JSME Technical Publication. MSEC_ICMP2008-72448
-***Hideki Kyogoku***, *Kinki University, Higashihiroshima, Hiroshima, Japan*, ***Akira Terayama***, *Hiroshima Prefectural Technology Research Institute, Kure, Hiroshima, Japan*

Effect of Fe or Cr Addition on the Strengthening Ti-6al-4v Alloy by Metal Injection Molding
JSME Technical Publication. MSEC_ICMP2008-72440
-***Yoshinori Itoh***, *Hamamatsu Technical Support Center Industrial Research Institute of Shizuoka Prefecture, Hamamatsu, Japan*, ***Hideshi Miura***, *Kyushu University, Fukuoka, Japan*, ***Toshiaki Uematsu***, *Hamamatsu Technical Support Center Industrial Research Institute of Shizuoka Prefecture, Hamamatsu, Japan*, ***Toshiko Osada***, *Kyushu University, Fukuoka, Japan*, ***Kenji Sato***, *Hamamatsu Technical Support Center Industrial Research Institute of Shizuoka Prefecture, Hamamatsu, Japan*

Effect of Particle Size on the Processing Parameters and Properties of Compacts by Micro MIM
JSME Technical Publication. MSEC_ICMP2008-72321
-***Toshiko Osada, Hideshi Miura***, *Kyushu University, Fukuoka, Japan*

High Strengthened and Texture-Controlled P/M Magnesium Alloys And Their Isotropic Tensile Properties
JSME Technical Publication. MSEC_ICMP2008-72007
-***Katsuyoshi Kondoh***, *Osaka University, Ibaragi, Japan*

2-13 -ENERGY FIELD MANUFACTURING

2-13-3 -Laser Shock Peening (ASME & JSME Technical Papers)

WildCat A (Room 101A) 3:30pm - 5:00pm

Session Chair: **Yuebin Guo**, *Univ. of Alabama, Tuscaloosa, AL, United States*
Session Co-Chair: **Benxin Wu**, *Illinois Institute of Technology, Chicago, IL, United States*

Fabrication and Finite Element Analysis of Micro Dents Using u-Laser Shock Peening
ASME Technical Publication. MSEC_ICMP2008-72231
-***Michael Sealy***, *The University of Alabama, Tuscaloosa, AL, United States*, ***Y.B. Guo***, *The Univ. of Alabama, Tuscaloosa, AL, United States*, ***M.F. Horstemeyer***, *Mississippi State University, Starkville, MS, United States*

A Parametric Study on Overlapping Laser Shock Peening on 4140 Steel via Modeling and Experiments
ASME Technical Publication. MSEC_ICMP2008-72259
-***Yunfeng Cao***, *Purdue University, W. Lafayette, IN, United States*, ***Yung Shin***, *Purdue University, West Lafayette, IN, United States*, ***Benxin Wu***, *Illinois Institute of Technology, Chicago, IL, United States*

Spatially Resolved Characterization of Geometrically Necessary Dislocation Dependent Deformation in Micro-Scale Laser Shock Peening
ASME Technical Publication. MSEC_ICMP2008-72514
-***Youneng Wang, Sinisa Vukelic, Jeffrey W. Kysar, Y. Lawrence Yao***, *Columbia University, New York, NY, United States*

TK 4 Micro and Nano Technologies

Track Chair: **Gloria Wiens**, *University of Florida, Gainesville, FL, United States*

4-2 -ADVANCES IN MECHANICAL MICROMACHINING

4-2-1 -Advances in Mechanical Micromachining (ASME Technical Papers)

Armadillo (Room 208) 3:30pm - 5:00pm

Session Chair: **J.Rhett Mayor**, *Georgia Institute of Technology, Atlanta, GA, United States*
Session Co-Chair: **Takayuki Shibata**, *Toyohashi University of Technology, Toyohashi, Aichi, Japan*

Effect of Carbon Nanotube (CNT) Loading on the Thermo-Mechanical Properties and the Machinability of CNT-Reinforced Polymer Composites
ASME Technical Publication. MSEC_ICMP2008-72028
-***Johnson Samuel, Ashutosh Dikshit***, *University of Illinois at Urbana Champaign, Urbana, IL, United States*, ***Shiv Kapoor***, *University of Illinois at Urbana-Champaign, Urbana, IL, United States*, ***Richard E. DeVor, Jimmy K. Hsia***, *University of Illinois at Urbana Champaign, Urbana, IL, United States*

Wear Signal Measurement of Micro-End Mill using Wavelet Analysis
ASME Technical Publication. MSEC_ICMP2008-72121
-***Jeong-Bin Park, Yeong-Seon Hong, Jin-Woong Kim, Jun-Cheol Yeo, Kyung-Tae Lee***, *Seoul National University, Seoul, Seoul, Korea (Republic)*, ***Jae-Seuk Park***, *NEO Technical System CO., LTD., Gyeonggi-Do, Korea (Republic)*, ***Young-Man Cho, Sung-Hoon Ahn***, *Seoul National University, Seoul, Korea (Republic)*

Micro Ultrasonic Machining Using Oil Based Abrasive Slurry
ASME Technical Publication. MSEC_ICMP2008-72138
-***Murali Sundaram, Sreenidhi Cherku, K.P. Rajurkar***, *University of Nebraska-Lincoln, Lincoln, NE, United States*

Investigation of Optimal Parameter Space for High-Speed, High-Precision Micromilling
ASME Technical Publication. MSEC_ICMP2008-72262
-***J.Rhett Mayor, Angela Sodemann****, Georgia Institute of Technology, Atlanta, GA, United States*

Molecular Dynamics Simulation of Nanometric Machining Under Realistic Cutting Conditions
ASME Technical Publication. MSEC_ICMP2008-72533
-***Rapeepan Promyoo, Hazim El-Mounayri****, IUPUI, Indianapolis, IN, United States*, ***Xiaoping Yang****, Cummins Inc., Columbus, IN, United States*

4-8 -ULTRA-PRECISION AND MICRO/NANO FORMING OF MATERIALS

4-8-3 -Ultra-Precision and Micro/Nano Forming of Materials III (ASME & JSME Technical Papers)

Big Ten (Room 104) 3:30pm - 5:00pm

Session Chair: **Brad Kinsey***, University of New Hampshire, Durham, NH, United States*
Session Co-Chair: **Ri-ichi Murakami***, The University of Tokushima, Tokushima, Japan*

Laser Forming of Single Crystalline Silicon
JSME Technical Publication. MSEC_ICMP2008-72152
-***Masaaki Otsu, Jumpei Oka, Kazuki Takashima****, Kumamoto University, Kumamoto, Japan*

Laser Forming of Thin Film Metallic Glass
JSME Technical Publication. MSEC_ICMP2008-72153
-***Masaaki Otsu, Yuki Ide****, Kumamoto University, Kumamoto, Japan*, ***J. Sakurai, Seiichi Hata****, Tokyo Institute of Technology, Yokohama, Japan*, ***Kazuki Takashima****, Kumamoto University, Kumamoto, Japan*

Characteristic Behavior of Nanoimprint of Pt-based Metallic Glass
JSME Technical Publication. MSEC_ICMP2008-72418
-***Yasunori Saotome****, Tohoku University, Sakai, Osaka, Japan*, ***Yasuyuki Fukuda****, Graduate Student, Gunma University, Kiryu, Gunma, Japan*, ***Hisamichi Kimura, Akihisa Inoue****, Tohoku University, Sendai, Miyagi, Japan*

TK 6 Other Conference Events

Track Chair: **John T. Roth***, Penn State Erie, The Behrend College, Erie, PA, United States*

6-3 -STUDENT EVENTS

6-3-2 -Student Design Manufacturing Competition II

Rock (Room 207) 3:30pm - 5:00pm

Three Cylindrical Die Forced Thru-Feed Spline Rolling Adaptation
Student Presentation. MSEC_ICMP2008-72617
-***David Willens****, Worcester Polytechnic Institute, United States*

Automated Manufacturing of a Rocket Candy Dispenser
Student Presentation. MSEC_ICMP2008-72618
-***Christina Laskowski****, Rensselaer Polytechnic Institute, Troy, NY, United States*

Experimental Analysis of Die Wear
Student Presentation. MSEC_ICMP2008-72619
-***Rui Zhou****, Northwestern University, United States*

"Wax Me Up": Portable Ski Waxer
Student Presentation. MSEC_ICMP2008-72620
-***Todd Spitz****, Columbia University, United States*

THURSDAY
OCTOBER 9, 2008

THURSDAY 8:30 – 10:00 AM

TK 1 Materials

Track Chair: **Hiroshi Asanuma**, *Chiba University, Chiba, Japan*

1-1 -POLYMER AND POLYMER MATRIX COMPOSITES

1-1-1 -Polymer and Polymer Matrix Composites I (ASME Technical Papers)

WildCat B (Room 101B) 8:30am - 10:00am

Session Chair: **Emmanuelle Reynaud**, *University of Massachusetts Lowell, Lowell, MA, United States*
Session Co-Chair: **Takashi Yokoyama**, *Okayama University of Science, Okayama, Okayama, Japan*

Modeling the Flow and Distribution of Nanaoparticles in Friction Stir Processed Polymeric Composite Materials
ASME Technical Publication. MSEC_ICMP2008-72049
-***Yong Gan***, *University of Toledo, Toledo, OH, United States*

Numerical and Experimental Study on the Injection Moulding of a Thin-Wall Complex Part
ASME Technical Publication. MSEC_ICMP2008-72196
-***Catalin Fetecau***, *Dunarea de Jos University of Galati, Galati, Galati, Romania*, ***Ion Postolache***, *Universitatea Dunarea de Jos din Galati, Galati, Galati, Romania*, ***Felicia STAN***, *Dunarea de Jos University of Galati, Galati, Romania*

Improved Performance of Polymethyl Methacrylate for Minimally Invasive Orthopedic Implants
ASME Technical Publication. MSEC_ICMP2008-72466
-***Megan Schroeder, Steven Schmid***, *University of Notre Dame, Notre Dame, IN, United States*

Meso-Macro Imulations of Textile Composite Forming
ASME Technical Publication. MSEC_ICMP2008-72382
-***Philippe Boisse***, *INSA de Lyon, Lyon, France*, ***Nahiene Hamila***, *INSA de Lyon, France*, ***Sylvain Chatel***, *EADS IW, Suresnes, France*

TK 2 Processing

Track Chair: **Brad Kinsey**, *University of New Hampshire, Durham, NH, United States*
Track Co-Chair: **Jaime Camelio**, *Virginia Tech, Blacksburg, VA, United States*

2-5 -COATING AND THERMAL SPRAYING

2-5-1 -Coating and Thermal Spraying I (ASME & JSME Technical Papers)

WildCat A (Room 101A) 8:30am - 10:00am

Session Chair: **Kazuhiko Sakaki**, *Shinshu University, Nagano, Japan*
Session Co-Chair: **Masahiro Fukumoto**, *Toyohashi University of Technology, Toyohashi, Japan*

Influence of the Expansion Ratio of the Gun Nozzle and Gas Pressure on Properties of Cold Sprayed Copper Coatings
JSME Technical Publication. MSEC_ICMP2008-72015
-***Kazuhiko Sakaki***, *Shinshu University, Nagano, Japan*, ***Kazuya Takeda, Koichi Takada***, *Graduate School, Shinshu University, Nagano, Japan*, ***Takashi Hosono, Yasuo Shimizu***, *Shinshu University, Nagano, Japan*

Deposition of Copper Fine Particle onto Metallic Substrate in Cold Spray Process
JSME Technical Publication. MSEC_ICMP2008-72044
-***Masahiro Fukumoto***, *Toyohashi University of Technology, Toyohashi, Japan*, ***H. Terada, M. Mashiko***, *Toyohashi Univ. of Technology, Toyohashi, Japan*, ***Kazunori Sato***, *Toyohashi University of Technology, Aichi, Japan*, ***Motohiro Yamada***, *Toyohashi University of Technology, Toyohashi, Japan*, ***E. Yamaguchi***, *Shintobrator, Ltd., Toyokawa, Japan*

Fabrication of Titanium Dioxide Photocatalyst Coatings by Cold Spray
JSME Technical Publication. MSEC_ICMP2008-72312
-***Motohiro Yamada***, *Toyohashi University of Technology, Toyohashi, Japan*, ***Kazunori Sato, Yuko Kandori***, *Toyohashi University of Technology, Aichi, Japan*, ***Masahiro Fukumoto***, *Toyohashi University of Technology, Toyohashi, Japan*

Fabrication of Yttria-stabilized Zirconia Thin Film under Room Temperature and Atmospheric Pressure Condition
JSME Technical Publication. MSEC_ICMP2008-72316
-***T. Sone, K. Sato, K. Yashiro, Kazuhiro Ogawa, T. Kawada, T. Kuriyagawa, T. Hashida, J. Mizusaki****, Tohoku University, Sendai, Miyagi, Japan*

2-9 -INNOVATIVE CUTTING TOOL TECHNOLOGIES FOR MODERN MACHINING CHALLENGES

2-9-1 -Tool Wear and Process Monitoring (ASME Technical Papers)

Arch (Room 206) 8:30am - 10:00am

Session Chair: **Daniel Waldorf***, California Polytechnic State University, San Luis Obispo, CA, United States*
Session Co-Chair: **Anna Araujo***, Centros Federais de Educação Tecnológica, Rio de Janeiro, Brazil*

Microstructure and Material Analysis of Worn WC-Co Ball-End Mills
ASME Technical Publication. MSEC_ICMP2008-72366
-***Hsin-Yu Kuo****, University of Michigan, Ann Arbor, MI, United States*, ***Kevin Meyer, Roger Lindle, Howard Weaver****, GE aviation, Cincinnati, OH, United States*, ***Jun Ni****, University of Michigan, Ann Arbor, MI, United States*

Dry Machining Using Vortex-Tube Generated Cold Air as Coolant: A Literature Review
ASME Technical Publication. MSEC_ICMP2008-72469
-***Ben Cong, ZJ Pei****, Kansas State University, Manhattan, KS, United States*

A Low Cost Wireless Tool Tip Vibration Sensor for Milling
ASME Technical Publication. MSEC_ICMP2008-72492
-***Christopher Suprock, Robert B Jerard, Barry K Fussell, Raed Hassan****, University of New Hampshire, Durham, NH, United States*

A Comparability Study of a Wireless Electret Accelerometer to a Traditional Piezoelectric Accelerometer
ASME Technical Publication. MSEC_ICMP2008-72513
-***Joshua J. Jones****, Penn State Erie, The Behrend College, Pittsburgh, PA, United States*, ***Timothy A. McNeal****, Penn State Erie, The Behrend College, Erie, PA, United States*, ***Wesley A. Salandro****, Penn State Erie, The Behrend College, Latrobe, PA, United States*, ***John T. Roth****, Penn State Erie, The Behrend College, Erie, PA, United States*, ***Christopher A. Suprock, Barry K Fussell****, University of New Hampshire, Durham, NH, United States*

TK 3 Properties and Applications

Track Chair: **Ikuo Ihara***, Nagaoka University of Technology, Nagaoka, Niigata, Japan*

3-3 -CONTACT SURFACE MECHANICS, FRACTURE AND FRACTURE RELIABILITY

3-3-1 -Contact Surface Mechanics, Fracture and Fracture Reliability I (ASME & JSME Technical Papers)

Rock (Room 207) 8:30am - 10:00am

Session Chair: **Yuebin Guo***, Univ. of Alabama, Tuscaloosa, AL, United States*
Session Co-Chair: **Kenji Kaneko***, Tokyo University of Science, Tokyo, Japan*

Ultrasonic Detection of Invisible Fatigue Crack Initiated at Bolted Joints of Aluminum Alloy Plates
JSME Technical Publication. MSEC_ICMP2008-72038
-***Sanat Wagle, Hiroshi Kato****, Saitama university, Saitama, Saitama, Japan*

Mechanism of Reduction of Fretting Fatigue Limit in Hydrogen Gas Environment
JSME Technical Publication. MSEC_ICMP2008-72112
-***Masanobu Kubota, Yoshiyuki Kondo****, Kyushu University, Fukuoka, Fukuoka, Japan*, ***Kyohei Kuwada****, Graduate School of Kyushu University, Fukuoka, Fukuola, Japan*, ***Yasuhiro Tanaka****, Graduate School oh Kyushu University, Fukuoka, Fukuoka, Japan*

Effect of Contact Pad Foot Height and Width on Fretting Fatigue Behavior of Turbine Steel
JSME Technical Publication. MSEC_ICMP2008-72320

-***Jayaprakash Murugesan, Yoshiharu Mutoh***, *Nagaoka University of Technology, Nagaoka, Niigata, Japan*, ***Kunio Asai***, *Materials Research Laboratory, Hitachi, Ltd., Hitachi-Shi, Ibaraki-Ken, Japan*, ***Kunihiro Ichikawa***, *Hitachi Ltd., Hitachi- shi, Ibaraki-ken, Japan*

Mechanical Considerations of Fretting Fatigue Strength & Life
JSME Technical Publication. MSEC_ICMP2008-72480

-***Toshio Hattori***, *Gifu University, Gifu, Japan*, ***Minoru Yamashita***, *Gifu-University, Gifu, Japan*, ***Naoya Nishimura***, *Meijo University, Nagoya, Aichi, Japan*, ***Vu Kien***, *Gifu University, Gifu, Gifu, Japan*

The Basic Relationship between Machining Induced Residual Stress Profiles and Fatigue Life
ASME Technical Publication. MSEC_ICMP2008-72229

-***Y.B. Guo***, *The Univ. of Alabama, Tuscaloosa, AL, United States*, ***Andrew W. Warren***, *The University of Alabama, Tuscaloosa, AL, United States*

3-4 -SURFACE MODIFICATION TECHNIQUES, WEAR AND TRIBOLOGY

3-4-1 -Manufacturing Process and Surface Modification (ASME & JSME Technical Papers)

Northwestern B (Room 202B) 8:30am - 10:00am

Session Chair: **Akira Azushima**, *Yokohama National University, Yokohama, Japan*
Session Co-Chair: **Prakash K. Brahmankar**, *Dr. Babasaheb Ambedkar Technological University, Dist. Raigad, Maharashtra, India*

A Metallic Foil Thinning Process Using An Indirect Shot Blasting Technique
JSME Technical Publication. MSEC_ICMP2008-72240

-***Ken Yamashita, Ryo Katsube***, *Nagaoka University of Technology, Nagaoka, Japan*, ***Masayoshi Ogata, Tohru Matsubara***, *MACOHO Co.,Ltd., Nagaoka, Niigata, Japan*, ***Shigeru Nagasawa, Yasushi Fukuzawa***, *Nagaoka University of Technology, Nagaoka, Niigata, Japan*

In Situ Observation Of Dynamic Chemical Changes Of ZNDTP On Metal Friction Surfaces
JSME Technical Publication. MSEC_ICMP2008-72009

-***Keiji Sasaki, Naruhiko Inayoshi***, *DENSO, Kariya-shi, Aichi, Japan*, ***Kohji Tashiro***, *Toyota Technological Institute, Nagoya, Japan*

Micro-Features Formation in Injection Compression Molding
JSME Technical Publication. MSEC_ICMP2008-72055

-***Hiroshi Ito, Hajime Suzuki***, *Yamagata University, Yamagata, Japan*

TK 4 Micro and Nano Technologies

Track Chair: **Gloria Wiens**, *University of Florida, Gainesville, FL, United States*

4-6 -DEVELOPMENT AND APPLICATIONS OF MICRO MANUFACTURING EQUIPMENT

4-6-1 -Development and Applications of Micro Manufacturing Equipment I (ASME Technical Papers)

Northwestern A (Room 202A) 8:30am - 10:00am

Session Chair: **Xiaochun Li**, *University of Wisconsin-Madison, Madison, WI, United States*
Session Co-Chair: **Ming Yang**, *Tokyo Metropolitan University, Tokyo, Japan*

Prototyping of Electric Tweezer-type Soldering Iron Device with Flexible Fingers for SMD
ASME Technical Publication. MSEC_ICMP2008-72067

-***Hiroki Ando***, *Nagoya University, Nagoya, Aichi, Japan*, ***Takahiko Murakami***, *Mitsubishi Electric Corporation, Nagoya, Aichi, Japan*, ***Naoki Muramatsu***, *Nagoya University, Nagoya, Aichi, Japan*

Application of an Accuracy Enhancement Module for Precision Machine Tools by Spatial Error Compensation
ASME Technical Publication. MSEC_ICMP2008-72177
-***Fu-Chuan Hsu***, *Metal Industries Research & Development Centre (MIRDC), Kaohsiung, Taiwan*, ***Cheng-Chang Chiu***, *Metal Industries Research and Development Centre (MIRDC), Kaohsiung, Taiwan*, ***Wen-Long Chang, Yu-Ting Lyu***, *Metal Industries Research & Development Centre (MIRDC), Kaohsiung, Taiwan*, ***Y. Y. Liao***, *National Cheng Kung University, Tainan, Taiwan*, ***J. J. Wang***, *National Cheng Kong University, Tainan City, Taiwan*, ***Steven Liang***, *Manufacturing Research Center (MaRC), Georgia Institute of Technology, Atlanta, GA, United States*

Electrospun Nanocomposites as Flexible Sensors
ASME Technical Publication. MSEC_ICMP2008-72475
-***Manish K. Tiwari, Alexander L. Yarin, Constantine M. Megaridis***, *University of Illinois at Chicago, Chicago, IL, United States*

Embedding of Micro Thin Film Sensors Into Polycrystaline Cubic Boron Nitride (PCBN) for Potential Tooling Applications Via Diffusion Bonding
ASME Technical Publication. MSEC_ICMP2008-72504
-***Dirk Werschmoeller, Xiaochun Li***, *University of Wisconsin-Madison, Madison, WI, United States*

Numerical Study and Scale Analysis of Inner and Outer Diameters Prediction in Fabrication of Hollow Fiber Membranes for Nerve Regeneration
ASME Technical Publication. MSEC_ICMP2008-72243
-***Jun Yin, Nicole Coutris, Yong Huang***, *Clemson University, Clemson, SC, United States*

Study of Structured Porogen Method for Bone Scaffold Fabrication
ASME Technical Publication. MSEC_ICMP2008-72134
-***Lin Lu, Jack G. Zhou, Peter Lelkes***, *Drexel University, Philadelphia, PA, United States*, ***David Wootton***, *Cooper Union, New York, NY, United States*

Ink-Jet as a Manufacturing Method for Drug Delivery Applications
ASME Technical Publication. MSEC_ICMP2008-72248
-***Bogdan V. Antohe, David B. Wallace***, *MicroFab Technologies, Inc., Plano, TX, United States*

Mechanical Properties of PDMS and Influences by Micromachining Processes
ASME Technical Publication. MSEC_ICMP2008-72296
-***Jianren Sun, Christopher Bock, Quanfang Chen***, *University of Central Florida, Orlando, FL, United States*

TK 5 Biological Technologies

Track Chair: **Wei Sun**, *Drexel University, Philadelphia, PA, United States*

5-2 -MANUFACTURING PROCESSES FOR BIOMEDICAL APPLICATIONS: THEORY, APPLICATIONS AND EDUCATION

5-2-1 -Advanced Manufacturing Processes for Biomedical Applications (ASME Technical Papers)

Armadillo (Room 208) 8:30am - 10:00am

Session Chair: **Yong Huang**, *Clemson University, Clemson, SC, United States*
Session Co-Chair: **David B. Wallace**, *MicroFab Technologies, Inc., Plano, TX, United States*

TK 6 Other Conference Events

Track Chair: **John T. Roth**, *Penn State Erie, The Behrend College, Erie, PA, United States*

6-3 -STUDENT EVENTS

6-3-3 -Career Planning Panel for Students

Big Ten (Room 104) 8:30am - 10:00am

THURSDAY 10:30 – 12:00 PM

TK 1 Materials

Track Chair: **Hiroshi Asanuma**

1-1 -POLYMER AND POLYMER MATRIX COMPOSITES

1-1-2 -Polymer and Polymer Matrix Composites II (JSME Technical Papers)

WildCat B (Room 101B) 10:30am - 12:00pm

Session Chair: **Emmanuelle Reynaud**, *University of Massachusetts Lowell, Lowell, MA, United States*
Session Co-Chair: **Shinji Ogihara**, *Tokyo University of Science, Noda, Japan*

Formulation of Time-Temperature Dependent Strength of Unidirectional CFRP
JSME Technical Publication. MSEC_ICMP2008-72339
-***Sho Yamashiro***, *Kanazawa Institute of Technology, Nonoichi, Japan*, ***Hongneng Cai, Masayuki Nakada, Yasushi Miyano***, *Kanazawa Institute of Technology, Hakusan, Japan*

Influence of Temperature and Water Absorption on static strengths for Unidirectional CFRP
JSME Technical Publication. MSEC_ICMP2008-72340
-***Masahiko Murata***, *Kanazawa Institute of Technology, Nonoichi, Japan*, ***Masayuki Nakada, Yasushi Miyano***, *Kanazawa Institute of Technology, Hakusan, Japan*

Effect of Physical aging on Creep Behavior of Carbon Fiber Reinforced Polyimide
JSME Technical Publication. MSEC_ICMP2008-72483
-***Satoshi Somiya, Reiji Nakamura***, *Keio University, Yokohama, Japan*

Experimental Study on Effects of Elastomer Coating on the Vibration-Damping Property of Steel and CFRP Plates for Ship`s Hull
JSME Technical Publication. MSEC_ICMP2008-72039
-***Shigemitu Kurano***, *Technical Research & Development Institute The Ministry of Japan Defense, Tokyo, Japan*

TK 2 Processing

Track Chair: **Brad Kinsey**, *University of New Hampshire, Durham, NH, United States*
Track Co-Chair: **Jaime Camelio**, *Virginia Tech, Blacksburg, VA, United States*

2-1 -PLASTIC FORMING OF METALS

2-1-1 -Plastic Forming of Metals: Analytical & Experimental Modeling I (ASME Technical Papers)

Big Ten (Room 104) 10:30am - 12:00pm

Session Chair: **Cedric Xia**, *Ford Motor Company, Dearborn, MI, United States*
Session Co-Chair: **Motoo Asakawa**, *Department of Applied Mechanics and Aerospace Engineering, Waseda University, Tokyo, Japan*

Single- and Multi-Stand Chatter Models for Tandem Rolling Mills
ASME Technical Publication. MSEC_ICMP2008-72530
-***Huyue Zhao***, *Argonne National Laboratory, Argonne, IL, United States*, ***Kornel Ehmann***, *Northwestern University, Evanston, IL, United States*

The Effect of Model Parameters on Predicted Stress Based Failure Criterion for Sheet Metal
ASME Technical Publication. MSEC_ICMP2008-72136
-***Brad Kinsey, Matthew Derov, Igor Tsukrov***, *University of New Hampshire, Durham, NH, United States*

Analytical Model for the Characterization of the Guiding Zone Tribotest for Tube Hydroforming
ASME Technical Publication. MSEC_ICMP2008-72250
-***Gracious Ngaile***, *North Carolina State University, Raleigh, NC, United States*, ***Chen Yang***, *North Carolina State University, Raleigh, NC, United States*

Mathematical Modeling and Finite Element Simulation of Pre-bending Stage of Three-Roller Plate Bending Process
ASME Technical Publication. MSEC_ICMP2008-72454
-***A. H. Gandhi***, *C. K. Pithawalla College of Engineering & Technology,, Surat, India*, ***H. V. Gajjar***, *Larsen & Toubro Ltd., Surat, India*, ***H. K. Raval***, *Sardar Vallabhbhai National Institute of Technology, Surat, GUJARAT, India*

2-5 -COATING AND THERMAL SPRAYING

2-5-2 -Coating and Thermal Spraying II (ASME & JSME Technical Papers)

WildCat A (Room 101A) 10:30am - 12:00pm

Session Chair: **Masahiro Fukumoto**, *Toyohashi University of Technology, Toyohashi, Japan*
Session Co-Chair: **Yuebin Guo**, *Univ. of Alabama, Tuscaloosa, AL, United States*

Improving the Surface Roughness of a CVD Coated Silicon Carbide Disk by Performing Ductile Regime Single Point Diamond Turning
ASME Technical Publication. MSEC_ICMP2008-72145
-***Deepak Ravindra, John Patten***, *Western Michigan University, Kalamazoo, MI, United States*

Surface Integrity of End Milled TI-6AL-4V using the TIAIN Coated Tool
ASME Technical Publication. MSEC_ICMP2008-72234
-***Jie Sun***, *Shandong University, Jinan, Shandong Province, China*, ***Y.B. Guo***, *The Univ. of Alabama, Tuscaloosa, AL, United States*

Stress Histories of Yttria-Stabilized Zirconia and CoNiCrAlY Coatings during Thermal Spraying
JSME Technical Publication. MSEC_ICMP2008-72179
-***Hiroyuki Waki***, *Osaka Electro-Communication University, Dept. Mechanical Engineering, Neyagawa-shi, Osaka, Japan*, ***Akira Kobayashi***, *Osaka University, Joining and Welding Research Institute, Ibaraki-shi, Osaka, Japan*

Difference in High-Temperature Oxidation Behavior Between Cold-Sprayed and Low-Pressure Plasma-Sprayed Mcraly Coating
JSME Technical Publication. MSEC_ICMP2008-72536
-***Yuji Ichikawa, Kazuhiro Ogawa, Tetsuo Shoji***, *Tohoku University, Sendai, Japan*

2-9 -INNOVATIVE CUTTING TOOL TECHNOLOGIES FOR MODERN MACHINING CHALLENGES

2-9-2 -New Cutting Tool Technologies (ASME Technical Papers)

Arch (Room 206) 10:30am - 12:00pm

Session Chair: **James J. Mason**, *Zimmer Inc, Warsaw, IN, United States*
Session Co-Chair: **Raja Kountanya**, *Diamond Innovations, Columbus, OH, United States*

Alternative Binder Carbide Tools for Machining Superalloys
ASME Technical Publication. MSEC_ICMP2008-72369
-***Daniel Waldorf***, *California Polytechnic State University, San Luis Obispo, CA, United States*, ***Scott Liu***, *Genius Metal Inc., Monrovia, CA, United States*, ***Michael Stender, Daniel Norgan***, *California Polytechnic State University, San Luis Obispo, CA, United States*

Crater Wear Patterns and Evolution on Multi-Layer Coated Carbides Using The Wavelet Transform
ASME Technical Publication. MSEC_ICMP2008-72402
-***Jorge Olortegui-Yume***, *Michigan State University, East Lansing, MI, United States*, ***Moon Chul Yoon***, *Pukyong National University, Busan, Korea (Republic)*, ***Patrick Kwon***, *Michigan State University, East Lansing, MI, United States*

Experimental Investigation on Diamond Drilling of Potassium Di-Hydrogen Phosphate (KDP) Crystal
ASME Technical Publication. MSEC_ICMP2008-72489
-***Qiangguo Wang, ZJ Pei***, *Kansas State University, Manhattan, KS, United States*, ***Hang Gao***, *Dalian University of Technology, Dalian, China*, ***Nikhil Churi***, *Kansas State Univ, Manhattan, KS, United States*, ***Renke Kang***, *Dalian University of Technology, Dalian, Liaoning, China*

Numerical Simulations of 3D Tool Geometry Effects on Deposition Stresses in Diamond Coated Cutting Tools
ASME Technical Publication. MSEC_ICMP2008-72204
-***Anderson Renaud, Jianwen Hu, Feng Qin***, *UA, Tuscaloosa, AL, United States*, ***Kevin Chou***, *The University of Alabama, Tuscaloosa, AL, United States*

TK 3 Properties and Applications

Track Chair: **Ikuo Ihara**, *Nagaoka University of Technology, Nagaoka, Niigata, Japan*

3-3 -CONTACT SURFACE MECHANICS, FRACTURE AND FRACTURE RELIABILITY

3-3-2 -Contact Surface Mechanics, Fracture and Fracture Reliability II (ASME & JSME Technical Papers)

Rock (Room 207) 10:30am - 12:00pm

Session Chair: **Felicia Stan**, *Dunarea de Jos University of Galati, Galati, Romania*
Session Co-Chair: **Toshio Hattori**, *Gifu University, Gifu, Japan*

Effect of an Interlayer on the Free-Edge Singular Stress Field of Bonded Dissimilar Materials
JSME Technical Publication. MSEC_ICMP2008-72154
-***Seiji Ioka, Shiro Kubo***, *Osaka University, Suita, Japan*

Study on Adhesive Strength Criterion under Complex Stresses
JSME Technical Publication. MSEC_ICMP2008-72350
-***Kenji Kaneko***, *Tokyo university of science, Tokyo, Japan*

Molten-shape Prediction and Fracture-life Evaluation of Micro-solder Joint in Semiconductor Structure
JSME Technical Publication. MSEC_ICMP2008-72525
-***Hisashi Tanie***, *Hitachi, Ltd., Hitachinaka, Ibaraki, Japan*

Study of the Dynamic Crack Growth of a Planar Crack Front in Three-Dimensional Body Subjected to Mode I Loading
ASME Technical Publication. MSEC_ICMP2008-72239
-***Felicia Stan***, *Dunarea de Jos University of Galati, Galati, Romania*

3-4 -SURFACE MODIFICATION TECHNIQUES, WEAR AND TRIBOLOGY

3-4-2 -Thin Films and Tribology I (ASME & JSME Technical Papers)

Northwestern B (Room 202B) 10:30am - 12:00pm

Session Chair: **Hiroshi Ito**, *Yamagata University, Yamagata, Japan*
Session Co-Chair: **Naoto Ohtake**, *Nagoya University, Nagoya, Aichi, Japan*

Wear Resistance of AISI316L Steel Modified by Pre-FPP Treated DLC Coating.
JSME Technical Publication. MSEC_ICMP2008-72226
-***Hiroshi Nanbu, Shoichi Kikuchi***, *KEIO University, Yokohama-shi, Kanagawa, Japan*, ***Yutaka Kameyama***, *RIKEN Material Fabrication Laboratory, Wakou-shi, Saitama, Japan*, ***Jun Komotori***, *KEIO University, Yokohama-shi, Kanagawa, Japan*

Tribological Properties of Segment-structured DLC Films Coated on Stainless Steel Substrate
JSME Technical Publication. MSEC_ICMP2008-72435
-***Tsuyoshi Kuroda, Mai Takashima, Naoto Ohtake, Osamu Takai***, *Nagoya university, Nagoya, Aichi, Japan*

Development of Antiwear Shim Inserts Utilizing Segment-Structured DLC Coatings
JSME Technical Publication. MSEC_ICMP2008-72442
-***Mai Takashima, Tsuyoshi Kuroda***, *Nagoya University, Nagoya, Japan*, ***Masanori Saito***, *Tokyo Institute of Technology, Tokyo, Japan*, ***Naoto Ohtake***, *Nagoya University, Nagoya, Aichi, Japan*, ***Makoto Matsuo***, *iMott Inc., Yokohama, Kanagawa, Japan*, ***Yoshinao Iwamoto***, *iMott Inc, Yokohama, Kanagawa, Japan*, ***Masao Kumagai, Makoto Kano***, *Kanagawa Industrial Technology Center, Ebina, Kanagawa, Japan*, ***Hiroshi Kimoto***, *Kobe Material Testing Laboratory, Hitachi, Ibaraki, Japan*, ***Masaru Shinohara***, *KURITA SEISAKUSYO Co., Ltd., Tsuzuki-Gun, Kyoto, Japan*

Frictional Properties of Titanium-Boron-Niteride Coatings with Preferred Grain Orientation Deposited by AIP Under Dry Condition
JSME Technical Publication. MSEC_ICMP2008-72524
-***Yasuo Tanno***, *Sumitmo Heavy Industries Ltd., Yokosuka, Japan*, ***Akira Azushima***, *Yokohama National University, Yokohama, Japan*

TK 4 Micro and Nano Technologies

Track Chair: **Gloria Wiens**, *University of Florida, Gainesville, FL, United States*

4-6 -DEVELOPMENT AND APPLICATIONS OF MICRO MANUFACTURING EQUIPMENT

4-6-2 -Development and Applications of Micro Manufacturing Equipment II (ASME Technical Papers)

Northwestern A (Room 202A) 10:30am - 12:00pm

Session Chair: **Ming-Chyuan Lu**, *National Chung Hsing University, Taichung, Taiwan*
Session Co-Chair: **Seiichi Hata**, *Tokyo Institute of Technology, Yokohama, Kanagawa, Japan*

Determination of Cutting Forces for Micro Milling
ASME Technical Publication. MSEC_ICMP2008-72532
-***Shih-Ming Wang***, *ME Dept., Chung- Yuan Christian University, Chung-Li, Taiwan*, ***Zou-Sung Chiang***, *Chung Yuan Christian University, Taiwan, Chung-Li, Taiwan*, ***Da-Fun Chen***, *Chung Yuan Christian Univ, Chung-Li, Taiwan*

Development of a PC-based Millimeter Scale CNC Turning Centre with Gear Hobbing Capability
ASME Technical Publication. MSEC_ICMP2008-72311
-***Shiqing Liu, Sunny Chan, Ho Ching, Tom Ching Kong, Ruxu Du***, *Institute of Precision Engineering, The Chinese University of Hong Kong, Hong Kong, China*

A Mesoscale Micro-Turning Machine with Modular Linear Air-Bearing Stages
ASME Technical Publication. MSEC_ICMP2008-72380
-***Seung-Kook Ro, Sung-Kweon Jang***, *Korea Institute of Machinery & Materials, Daejeon, Korea (Republic)*, ***Jong-Kweon Park,*** *Korea Institute of Machinery & Materials, Daejeon, Korea (Republic)*

Experimental Study of Sound Signal for Tool Condition Monitoring in Micro Milling Processes
ASME Technical Publication. MSEC_ICMP2008-72181
-***Chia-Liang Yen, Ming-Chyuan Lu***, *National Chung Hsing University, Taichung, Taiwan*, ***Ching-Yuan Lin***, *Mechanical and Systems Research Laboratories, Industrial Technology Research Institute, Hsin Chu, Taiwan*, ***Tin-Hong Chen***, *National Chung Hsing University, Taichung, Taiwan*

TK 5 Biological Technologies

Track Chair: **Wei Sun**, *Drexel University, Philadelphia, PA, United States*

5-2 -MANUFACTURING PROCESSES FOR BIOMEDICAL APPLICATIONS: THEORY, APPLICATIONS AND EDUCATION

5-2-2 -Laser-Assisted Manufacturing Processes for Biomedical Applications (ASME Technical Papers)

Armadillo (Room 208) 10:30am - 12:00pm

Session Chair: **Yong Huang**, *Clemson University, Clemson, SC, United States*
Session Co-Chair: **Gary Cheng**, *Purdue University, West Lafayette, IN, United States*

"Experiment, Thermal Simulation and Characterizations on Transmission Laser Coating of Hydroxyapatite on Metal Implant"
ASME Technical Publication. MSEC_ICMP2008-72290
-***Chang Ye***, *Purdue University, West Lafayette, IN, United States*, ***Gary Cheng***, *Purdue University, West Lafayette, IN, United States*

Bubble Formation Modeling In Matrix-Assisted Pulsed-Laser Evaporation Direct Write
ASME Technical Publication. MSEC_ICMP2008-72241
-***Yafu Lin, Kevin Foy, Yong Huang***, *Clemson University, Clemson, SC, United States*, ***Douglas B. Chrisey***

Modeling of Bubble Expansion-Induced Cell Mechanical Profile in Laser-Assisted Cell Direct Writing
ASME Technical Publication. MSEC_ICMP2008-72242
-***Wei Wang, Gang Li, Yong Huang***, *Clemson University, Clemson, SC, United States*

TK 6 Other Conference Events

Track Chair: **John T. Roth**, *Penn State Erie, The Behrend College, Erie, PA, United States*

6-2 -GENERAL MEETINGS AND PLENARY TALKS

6-2-4 -ASME Manufacturing Group Meeting

Evans (Room 102) 10:30am - 12:00pm

THURSDAY 12:00 – 1:15 PM

TK 6 Other Conference Events

Track Chair: **John T. Roth**, *Penn State Erie, The Behrend College, Erie, PA, United States*

6-2 -GENERAL MEETINGS AND PLENARY TALKS

6-2-9 -Thursday Luncheon Speaker

Louis & Lake (Rooms 203 & 205) 12:00pm - 1:15pm

Current Manufacturing Industries in South Asia and R&D in Singapore
Keynote. MSEC_ICMP2008-72624
-***Atsushi Danno***, *Singapore Institute of Manufacturing Technology, Singapore, Singapore*

THURSDAY 1:30 – 3:00 PM

TK 1 Materials

Track Chair: **Hiroshi Asanuma,** *Chiba University, Chiba, Japan*

1-1 -POLYMER AND POLYMER MATRIX COMPOSITES

1-1-3 -Polymer and Polymer Matrix Composites III (JSME Technical Papers)

WildCat B (Room 101B) 1:30pm - 3:00pm

Session Chair: **Emmanuelle Reynaud**, *University of Massachusetts Lowell, Lowell, MA, United States*
Session Co-Chair: **Satoshi Somiya**, *Keio University, Yokohama, Japan*

Variations of Fatigue Damage Growth in Cross-Ply and Quasi-Isotropic Laminates under High-Cycle Fatigue Loading
JSME Technical Publication. MSEC_ICMP2008-72359
-***Atsushi Hosoi***, *Nagoya University, Nagoya, Japan*, ***Narumichi Sato***, *Toray Industries, Inc., Ehime, Japan*, ***Jiadi Shi, Hiroyuki Kawada***, *Waseda University, Tokyo, Japan*

Orientation Dependence of In-Plane Tensile Properties of Paperboard and Linerboard: Application of Composite Theories
JSME Technical Publication. MSEC_ICMP2008-72462
-***Takashi Yokoyama, Kenji Nakai***, *Okayama University of Science, Okayama, Okayama, Japan*

Rheological Aspects to Horizontal Rotational-Forming of Thermoplastic Materials
JSME Technical Publication. MSEC_ICMP2008-72431
-***Petru/A Pop, Petru Ungur, Mircea Veres, Cornelia Gordan***, *University of Oradea, ORADEA, BIHOR, Romania*

Interfacial Strength Evaluation in Glass Fiber Reinforced Composites Using the Cruciform Specimen Method
JSME Technical Publication. MSEC_ICMP2008-72281
-***Shinji Ogihara***, *Tokyo University of Science, Noda, Japan*, ***Hajime Kato***, *Tokyo University of Science, Noda, Japan*

TK 2 Processing

Track Chair: **Brad Kinsey**, *University of New Hampshire, Durham, NH, United States*
Track Co-Chair: **Jaime Camelio**, *Virginia Tech, Blacksburg, VA, United States*

2-1 -PLASTIC FORMING OF METALS

2-1-5 -Plastic Forming of Metals: Processing I (ASME & JSME Technical Papers)

Big Ten (Room 104) 1:30pm - 3:00pm

Session Chair: **Joseph Domblesky**, *Marquette University, Milwaukee, WI, United States*
Session Co-Chair: **Kazuhiko Kitamura**, *Nagoya Institute of Technology, Nagoya, Japan*

Experimental Study On A New Method Of Double Side Incremental Forming
ASME Technical Publication. MSEC_ICMP2008-72279
-***Yongjun Wang***, *Northeastern Polytechnical University, Xi'an, Shaanxi, China*, ***Ying Huang, Jian Cao***, *Northwestern University, Evanston, IL, United States*, ***N Venkata Reddy***, *Indian Institute of Technology Kanpur, Kanpur, India*

Transcription of Roll Surface Texture onto Deformed Mild Steel Sheet in Temper Rolling
JSME Technical Publication. MSEC_ICMP2008-72023
-***Ikuo Yarita***, *Chiba Institute of Technology, Chiba, Japan*, ***Naoki Nagase***, *Idemitsu Kosan Co., Ltd., Ichihara, Japan*

Effect of Lubricating Conditions on Transfer of Roll Surface Texture in Temper Rolling
JSME Technical Publication. MSEC_ICMP2008-72060
-***Naoki Nagase****, Idemitsu Kosan Co., Ltd., Ichihara, Japan*, ***Ikuo Yarita****, Chiba Institute of Technology, Chiba, Japan*

Drawability Improvement of Titanium Wire and Fabrication of Microparts of Medical Applications
JSME Technical Publication. MSEC_ICMP2008-72101
-***Kazunari Yoshida***, ***Masayuki Kojima****, Tokai University, Hiratsuka, Kanagawa, Japan*

2-5 -COATING AND THERMAL SPRAYING

2-5-3 -Coating and Thermal Spraying III (ASME & JSME Technical Papers)

WildCat A (Room 101A) 1:30pm - 3:00pm

Session Chair: **Kazuhiro Ogawa***, Tohoku University, Sendai, Japan*
Session Co-Chair: **Masahiro Fukumoto***, Toyohashi University of Technology, Toyohashi, Japan*

Effect of Bias Voltage on Fatigue Behavior of CrN Film Deposited on Ti-6Al-4V Alloy
ASME Technical Publication. MSEC_ICMP2008-72441
-***Md. Shamimur Rahman****, Graduate School of The University of Tokushima, Tokushima, Japan*, ***Takeshi Katsuma, Daisuke Yonekura, Ri-ichi Murakami****, The University of Tokushima, Tokushima, Japan*

Development of Thermal Barrier Coating System with an Intermediate Layer Containing MoSi2 with Superior Thermal Cyclic Properties
JSME Technical Publication. MSEC_ICMP2008-72528
-***Keiji Sonoya****, Shibaura Institute of Technology, Tokyo, Tokyo, Japan*, ***Shogo Tobe****, Ashikaga Institute of Technology, Ashikaga, Tochigi, Japan*

Tribological Properties of Amorphous Boron Nitride Films Prepared by Nanopulse Plasma CVD
JSME Technical Publication. MSEC_ICMP2008-72550
-***Masanori Saito****, Tokyo Institute of Technology, Tokyo, Japan*, ***Toshiyuki Yasuhara, Hiroya Murakami****, Tokyo Institute of Technology, Meguro-ku, Tokyo, Japan*, ***Naoto Ohtake****, Nagoya University, Nagoya, Aichi, Japan*

2-9 -INNOVATIVE CUTTING TOOL TECHNOLOGIES FOR MODERN MACHINING CHALLENGES

2-9-3 -Machining Issues Related to Tool Design (ASME & JSME Technical Papers)

Arch (Room 206) 1:30pm - 3:00pm

Session Chair: **ZJ Pei***, Kansas State University, Manhattan, KS, United States*
Session Co-Chair: **Christian Fischer***, Scientific Forming Technologies Corporation, Columbus, OH, United States*

Definition of Cutting Conditions for Thin-to-thin Milling of Aerospace Low Rigidity Parts
ASME Technical Publication. MSEC_ICMP2008-72200
-***Francisco J. Campa, Luis N. Lopez de Lacalle, Gorka Urbikain, Daniel Ruiz****, University of the Basque Country, Bilbao, Spain*

Characteristics of Residual Stress Profiles in Hard Turned versus Ground Surfaces with and without a White Layer
ASME Technical Publication. MSEC_ICMP2008-72230
-***Andrew W. Warren****, The University of Alabama, Tuscaloosa, AL, United States*, ***Y.B. Guo****, The Univ. of Alabama, Tuscaloosa, AL, United States*

Implementation of Multirate Estimation for the Cylindrical Grinding Process
ASME Technical Publication. MSEC_ICMP2008-72307
-***Cheol W. Lee****, University of Michigan - Dearborn, Dearborn, MI, United States*

Methods for Improving Chucking Accuracy
ASME Technical Publication. MSEC_ICMP2008-72388
-***Jeongmin Byun****, St. Cloud State University, St. Cloud, MN, United States*, ***Richard Liu****, Purdue University, West Lafayette, IN, United States*

TK 3 Properties and Applications

Track Chair: **Ikuo Ihara**, *Nagaoka University of Technology, Nagaoka, Niigata, Japan*

3-4 -SURFACE MODIFICATION TECHNIQUES, WEAR AND TRIBOLOGY

3-4-3 -Thin Films and Tribology II (ASME & JSME Technical Papers)

Northwestern B (Room 202B) 1:30pm - 3:00pm

Session Chair: **Akira Yanagida**, *Yokohama National University, Yokohama City, Japan*
Session Co-Chair: **Akira Azushima**, *Yokohama Natinal University, Yokohama, Japan*

Wear-Protective Tribofilms Produced by Supplying Oxide Nanoparticles on Rubbing Steel Surfaces
JSME Technical Publication. MSEC_ICMP2008-72021
-***Hirotaka Kato***, *Fukui National College of Technology, Sabae, Japan*

Mechanical Properties and Atomic Structure of Diamond-Like-Carbon Films Fabricated by Unbalanced Magnetron Sputtering
JSME Technical Publication. MSEC_ICMP2008-72317
-***Shinji Fujimoto***, *Matsushita Electric Works, Ltd., Osaka, Osaka, Japan*, ***Naoto Ohtake***, *Nagoya University, Nagoya, Aichi, Japan*

Segment-Structured Diamond-Like Carbon Coatings on Polymer Catheter
JSME Technical Publication. MSEC_ICMP2008-72535
-***Taku Nakagawa***, ***Ryusuke Ohishi***, ***Naoto Ohtake,*** ***Osamu Takai***, *Nagoya University, Nagoya, Aichi, Japan*, ***Nobumasa Tsutsui, Yasuhiro Tsutsui, Yasuhiro Muraki, Jyunpei Ogura***, *Tokai Medical Products, Inc., Kasugai, Japan*

TK 4 Micro and Nano Technologies

Track Chair: **Gloria Wiens**, *University of Florida, Gainesville, FL, United States*

4-5 -MICRO/MESOSCALE MANUFACTURING CHALLENGES IN MATERIAL HANDLING

4-5-2 -International Perspective of the Micro/Mesoscale Manufacturing Material Handling and Fixturing Needs

Northwestern A (Room 202A) 1:30pm - 3:00pm

Session Chair: **Gloria Wiens**, *University of Florida, Gainesville, FL, United States*
Session Co-Chair: **Tim VanRavenswaay**, *Alion Science and Technology, Rockford, IL, United States*

An Micro/Mesoscale Machine Tool Builder's Perspective in Fixturing
Panel. MSEC_ICMP2008-72610
-***Jim Hall***, *Atometric, Inc., Rockford, United States*

Micro-Nano Sensing for Micro/Mesoscale Material Handling and Fixturing
Panel. MSEC_ICMP2008-72611
-***Xiaochun Li***, *University of Wisconsin-Madison, Madison, WI, United States*

Technical Challenges in Micro/Meso Scale Part Fixturing and Handling
Panel. MSEC_ICMP2008-72621
-***S. Melkote***, *Georgia Institute of Technology University, Atlanta, United States*

TK 5 Biological Technologies

Track Chair: **Wei Sun**, *Drexel University, Philadelphia, PA, United States*

5-3 -ADVANCES IN MEDICAL MICRO/NANO MANUFACTURING AND ITS APPLICATIONS

5-3-1 -Advances in Medical Micro/Nano Manufacturing and Its Applications (ASME & JSME Technical Papers)

Armadillo (Room 208) 1:30pm - 3:00pm

Session Chair: **Masa P. Rao**, *Purdue University, West Lafayette, IN, United States*
Session Co-Chair: **Koji Ikuta**, *Nagoya University, Nagoya City, Aichi, Japan*

Desorption-Limited Mechanism of Release from Polymer Nanofibers
ASME Technical Publication. MSEC_ICMP2008-72054
-***Srikar Raman, Alexander L. Yarin, Constantine M. Megaridis, A. V. Bazilevsky***, *University of Illinois at Chicago, Chicago, IL, United States*

Microstructuring and Biofunctionalisation of Alumina Surfaces to Enhance Abrasion Resistance and Suppress Bacterial Biofilm Growth
ASME Technical Publication. MSEC_ICMP2008-72189
-***Laura Treccani***, *University of Bremen, Bioceramics Group, Bremen, Germany*, ***Kurosch Rezwan***, *University of Bremen, Bremen, Germany*

Comparison of Three Microstructure Fabrication Methods for Bone Cell Growth Studies
ASME Technical Publication. MSEC_ICMP2008-72198
-***Marzellus große Holthaus, Kurosch Rezwan***, *University of Bremen, Bremen, Germany*

Development of Membrane Micro Emboss Following Excimer Laser Ablation (MeME-X) Process and its Application to Pressure-Driven Micro Active Catheter
JSME Invited Paper. MSEC_ICMP2008-72405
-***Masashi Ikeuchi***, *Nagoya University, Nagoya, Aichi, Japan*, ***Koji Ikuta***, *Nagoya University, Nagoya City, Aichi, Japan*

THURSDAY 3:30 – 5:00 PM

TK 1 Materials

Track Chair: **Hiroshi Asanuma,** *Chiba University, Chiba, Japan*

1-3 -CERAMICS AND CERAMIC MATRIX COMPOSITES

1-3-1 -Ceramics and Ceramic Matrix Composites (JSME Technical Papers)

WildCat B (Room 101B) 3:30pm - 5:00pm

Session Chair: **Katsuyoshi Kondoh**, *Osaka University, Ibaragi, Japan*
Session Co-Chair: **Eiji Yuasa**, *Musashi Inst. Tech., Tokyo, Japan*

Amorphous Silica Originated From Rice Husks and Its Characteristics
JSME Technical Publication. MSEC_ICMP2008-72006
-***Katsuyoshi Kondoh, Junko Umeda****, Osaka University, Ibaragi, Japan*

Preparation and Microstructure of Carbon Nanotube-Toughened Alumina Composites
JSME Technical Publication. MSEC_ICMP2008-72348
-***Go Yamamoto, Mamoru Omori, Toshiyuki Hashida, Hisamichi Kimura****, Tohoku University, Sendai, Japan*

Fracture Analysis Based on Quantitative Evaluation of Microcracking in Ceramics Using AE Source Characterization
JSME Technical Publication. MSEC_ICMP2008-72470
-***Kohei Ishiwata****,* ***Shuichi Wakayama****, Tokyo Metropolitan University, Tokyo, Japan*

Asymptotic Characteristic Of Exact Distribution Of Fracture Strength Based On Gamma Distribution As Initial Flaw Size Distribution
JSME Technical Publication. MSEC_ICMP2008-72471
-***Chisato Wakabayashi, Kouichi Yasuda, Tadashi Shiota****, Tokyo Institute of Technology, Tokyo, Japan*

TK 2 Processing

Track Chair: **Brad Kinsey**, *University of New Hampshire, Durham, NH, United States*
Track Co-Chair: **Jaime Camelio**, *Virginia Tech, Blacksburg, VA, United States*

2-1 -PLASTIC FORMING OF METALS

2-1-4 -Plastic Forming of Metals: Processing II (ASME Technical Papers)

Big Ten (Room 104) 3:30pm - 5:00pm

Session Chair: **Richard Onyancha**, *Rose-Hulman Institute of Technology, Terre Haute, IN, United States*
Session Co-Chair: **Kazunari Yoshida**, *Tokai University, Hiratsuka, Kanagawa, Japan*

Hot Draw Mechanical Preforming of an Automotive Door Inner Panel
ASME Technical Publication. MSEC_ICMP2008-72133
-***George Luckey, Peter Friedman****, Ford Motor Company, Dearborn, MI, United States*

Studies of Size Effect on the Formability of a Domed Part in Incremental Forming
ASME Technical Publication. MSEC_ICMP2008-72545
-***Ying Huang, Jian Cao****, Northwestern University, Evanston, IL, United States*, ***K. Scott Smith, Bethany Woody****, University of North Carolina at Charlotte, Charlotte, NC, United States*, ***John Ziegert***, ***Ming Li****, Alcoa Technical Center, Pittsburgh, PA, United States*

A Generic Tool Path Generation Methodology for Incremental Forming
ASME Technical Publication. MSEC_ICMP2008-72547
-***Rajiv Malhotra****, Indian Institute of Technology, Kanpur, Kanpur, India*, ***N Venkata Reddy****, Indian Institute of Technology Kanpur, Kanpur, India*, ***Jian Cao****, Northwestern University, Evanston, IL, United States*

Sheet Metal Forming Limit under Stretch-Bending
ASME Technical Publication. MSEC_ICMP2008-72555
-***Cedric Xia, Danielle Zeng***, *Ford Motor Company, Dearborn, MI, United States*

Investigation of Fatigue Properties for Welded Aluminum Forging Preforms
ASME Technical Publication. MSEC_ICMP2008-72139
-***William P Harris***, *Cooper Power Systems, Waukesha, WI, United States*, ***Joseph Domblesky***, *Marquette University, Milwaukee, WI, United States*

2-9 -INNOVATIVE CUTTING TOOL TECHNOLOGIES FOR MODERN MACHINING CHALLENGES

2-9-4 -Process Modeling Related to Cutting Tools (ASME Technical Papers)

Arch (Room 206) 3:30pm - 5:00pm

Session Chair: **Patrick Kwon**, *Michigan State University, East Lansing, MI, United States*
Session Co-Chair: **Jeongmin Byun**, *St. Cloud State University, St. Cloud, MN, United States*

Modeling Machining At High Speeds as a Fluid Mechanics Problem
ASME Technical Publication. MSEC_ICMP2008-72082
-***Roman V. Kazban***, *Southwest Research Institute, San Antonio, TX, United States*, ***James J. Mason***, *Zimmer Inc, Warsaw, IN, United States*

Some Discussions of Virtual Testing of Cutting Tools
ASME Technical Publication. MSEC_ICMP2008-72131
-***Christian Fischer***, *Scientific Forming Technologies Corporation, Columbus, OH, United States*

Deformation Analysis on Worksheet with Flexible Underlay during Wedge Cutting Process
JSME Technical Publication. MSEC_ICMP2008-72156
-***Seksan Chaijit, Shigeru Nagasawa, Yasushi Fukuzawa***, *Nagaoka University of Technology, Nagaoka, Niigata, Japan*, ***Akira Hine***, *Katayama Steel Rule Die Inc., Tokyo, Japan*

Modeling and Analysis of the Thread Milling Operation in the Combined Drilling/Thread Milling Process
ASME Technical Publication. MSEC_ICMP2008-72209
-***Martin Jun***, *University of Victoria, Victoria, BC, Canada*, ***Anna Araujo***, *Centros Federais de Educação Tecnológica, Rio de Janeiro, Brazil*

2-12 -EMERGING AND NON-TRADITIONAL MANUFACTURING

2-12-1 -Emerging and Non-traditional Manufacturing Technologies I (ASME Technical Papers)

WildCat A (Room 101A) 3:30pm - 5:00pm

Session Chair: **Gary J. Cheng**, *Purdue University, West Lafayette, IN, United States*
Session Co-Chair: **Yasushi Fukuzawa,** *Nagaoka University of Technology, Niigata, Japan*

Experimental Study on Submersed Gas-Jetting EDM
ASME Technical Publication. MSEC_ICMP2008-72111
-***Xiaoming Kang, Wansheng Zhao, C. J. Tang, L. S. Ding***, *Shanghai Jiao Tong University, Shanghai, Shanghai, China*

Shifting Secondary Discharge as the Expulsion Mechanism in EDM
ASME Technical Publication. MSEC_ICMP2008-72274
-***Yuefeng Luo***, *Federal-Mogul, Ann Arbor, MI, United States*, ***Jia Tao***, *University of Michigan, Ann Arbor, MI, United States*

Experimental Investigation of Surface Roughness in Cylindrical Wire Electro Discharge Machining (CWEDM)
ASME Technical Publication. MSEC_ICMP2008-72604
-***Hossein Mohammadi, Alireza Fadaei Tehrani, ali Zeinal Hamadani, Aminollah Mohammadi***, *Isfahan University of Technology, Isfahan, Iran*

A New Computationally Efficient Method in Laser Hardening Modeling
ASME Technical Publication. MSEC_ICMP2008-72501
-***Leonardo Orazi***, *University of Modena and Reggio Emilia, Reggio Emilia, Reggio Emilia, Italy*, ***Alessandro Fortunato, Giovanni Tani***, *University of Bologna, Bologna, Bologna, Italy*, ***Giampaolo Campana***, *DIEM/University of Bologna, Bologna, Italy*, ***Alessandro Ascari***, *University of Bologna, Bologna, Italy*, ***Gabriele Cuccolini***, *DISMI/University of Modena-Reggio Emilia, Reggio Emilia, Italy*

TK 3 Properties and Applications

Track Chair: **Ikuo Ihara**, *Nagaoka University of Technology, Nagaoka, Niigata, Japan*

3-4 -SURFACE MODIFICATION TECHNIQUES, WEAR AND TRIBOLOGY

3-4-4 -Surface Measurement and Observation (ASME & JSME Technical Papers)

Northwestern B (Room 202B) 3:30pm - 5:00pm

Session Chair: **Hirotaka Kato**, *Fukui National College of Technology, Sabae, Japan*
Session Co-Chair: **Yuebin Guo**, *Univ. of Alabama, Tuscaloosa, AL, United States*

New Measurement Method for Adhesion of Hard Coating Film
JSME Technical Publication. MSEC_ICMP2008-72531
-***Kaoru Ikenaga, Akira Yanagida***, *Yokohama National University, Yokohama city, Japan*, ***Akira Azushima***, *Yokohama National University, Yokohama, Japan*

Experimental Investigations on Wear Resistance Characteristics of Alternative Die Materials for Stamping of Advanced High Strength Steels (AHSS)
ASME Technical Publication. MSEC_ICMP2008-72027
-***Omer Necati Cora, Muammer Koc***, *Virginia Commonwealth University, Richmond, VA, United States*

A Comparative Study on the Effect of Surface Topography by Hard Turning versus Grinding on Frictional Performance at Dry and Lubricated Sliding Contact
ASME Technical Publication. MSEC_ICMP2008-72232
-***Rahul Waikar***, *The University of Alabama, Tuscaloosa, AL, United States*, ***Y.B. Guo***, *The Univ. of Alabama, Tuscaloosa, AL, United States*

3-7 -CONDITION-BASED AND PREDICTIVE MAINTENANCE FOR MANUFACTURING EQUIPMENT AND SYSTEM

3-7-1 -Condition-Based and Predictive Maintenance for Manufacturing Equipment and Systems (ASME Technical Papers)

Rock (Room 207) 3:30pm - 5:00pm

Session Chair: **Takehiko Makino**, *Nagoya Institute of technology, Nagoya, Aichi, Japan*
Session Co-Chair: **Dragan Djurdjanovic**, *University of Texas at Austin, Austin, TX, United States*

Model and Information Theory Based Diagnostics for Machinery and Gears
ASME Technical Publication. MSEC_ICMP2008-72529
-***Michael Bryant***, *University of Texas at Austin, Austin, TX, United States*, ***Ji-Hoon Choi***, *Samsung Electronics Co., LTD, Chungnam, Cheonan, Korea (Republic)*

Feature-Based Tool Condition Monitoring in a Gear Shaving Application
ASME Technical Publication. MSEC_ICMP2008-72297
-***Adam Brzezinski***, *University of Michigan, Ann Arbor, Ann Arbor, MI, United States*, ***Yong Wang***, *Huazhong University of Science and Technology, Wuhan, MI, China*, ***D. K. Choi***, *Kangnung National University, Kangnung, Korea (Republic)*, ***George Qiao***, *University of Michigan, Ann Arbor, Ann Arbor, MI, United States*, ***Jun Ni***, *University of Michigan, Ann Arbor, MI, United States*

Smart Machine Health And Maintenance: Tool Assembly Prognostics
ASME Technical Publication. MSEC_ICMP2008-72314
-***Edzel Lapira***, *University of Cincinnati, Cincinnati, OH, United States*, ***Amit Deshpande***, *TechSolve, Inc., Cincinnati, OH, United States*, ***Jay Lee***, *University of Cincinnati, Cincinnati, OH, United States*, ***John Snyder***, *TechSolve, Inc., Cincinnati, OH, United States*

Identifying Correlations Between Independent Sets of Maintenance and Manufacturing Quality Data
ASME Technical Publication. MSEC_ICMP2008-72030
-***Hany El-Gheriani****, Queen's University, Kingston, ON, Canada*, ***Guillaume Graton****, Ecole Centrale de Marseille, Marseille, France*, ***Martin Guay****, Queen's University, Kingston, ON, Canada*, ***Jorge Arinez****, General Motors R&D Center, Warren, MI, United States*

Real-Time Diagnostics, Prognostics & Health Management for Large-Scale Manufacturing Maintenance Systems
ASME Technical Publication. MSEC_ICMP2008-72511
-***Leandro G. Barajas****, General Motors R&D, Warren, MI, United States*, ***Narayan Srinivasa****, HRL Laboratories, LLC, Malibu, CA, United States*

TK 4 Micro and Nano Technologies

Track Chair: **Gloria Wiens**, *University of Florida, Gainesville, FL, United States*

4-5 -MICRO/MESOSCALE MANUFACTURING CHALLENGES IN MATERIAL HANDLING

4-5-1 -Micro/Mesoscale Manufacturing Challenges in Material Handling (ASME Technical Papers)

Northwestern A (Room 202A) 3:30pm - 5:00pm

Session Chair: **Tim VanRavenswaay**, *Alion Science and Technology, Rockford, IL, United States*
Session Co-Chair: **Yoshimi Murata,** *Meiji University, Kawasaki, Japan*

Active Fixturing For Mesoscale Manufacturing Systems: Fixel Design Alternatives
ASME Technical Publication. MSEC_ICMP2008-72225
-***Gloria Wiens, Koustubh Rao, Troy Rippere****, University of Florida, Gainesville, FL, United States*

Modeling and Prediction of the Flow, Pressure and Holding Force Generated by a Bernoulli Handling Device
ASME Technical Publication. MSEC_ICMP2008-72472
-***Xavier F. Brun, Shreyes N. Melkote****, Georgia Institute of Technology, Atlanta, GA, United States*

An Innovative Polymeric Material for Microhandling
ASME Technical Publication. MSEC_ICMP2008-72485
-***Claudia Pagano, Irene Fassi****, ITIA-CNR, Milano, Italy*

TK 5 Biological Technologies

Track Chair: **Wei Sun**, *Drexel University, Philadelphia, PA, United States*

5-5 -OTHER BIOLOGICAL APPLICATIONS

5-5-1 -Advances in Biological Applications (ASME & JSME Technical Papers)

Armadillo (Room 208) 3:30pm - 5:00pm

Session Chair: **Gareth Walsh**, *Labcoat Ltd, Galway, Ireland*
Session Co-Chair: **Ming Yang**, *Tokyo Metropolitan University, Tokyo, Japan*

Design and Fabrication of a Roller Imprinting Device for Microfluidic Device Manufacturing
ASME Technical Publication. MSEC_ICMP2008-72202
-***Athulan Vijayaraghavan, Stephen Jayanathan, Moneer M Helu, David Dornfeld****, University of California, Berkeley, CA, United States*

Micro Manufacturing Using Advanced Hybrid Microstereolithography for 3-D Micro Chemical Devices
JSME Technical Publication. MSEC_ICMP2008-72341
-***Kengo Kobayashi****, Nagoya University, Nagoya, Aichi, Japan*, ***Koji Ikuta****, Nagoya University, Nagoya City, Aichi, Japan*

Development of Mouthpiece type Remote Controller for Serious Disability Persons- Basic investigation of possibility of using RFID technique for remote controller
JSME Technical Publication. MSEC_ICMP2008-72411
-***Shojiro Terashima****, Niigata Institute of Technology, Kashiwazaki-city, Niigata, Japan*, ***Takuya Kitazawa, Eiichi Satoh****, Niigata Institute of Technology, Niigata, Japan*, ***Kazuo Kotake****, Elite Ltd., Niigata, Japan*, ***Isao Sakamaki****, National Instruments Japan, Tokyo, Japan*

Medical Device Coating using Ink-Jet Technology
ASME Technical Publication. MSEC_ICMP2008-72515
-***Gareth Walsh****, Labcoat Ltd, Galway, Ireland*

TK 6 Other Conference Events
Track Chair: **John T. Roth***, Penn State Erie, The Behrend College, Erie, PA, United States*

6-2 -GENERAL MEETINGS AND PLENARY TALKS

6-2-3 -MED Executive Committee Meeting

Evans (Room 102) 3:30pm - 5:00pm

THURSDAY 5:30 – 6:30 PM

TK 6 Other Conference Events
Track Chair: **John T. Roth***, Penn State Erie, The Behrend College, Erie, PA, United States*

6-2 -GENERAL MEETINGS AND PLENARY TALKS

6-2-1 -ASME General Membership Meeting

Big Ten (Room 104) 5:30pm - 6:30pm

6-2-2 -JSME Committee Meeting

Evans (Room 102) 5:30pm - 6:30pm

FRIDAY
OCTOBER 10, 2008

FRIDAY 8:30 – 10:00 AM

TK 1 Materials

Track Chair: **Hiroshi Asanuma**, *Chiba University, Chiba, Japan*

1-2 -METAL AND METAL MATRIX COMPOSITES

1-2-1 -Metal and Metal Matrix Composites I (ASME Technical Papers)

WildCat B (Room 101B) 8:30am - 10:00am

Session Chair: **Brad Kinsey**, *University of New Hampshire, Durham, NH, United States*
Session Co-Chair: **Katsuhiro Nishiyama,** *Tokyo University of Science, SUWA, Nagano, Japan*

An Experimental Study on Shear Fracture of Advanced High Strength Steels
ASME Technical Publication. MSEC_ICMP2008-72046
-***Hua-Chu Shih, Ming Shi***, *United States Steel Corporation, Troy, MI, United States*

A Comparative Assessment of Austempered Ductile Iron as a Substitute in Weight Reduction Applications
ASME Technical Publication. MSEC_ICMP2008-72091
-***Ashwin Polishetty, Sarat Singamneni, Guy Littlefair***, *AUT University, Auckland, New Zealand*

Modeling Machinability Parameters of Turning Al-SiC(10p) MMC by Artificial Neural Network
ASME Technical Publication. MSEC_ICMP2008-72329
-***Muthu Krishnan N., Ravi Mohan, Thiagarajan M.S., Venugopal J***, *Sri Venkateswara College of Engineering, Chennai, India*

Study of the Sandwich Sheet Metal Cup Drawing Characteristics
ASME Technical Publication. MSEC_ICMP2008-72415
-***Jun Chen, Yong Wang, Haibo Li***, *Shanghai Jiao Tong University, Shanghai, China*

A Comparative Study on Hydraulic Bulge Testing and Analysis Methods
ASME Technical Publication. MSEC_ICMP2008-72238
-***Eren Billur, Muammer Koc***, *Virginia Commonwealth University, Richmond, VA, United States*

TK 2 Processing

Track Chair: **Brad Kinsey**, *University of New Hampshire, Durham, NH, United States*
Track Co-Chair: **Jaime Camelio**, *Virginia Tech, Blacksburg, VA, United States*

2-1 -PLASTIC FORMING OF METALS

2-1-3 -Plastic Forming of Metals: Process & Tool Design (ASME Technical Papers)

Big Ten (Room 104) 8:30am - 10:00am

Session Chair: **Yannis Korkolis**, *University of Texas at Austin, Austin, TX, United States*
Session Co-Chair: **Ikuo Yarita**, *Chiba Institute of Technology, Chiba, Japan*

Potential Theory Based Blank Design for Deep Drawing Irregular Shaped Components
ASME Technical Publication. MSEC_ICMP2008-72544
-***Jianjun Wu***, *Northwestern Polytechnicl University, Xi' an, Shaanxi, China*

A Smart Actuator Design for Multiple Bio-reagent Mixing in a High Pressure Optical Cell for Bio-Physical Research Applications
ASME Technical Publication. MSEC_ICMP2008-72137
-***Oliver Xie, Jack G. Zhou***, *Drexel University, Philadelphia, PA, United States*, ***Parkson Chong***, *Temple University Medical School, Philadelphia, PA, United States*

Finite Element Analysis of Deformed Geometry in Three-Roller Plate Bending Process
ASME Technical Publication. MSEC_ICMP2008-72439
-***Vishal K Tailor**, Sardar Vallabhbhai National Institute of Technology, Surat, Surat, India*, ***A. H. Gandhi**, C. K. Pithawalla College of Engineering & Technology,, Surat, India*, ***R.D Moliya**, Larsen & Toubro Limited, Hazira Surat, Surat, India*, ***Dr. Harit K. Raval**, S. V. National Institute of Technology, Surat, Gujarat, India*

Formability of Anisotropic Aluminum Tubes
ASME Poster Oral Presentation. MSEC_ICMP2008-72592
-***Yannis Korkolis, Stelios Kyriakides**, University of Texas at Austin, Austin, TX, United States*

Surface Finish in Hard Machining by PVD-Coated End-Mills using solid lubricant
ASME Technical Publication. MSEC_ICMP2008-72456
-***Geeta Lathkar**, MGM's College of Engineering,Nanded, Nanded, India*, ***Shantisagar Biradar**, MGMs JNEC, Aurangabad, India*, ***S. K. Basu**, Emeritus, College of Engineering, Shivajinagar, Pune, India*

An Integrated Decision Analysis for the Sustainable Product Design
ASME Technical Publication. MSEC_ICMP2008-72029
-***Jun-Ki Choi**, The Ohio State University, Columbus, OH, United States*, ***Karthik Ramani**, Purdue University, West Lafayette, IN, United States*

2-6 -ENVIRONMENTALLY SUSTAINABLE MANUFACTURING SYSTEMS

2-6-1 -Environmentally Sustainable Manufacturing Systems (ASME Technical Papers)

Arch (Room 206) 8:30am - 10:00am

Session Chair: **David Dornfeld**, *University of California, Berkeley, CA, United States*
Session Co-Chair: **Steven Skerlos**, *University of Michigan, Ann Arbor, MI, United States*

Introducing Sustainability Early Into Manufacturing Process Planning
ASME Technical Publication. MSEC_ICMP2008-72129
-***Mahesh Mani, Kevin W. Lyons, Sudarsan Rachuri, Eswaran Subrahmanian, Ram D. Sriram, Gaurav Ameta, Shaw C. Feng**, National Institute of Standards and Technology, Gaithersburg, MD, United States*

Metrics for Sustainable Manufacturing
ASME Technical Publication. MSEC_ICMP2008-72223
-***Corinne Reich-Weiser**, University of California at Berkeley, Berkeley, CA, United States*, ***Athulan Vijayaraghavan, David Dornfeld**, University of California, Berkeley, CA, United States*

2-12 -EMERGING AND NON-TRADITIONAL MANUFACTURING

2-12-2 -Emerging and Non-traditional Manufacturing Technologies II (ASME & JSME Technical Papers)

WildCat A (Room 101A) 8:30am - 10:00am

Session Chair: **Shuting Lei**, *Kansas State University, Manhattan, KS, United States*
Session Co-Chair: **Hitomi Yamaguchi**, *University of Florida, Gainesville, FL, United States*

Laser Polishing Parameter Optimisation for Die and Moulds Surface Finishing
ASME Technical Publication. MSEC_ICMP2008-72258
-***E. Ukar**, University of the Basque Country UPV/EHU, Portugalete, Bizkaia, Spain*, ***A. Lamikiz, L.N. Lopez de Lacalle**, University of the Basque Country UPV/EHU, Bilbao, Bizkaia, Spain*, ***F. Liebana**, ROBOTIKER-Tecnalia, Zamudio, Bizkaia, Spain*, ***J.M. Etayo**, Robotiker, Zamudio, Bizkaia, Spain*

Study of Magnetic Field Assisted Finishing of Quartz Wafers
JSME Technical Publication. MSEC_ICMP2008-72252
-***Hitomi Yamaguchi**, University of Florida, Gainesville, FL, United States*, ***Takeo Shinmura**, Utsunomiya University, Utsunomiya, Japan*, ***Kazuki Yumoto**, Nikon Corporation, Mito, Japan*, ***Takahiko Okazaki**, Bando Chemical Industries, Ltd., Kobe, Japan*

Machinability of Compacted Graphite Iron in Honing
ASME Technical Publication. MSEC_ICMP2008-72083
-***Yhu-Tin Lin**, General Motors Corporation, Warren, MI, United States*

Effect of Tool Wear on Rolling Contact Fatigue Performance of Superfinish Hard Machined Surfaces
ASME Technical Publication. MSEC_ICMP2008-72078
-***Youngsik Choi**, Florida Institute of Technology, Melbourne, FL, United States*, ***C. Richard Liu**, Purdue University, West Lafayette, IN, United States*

TK 3 Properties and Applications

Track Chair: **Ikuo Ihara**, *Nagaoka University of Technology, Nagaoka, Niigata, Japan*

3-5 -DYNAMIC BEHAVIOR OF MATERIALS AND STRUCTURES (IN HONOR OF PROF. SHIOYA AND DR. OGAWA)

3-5-1 -Dynamic Behavior of Materials and Structures I (JSME Invited Papers)

Northwestern A (Room 202A) 8:30am - 10:00am

Session Chair: **Takashi Yokoyama**, *Okayama University of Science, Okayama, Okayama, Japan*
Session Co-Chair: **Hiroyuki Mae**, *Honda R&D Co., Ltd., Tochigi, Japan*

Thermal Activation Theory and High Strain Rate Deformation
JSME Invited Paper. MSEC_ICMP2008-72191
-***Kinya Ogawa**, Space Dynamics Laboratory, Kyoto, Kyoto Prefecture, Japan*

Viscoelastic Analysis of Dynamic Behavior of Materials
JSME Invited Paper. MSEC_ICMP2008-72539
-***Toshifumi Kakiuchi**, The University of Elctro-Communications, Chofu, Tokyo, Japan*, ***Tadashi Shioya**, Nihon University, Narashino, Chiba, Japan*, ***Koji Fujimoto**, The University of Tokyo, Tokyo, Japan*, ***Masanao Sekine**, The University of Tokyo, Bunkyo-ku, Tokyo, Japan*

3-8 -QUALITY CONTROL IN MULTISTAGE MANUFACTURING SYSTEMS

3-8-1 -Quality Control in Multistage Manufacturing Systems (ASME Technical Papers)

Armadillo (Room 208) 8:30am - 10:00am

Session Chair: **Dragan Djurdjanovic**, *University of Texas at Austin, Austin, TX, United States*
Session Co-Chair: **Takehiko Makino**, *Nagoya Institute of technology, Nagoya, Aichi, Japan*

Improving Chucking Accuracy and Repeatability by Reducing Kinematic Redundancy
ASME Technical Publication. MSEC_ICMP2008-72147
-***Jeongmin Byun**, St. Cloud State University, St. Cloud, MN, United States*, ***Richard Liu**, Purdue University, West Lafayette, IN, United States*

Allocation of Flexible Tooling for Optimal Stochastic Multistation Manufacturing Process Quality Control
ASME Technical Publication. MSEC_ICMP2008-72443
-***Yibo Jiao, Dragan Djurdjanovic**, University of Texas at Austin, Austin, TX, United States*

Design of a Stamping Test for Investigating Surface Distortion in Sheet Metal Parts
ASME Technical Publication. MSEC_ICMP2008-72478
-***Zhengchun Fu**, Jilin University, Jilin, China*, ***Ping Hu**, Dalian University of Technology, Dalian, China*, ***Hui-Ping Wang, Kunmin Zhao**, General Motors, Warren, MI, United States*

Enhancing Safety In Manufacturing Systems by Integrating Diagnostic Information
ASME Technical Publication. MSEC_ICMP2008-72460
-***Kyle Schroeder, Aftab Khan, James Moyne, Dawn Tilbury**, University of Michigan, Ann Arbor, MI, United States*

TK 4 Micro and Nano Technologies

Track Chair: **Gloria Wiens**, *University of Florida, Gainesville, FL, United States*

4-3 -LASER MICROMACHINING TECHNOLOGY AND ITS APPLICATIONS

4-3-1 -Laser Micromachining Technology and Its Applications (ASME Technical Papers)

Northwestern B (Room 202B) 8:30am - 10:00am

Session Chair: **Frank Pfefferkorn**, *University of Wisconsin-Madison, Madison, WI, United States*
Session Co-Chair: **Kazunari Shinagawa**, *Kagawa University, Takamatsu, Kagawa, Japan*

Micromachining of Metals, Alloys and Ceramics by Picosecond Laser Ablation
ASME Technical Publication. MSEC_ICMP2008-72247
-***Wenqian Hu, Yung Shin, Galen King***, *Purdue University, West Lafayette, IN, United States*

Pulsed Laser Micro Polishing of Microfabricated Nickel and Ti6Al4V Samples
ASME Technical Publication. MSEC_ICMP2008-72505
-***Tyler Perry, Dirk Werschmoeller, Xiaochun Li, Frank Pfefferkorn, Neil Duffie***, *University of Wisconsin-Madison, Madison, WI, United States*

An Experimental Evaluation of Laser Assisted Micro-milling of Two Difficult to Machine Alloys
ASME Technical Publication. MSEC_ICMP2008-72246
-***Jonathan Shelton, Yung Shin***, *Purdue University, West Lafayette, IN, United States*

Estimation of Temperature Distribution in Silicon during Micro Laser Assisted Machining.
ASME Technical Publication. MSEC_ICMP2008-72195
-***Kamlesh Suthar, John Patten***, *Western Michigan University, Kalamazoo, MI, United States*, ***Lei Dong***, *Condor USA, Inc., Charlotte, NC, United States*, ***Hisham Abdel-Aal***, *University of Wisconsin at Platteville, Platteville, WI, United States*

FRIDAY 10:30 – 12:00 PM

TK 1 Materials

Track Chair: **Hiroshi Asanuma**, *Chiba University, Chiba, Japan*

1-2 -METAL AND METAL MATRIX COMPOSITES

1-2-2 -Metal and Metal Matrix Composites II (JSME Technical Papers)

WildCat B (Room 101B) 10:30am - 12:00pm

Session Chair: **Hua-Chu Shih**, *United States Steel Corporation, Troy, MI, United States*
Session Co-Chair: **Gen Sasaki**, *Hiroshima University, Higashi-Hiroshimasi, Japan*

Grain Refinement of Iron Bars by Torsion Processes and Heat Treatments
JSME Technical Publication. MSEC_ICMP2008-72065
-***Li-Bin Niu***, *Shinshu University, Nagano, Japan*, ***Naoki Yamaguchi, Tomohiro Shima***, *Graduate School of Shinshu University, Nagano, Japan*, ***Akihiko Nagasaka***, *Nagano National College of Technology, Nagano, Japan*

Infiltration Analysis of Molten Metal to Fibrous Preform by Low- Pressure Casting and Experimental Evaluation
JSME Technical Publication. MSEC_ICMP2008-72157
-***YongBum Choi, Gen Sasaki***, *Hiroshima University, Higashi-Hiroshimasi, Japan*, ***Kazuhiro Matsugi***, *Hiroshima university, Higashi-Hiroshima, Japan*, ***Sorida Naoki***, *Kolbenschmidt K.K, Higashi-Hiroshimasi, Japan*

Effect of Microstructure on Torsional Fatigue Endurance of Martensitic Carbon Steel
JSME Technical Publication. MSEC_ICMP2008-72371
-***Shunsuke Toyoda, Yasuhide Ishiguro, Yoshikazu Kawabata, Kei Sakata, Akio Sato***, *JFE Steel Corporation, Handa, Aichi, Japan*, ***Jun'ichi Sakai***, *Waseda University, Shinjuku-ku, Tokyo, Japan*

Internal Friction at High Temperatures and Microplasticity of Aluminum Matrix Composites
JSME Technical Publication. MSEC_ICMP2008-72464
-***Katsuhiro Nishiyama***, ***Shigenori Utsumi***, *Tokyo University of Science, SUWA, Chino, Japan*, ***Takanobu Nakamura, Hironori Nishiyama***, *Tokyo University of Science, Noda, Japan*

Effects of Deformation-Induced Martensite on Resistivity of Deforming Stainless Steel
JSME Technical Publication. MSEC_ICMP2008-72166
-***Hidefumi Date***, *Tohoku Gakuin University, Tagajo, Miyagi, Japan*

TK 2 Processing

Track Chair: **Brad Kinsey**, *University of New Hampshire, Durham, NH, United States*
Track Co-Chair: **Jaime Camelio**, *Virginia Tech, Blacksburg, VA, United States*

2-1 -PLASTIC FORMING OF METALS

2-1-2 -Plastic Forming of Metals: Analytical & Experimental Modeling II (JSME Technical Papers)

Big Ten (Room 104) 10:30am - 12:00pm

Session Chair: **Gracious Ngaile,** *North Carolina State University, Raleigh, NC, United States*
Session Co-Chair: **Kenichi Manabe**, *Tokyo Metropolitan University, Tokyo, Japan*

Experimental and Numerical Study on Blanking Process with a Negative Clearance
JSME Technical Publication. MSEC_ICMP2008-72395
-***Kenji Hirota, Hiroyuki Yanaga, Katsunori Fukushima***, *Kyushu Institute of Technology, Kitakyushu, Japan*

Toward Understanding in Atomistic Scale of Grain Boundary Plasticity
JSME Technical Publication. MSEC_ICMP2008-72403
-***Tokuteru Uesugi***, *Department of Materials Science, Graduate School of Engineering, Osaka Prefecture University, Sakai, Japan*, ***Kenji Higashi***, *Japan*

Influence of Friction and Anisotropy on Cube- And Ring- Compression Test
JSME Technical Publication. MSEC_ICMP2008-72494
-***Motoki Terano, Kazuhiko Kitamura, Takaaki Fukatsu, Takaji Mizuno***, *Nagoya Institute of Technology, Nagoya, Japan*

Plastic Working Method for Enlarging Diameter with a Final Outer Shape
JSME Technical Publication. MSEC_ICMP2008-72540
-***Yoshitaka Kuwahara***, *Ehime University, Hiratuka, Kanagawa, Japan*, ***Xia Zhu***, *Ehime University, Matsuyama, Ehime, Japan*, ***Nagatoshi Okabe***, *Graduate School of Science and Engineering Ehime University, Matsuyama, Ehime, Japan*, ***Fumiaki Ikuta***, *Neturen Co.Ltd.,, Hiratuka, Kanagawa, Japan*, ***Keiji Ogi***, *Ehime University, Matsuyama, Ehime, Japan*

2-4 -ADVANCED WELDING AND BONDING

2-4-1 -Advanced Welding and Bonding Technology I (ASME Technical Papers)

WildCat A (Room 101A) 10:30am - 12:00pm

Session Chair: **Grant Kruger**, *University of Michigan, Ann Arbor, MI, United States*
Session Co-Chair: **Akio Suzumura**, *Tokyo Institute of Technology, Tokyo, Japan*

Dimensional Variation Analysis of T-Node Joints Using Aluminum 6063-T52 Extrusion Material in Gas Metal Arc Welding (GMAW) Joining Process
ASME Technical Publication. MSEC_ICMP2008-72071
-***Ramakrishna Koganti, Armando Joaquin***, *Ford Motor Company, Dearborn, MI, United States*, ***Chris Karas***, *Metro Technologies, Troy, MI, United States*

Influence of Metal Inert Gas (MIG) Welding Factors Wire Feed Rate and Weld Travel Speed on Aluminum Weld Joint Strength
ASME Technical Publication. MSEC_ICMP2008-72127
-***Ramakrishna Koganti, Armando Joaquin, Chris Karas, Matt Zaluzec***, *Ford Motor Company, Dearborn, MI, United States*

Monitoring of the Spatter Formation in Laser Welding of Galvanized Steels in Lap Joint Configuration by the Measurement of the Acoustic Emission
ASME Technical Publication. MSEC_ICMP2008-72224
-***Shanglu Yang***, *Southern Methodist University, Dallas, TX, United States*, ***Wei Huang***, *Research Center for Advanced Manufacturing, Dallas, TX, United States*, ***Dechao Lin***, *Southter Methodist University, Dallas, TX, United States*, ***Fanrong Kong***, *Research Center for Advanced Manufacturing, Dallas, TX, United States*, ***Radovan Kovacevic***, *3101 Dyer Street, Dallas, TX, United States*

Spot Friction Weld Strength Improvement Through In-Process Metal Matrix Formation
ASME Technical Publication. MSEC_ICMP2008-72502
-***Senthil Arul***, *Ford Motor Company, West Bloomfield, MI, United States*, ***Grant Kruger***, *University of Michigan, Ann Arbor, MI, United States*, ***Scott Miller***, *The University of Hawaii, Honolulu, HI, United States*, ***Tsung-Yu Pan***, *Ford Motor Company, Dearborn, MI, United States*, ***Albert Shih***, *The University of Michigan, Ann Arbor, MI, United States*

2-8 -SEMICONDUCTOR MATERIALS MANUFACTURING

2-8-1 -Semiconductor Materials Manufacturing Processes (ASME Technical Papers)

Arch (Room 206) 10:30am - 12:00pm

Session Chair: **ZJ Pei**, *Kansas State University, Manhattan, KS, United States*
Session Co-Chair: **Abhijit Chandra**, *Iowa State University, Ames, IA, United States*

Ultra-Precision Machining Technology of the Soft and Brittle Functional Crystal
ASME Technical Publication. MSEC_ICMP2008-72059
-***Chunpeng Lu***, *Dalian University of Technology, Dlian, Liaoning, China*, ***Hang Gao, Renke Kang, Xiaoji Teng, Qiangguo Wang***, *Dalian University of Technology, Dalian, Liaoning, China*

Dry Polishing of Non-Cubic Crystal Wafers.
ASME Technical Publication. MSEC_ICMP2008-72171
-***Scott Sullivan**, DISCO, Tokyo, Japan*

Comparison of Free Abrasive Machining Processes in Wafer Manufacturing
ASME Technical Publication. MSEC_ICMP2008-72253
-***Chunhui Chung, Imin Kao**, Stony Brook University, Stony Brook, NY, United States*

A Multi-Scale Model for Wafer Surface Evolution in Chemical Mechanical Planarization
ASME Oral Presentation Only. MSEC_ICMP2008-72445
-***Pavan Karra, Abhijit Chandra, David Asplund**, Iowa STate University, Ames, IA, United States*

Difference in Tensile and Compressive Stresses of Pure Titanium and Aluminum Alloy Sheets and Its Effect on Bending Characteristics
JSME Technical Publication. MSEC_ICMP2008-72318
-***Toshihiko Kuwabara**, Tokyo University of Agriculture & Technology, Tokyo, Japan*, ***Y. Ichinose**, University of Agriculture and Technology, Koganei-shi, Tokyo, Japan*

Effect of the Spherical Indenter Tip Assumption on Nanoindentation
ASME Oral Presentation Only. MSEC_ICMP2008-72582
-***Li Ma, Dylan Morris**, National Institute of Standards and Technology, Gaitherburg, MD, United States*, ***Lyle Levine**, National Institute of Standards and Technology, Gaithersburg, MD, United States*, ***Stefhanni Jennerjohn, David Bahr**, Washington State University, Pullman, WA, United States*

TK 3 Properties and Applications

Track Chair: **Ikuo Ihara**, *Nagaoka University of Technology, Nagaoka, Niigata, Japan*

3-1 -MECHANICAL CHARACTERIZATION AND MEASUREMENT TECHNIQUES

3-1-1 -Mechanical Characterization and Measurement Techniques I (ASME & JSME Technical Papers)

Rock (Room 207) 10:30am - 12:00pm

Session Chair: **Koji Fujimoto**, *The University of Tokyo, Tokyo, Japan*
Session Co-Chair: **Li Ma**, *National Institute of Standards and Technology, Gaitherburg, MD, United States*

Effect of Chemical Composition on Elevated Temperature Brittleness of Ductile Cast Iron
JSME Technical Publication. MSEC_ICMP2008-72013
-***Yoshitaka Iwabuchi**, Kushiro National College of Technology, Kushiro, Hokkaido, Japan*

3-5 -DYNAMIC BEHAVIOR OF MATERIALS AND STRUCTURES (IN HONOR OF PROF. SHIOYA AND DR. OGAWA)

3-5-2 -Dynamic Behavior of Materials and Structures II (ASME and JSME Technical Papers)

Northwestern A (Room 202A) 10:30am - 12:00pm

Session Chair: **Masaaki Itabashi**, *Tokyo University of Science, Suwa, Chino, Nagano, Japan*
Session Co-Chair: **Matthew T. Bement**, *Los Alamos National Laboratory, Los Alamos, NM, United States*

Chip Stick and Slip Motions of a Machine Tool in the Cutting Process
ASME Technical Publication. MSEC_ICMP2008-72052
-***Brandon Gegg, Steve Suh**, Texas A&M University, College Station, TX, United States*, ***Albert Luo**, Southern Illinois University At Edwardsville, Edwardsville, TX, United States*

A Geometrically Comprehensive Approach to Modeling Dynamic Cutting Forces in Turning: Application to Regenerative Chatter
ASME Technical Publication. MSEC_ICMP2008-72313
-***Adam Cardi**, Georgia Institute of Technology, Atlanta, GA, United States*, ***Matthew Bement**, Los Alamos National Laboratory, Los Alamos, NM, United States*, ***Steven Liang**, Manufacturing Research Center (MaRC), Georgia Institute of Technology, Atlanta, GA, United States*

Effects of Strain Rate and Temperature on Compressive Properties of Starch-based Biodegradable Plastics
JSME Technical Publication. MSEC_ICMP2008-72163
-***Masahiro Nishida, Noriomi Ito, Hiroyuki Kawase, Koichi Tanaka****, Nagoya Institute of Technology, Nagoya, Aichi, Japan*

Impact Lateral Compression Tests of Thin-Walled Circular Tube Filled with Aluminum Foam
JSME Technical Publication. MSEC_ICMP2008-72095
-***Hidetoshi Kobayashi, Keitaro Horikawa, Masahiro Hori****, Osaka University, Toyonaka, Osaka, Japan*, ***Kinya Ogawa****, Space Dynamics Laboratory, Kyoto, Kyoto Prefecture, Japan*, ***Masashi Daimaruya****, Muroran Institute of Technology, Muroran, Hokkaido, Japan*

Welding of Metallic Foil with Electron Beam
JSME Technical Publication. MSEC_ICMP2008-72355
-***Hiroki Ogawa****, Tokyo Metropolitan University, Hino city, Tokyo, Japan*, ***Ming Yang****, Tokyo Metropolitan University, Tokyo, Japan*, ***Yukiko Matsumoto, Wei Guo****, Tokyo Metropolitan University, Hino city, Tokyo, Japan*

A Cylindrical Ultrasonic Linear Microactuator
JSME Technical Publication. MSEC_ICMP2008-72404
-***Sheng Wang, Doingming Sun, Seiichi Hata, Akira Shimokohbe****, Tokyo Institute of Technology, Yokohama, Yokohama, Japan*

Fabrication and Fluid Ejection Performance of Hollow Microneedle Array for Cellular Function Analysis
JSME Technical Publication. MSEC_ICMP2008-72491
-***Takayuki Shibata, Norihisa Kato, Takahiro Sakai, Takahiro Kawashima, Mitsuyoshi Nomura****, Toyohashi University of Technology, Toyohashi, Aichi, Japan*, ***Takashi Mineta, Eiji Makino****, Hirosaki University, Hirosaki, Aomori, Japan*

TK 4 Micro and Nano Technologies

Track Chair: **Gloria Wiens**, *University of Florida, Gainesville, FL, United States*

4-1 -MEMS AND NEMS APPLICATIONS

4-1-1 -MEMS and NEMS Applications (JSME Technical Papers)

Armadillo (Room 208) 10:30am - 12:00pm

Session Chair: **Xiaochun Li**, *University of Wisconsin-Madison, Madison, WI, United States*
Session Co-Chair: **Naoto Ohtake**, *Nagoya University, Nagoya, Aichi, Japan*

Development of Micro Metallic Valve For mTAS
JSME Technical Publication. MSEC_ICMP2008-72349
-***Ming Yang, Satoshi Ogata, Arata Kaneko, Keisuke Yamoto****, Tokyo Metropolitan University, Tokyo, Japan*

Nanostructured Surface By Self-Assembly Of Carbon Nanotubes for Bio-Analysis
JSME Technical Publication. MSEC_ICMP2008-72351
-***Ryuuichi Kobayashi****, Tokyo Metropolitan University, Hino city, Tokyo, Japan*, ***Ming Yang****, Tokyo Metropolitan University, Tokyo, Japan*

4-4 -MINIATURIZATION OF MOLDING PROCESSES FOR MICROFABRICATION

4-4-1 -Miniaturization of Molding Processes for Microfabrication I (ASME & JSME Technical Papers)

Northwestern B (Room 202B) 10:30am - 12:00pm

Session Chair: **Allen Yi**, *The Ohio State University, Columbus, OH, United States*
Session Co-Chair: **Atsushi Hosoi**, *Nagoya University, Nagoya, Japan*

Fabrication of Metallic Stamp with 30 nm Hole Array using UV Nanoimprinting and Nanoelectroforming
ASME Technical Publication. MSEC_ICMP2008-72237
-***Jeongwon Han, Jungmo Yang, Byung Soo William Lee, Shinill Kang****, Yonsei University, Seoul, Korea (Republic)*

Dynamic Mold Temperature Control Using Gas-Assisted Heating and Its Effect on the Molding Replication Qualities of Micro Channels
ASME Technical Publication. MSEC_ICMP2008-72458

-***Shia-Chung Chen, Yaw-Jen Chang, Jen-An Chang, Hsin-shu Peng, Ying-Chieh Wang***, *Chung Yuan Christian University, Chung-Li, Taiwan*

Thermal Reflow Process for Glass Microlens Manufacturing
ASME Technical Publication. MSEC_ICMP2008-72459

-***Yang Chen, Allen Yi***, *The Ohio State University, Columbus, OH, United States*, ***Donggang Yao***, *Georgia Institute of Technology, Atlanta, GA, United States*, ***Fritz Klocke, Guido Pongs***, *Fraunhofer Institute for Production Technology, Aachen, 52074, Germany*

FRIDAY 12:00 – 1:15 PM

TK 6 Other Conference Events

Track Chair: **John T. Roth**, *Penn State Erie, The Behrend College, Erie, PA, United States*

6-2 -GENERAL MEETINGS AND PLENARY TALKS

6-2-10 -Friday Luncheon Speaker

Louis & Lake (Rooms 203 & 205) 12:00pm - 1:15pm

Merchant Medal Recipient
Keynote. MSEC_ICMP2008-72625
-***James Bryan***, *United States*

FRIDAY 1:30 – 3:00 PM

TK 1 Materials

Track Chair: **Hiroshi Asanuma**, *Chiba University, Chiba, Japan*

1-2 -METAL AND METAL MATRIX COMPOSITES

1-2-3 -Metal and Metal Matrix Composites III (JSME Technical Papers)

WildCat B (Room 101B) 1:30pm - 3:00pm

Session Chair: **Hidefumi Date**, *Tohoku Gakuin University, Tagajo, Miyagi, Japan*
Session Co-Chair: **Katsuhiro Nishiyama,** *Tokyo University of Science, SUWA, Nagano, Japan*

Effect of Aging on Microstructure of Aluminum Borate Whisker Reinforced AZ91D Magnesium Alloy Composite
JSME Technical Publication. MSEC_ICMP2008-72413
-***Gen Sasaki****, Hiroshima University, Higashi-Hiroshimasi, Japan*, ***Koji Maruo****, Hiroshima University, Dept. of Mech. Eng., Higashi-Hiroshima, Hiroshima, Japan*, ***YongBum Choi****, Hiroshima University, Higashi-Hiroshimasi, Japan*, ***Kazuhiro Matsugi****, Hiroshima university, Higashi-Hiroshima, Japan*

Composite Magnesium Powder Coated with Un-Bundled Carbon Nanotubes (CNT) and Characteristics of its Extruded Material
JSME Technical Publication. MSEC_ICMP2008-72521
-***Fukuda Hiroyuki****, Osaka university, Ibaraki, Osaka, Japan*

Theoretical and Practical Aspects Regarding of Electronic Efficiency Improving of Power Magnetrons with Continuous Working and Bimetal Anode
JSME Technical Publication. MSEC_ICMP2008-72433
-***Petru Ungur, Petru/A Pop, Cornelia Gordan, Mircea Gordan****, University of Oradea, ORADEA, BIHOR, Romania*

TK 2 Processing

Track Chair: **Brad Kinsey**, *University of New Hampshire, Durham, NH, United States*
Track Co-Chair: **Jaime Camelio**, *Virginia Tech, Blacksburg, VA, United States*

2-1 -PLASTIC FORMING OF METALS

2-1-6 -Plastic Forming of Metals: Processing III (JSME Technical Papers)

Big Ten (Room 104) 1:30pm - 3:00pm

Session Chair: **Gracious Ngaile,** *NC State University, Raleigh, NC,* United States
Session Co-Chair: **Sumio Sugiyama**, *The University of Tokyo, Tokyo, Japan*

Development of Micro-Dimple Forming Process
JSME Technical Publication. MSEC_ICMP2008-72476
-***Masaru Futamura****, Nagoya Institute of Technology, Kakegawa City, Shizuoka, Japan*, ***Kuniaki Dohda***, ***Takehiko Makino****, Nagoya Institute of Technology, Nagoya, Aichi, Japan*, ***Tetsuya Suzuki****, Sugino Machine Ltd., Kakegawa, Sizuoka, Japan*

Forming for Inside Spiral Multi-Grooved Tube by Hot Extrusion
JSME Technical Publication. MSEC_ICMP2008-72173
-***Norio Takatsuji****, University of Toyama, Toyama, Japan*, ***Satoshi Murakami****, Aisin Keikinzoku Co.,Ltd, Imizu, Japan*, ***Kenji Matsuki, Tetsuo Aida, Kazuo Murotani****, University of Toyama, Toyama, Japan*

Effect of Compression Properties on Porous Material with Mg-Al-Zn-Ca System Alloy
JSME Technical Publication. MSEC_ICMP2008-72419
-***Tetsuo Aida, Norio Takatsuji, Kenji Matsuki, Yuukou Horita, Kazunori Takeuchi****, University of Toyama, Toyama, JAPAN, Japan*

Effect of Shear Stress on Twist in U Section Product of High Strength Steel Sheet
JSME Technical Publication. MSEC_ICMP2008-72155
-***Masashi Sakata**, Waseda University, Tokyo, Japan*, ***Motoo Asakawa**, Department of Applied Mechanics and Aerospace Engineering, Waseda University, Tokyo, Japan*, ***Yuu Hirose, Keisuke Nakamichi, Ikuhiko Hayashi**, Waseda University, Tokyo, Japan*, ***Hideyuki Sunaga**, RIKEN, Saitama, Japan*, ***Hiroshi Yano**, UNIPRES, Kanagawa, Japan*

2-4 -ADVANCED WELDING AND BONDING

2-4-2 -Advanced Welding and Bonding Technology II (ASME & JSME Technical Papers)

WildCat A (Room 101A) 1:30pm - 3:00pm

Session Chair: **Grant Kruger**, *University of Michigan, Ann Arbor, MI, United States*
Session Co-Chair: **Yoshiharu Mutoh**, *Nagaoka University of Technology, Nagaoka, Niigata, Japan*

Fatigue Properties of Friction Stir Welded 2024-T3 Aluminum Alloy
JSME Technical Publication. MSEC_ICMP2008-72197
-***Masako Suzuki**, Graduate School of Fundamental Science and Engineering, Waseda University, Tokyo, Japan*, ***Motoo Asakawa**, Department of Applied Mechanics and Aerospace Engineering, Waseda University, Tokyo, Japan*, ***Takao Okada**, Aviation Program Group, Japan Aerospace Exploration Agency, Tokyo, Japan*, ***Haruka Miyake**, Graduate School of Fundamental Science and Engineering, Waseda University, Tokyo, Japan*, ***Toshiya Nakamura, Shigeru Machida**, Aviation Program Group, Japan Aerospace Exploration Agency, Tokyo, Japan*

Lap Weldability of Pure Ti and 5052 Aluminum Alloy Sheets Using Pulsed YAG Laser
JSME Technical Publication. MSEC_ICMP2008-72088
-***Kan Watanabe, Toshikatsu Asahina**, Nihon University, Chiba, Japan*

Brazing of Carbon/Carbon Composites to Titanium with Active Filler Metal
JSME Technical Publication. MSEC_ICMP2008-72114
-***Toshi-Taka Ikeshoji, Nariaki Kunika, Akio Suzumura**, **Takahisa Yamazaki**, Tokyo Institute of Technology, Tokyo, Japan*

E-Design Tool for Friction Stir Welding
ASME Technical Publication. MSEC_ICMP2008-72207
-***Harish Bagaitkar, Venkat Allada**, Missouri University of Science & Technology, Rolla, MO, United States*

2-7 -MODEL-BASED MANUFACTURING CONTROL

2-7-1 -Model-Based Control and Quality (ASME Technical Papers)

Arch (Room 206) 1:30pm - 3:00pm

Session Chair: **Laine Mears**, *Clemson University, Greenville, SC, United States*
Session Co-Chair: **Jaime Camelio**, *Virginia Tech, Blacksburg, VA, United States*

Dimensional Error Compensation in Compliant Assembly Processes Using Virtual Assembly Training
ASME Technical Publication. MSEC_ICMP2008-72219
-***Kang Xie**, Michigan Technological University, Houghton, MI, United States*, ***Jaime Camelio**, Virginia Tech, Blacksburg, VA, United States*, ***L. Eduardo Izquierdo**, University of Warwick, Coventry, United Kingdom*

Quality Monitoring and Fault Detection on Stamped Parts Using DCA and LDA Image Recognition Techniques
ASME Technical Publication. MSEC_ICMP2008-72218
-***Qiangsheng Zhao**, Michigan Technological University, Houghton, MI, United States*, ***Jaime Camelio**, Virginia Tech, Blacksburg, VA, United States*

A New Position Feedback Method for Manufacturing Equipment
ASME Technical Publication. MSEC_ICMP2008-72222
-***Chan Wong, Carlos Montes, Laine Mears, John Ziegert**, Clemson University, Greenville, SC, United States*

Graphical MPC for Fast Dynamic Systems
ASME Technical Publication. MSEC_ICMP2008-72310
-***Ricardo Dunia, Javier Gutierrez**, National Instruments, Austin, TX, United States*

ERP Systems Supporting Lean Manufacturing: A Literature Review
ASME Technical Publication. MSEC_ICMP2008-72542
-***Pritish Halgeri, ZJ Pei***, *Kansas State University, Manhattan, KS, United States*, ***Karthik Iyer, Kendal Bishop, Ahmad Shehadeh***, *KSU, Manhattan, KS, United States*

Material Characterization of Uncoated Boron Steel for Automotive Body Structure Applications
ASME Technical Publication. MSEC_ICMP2008-72193
-***Ramakrishna Koganti, Sergio Angotti, Ronald Cooper, Dan Houston***, *Ford Motor Company, Dearborn, MI, United States*, ***Asif Waheed***, *AECL, Mississauga, ON, Canada*, ***Timothy Topper***, *University of Waterloo, Waterloo, ON, Canada*

TK 3 Properties and Applications

Track Chair: **Ikuo Ihara**, *Nagaoka University of Technology, Nagaoka, Niigata, Japan*

3-1 -MECHANICAL CHARACTERIZATION AND MEASUREMENT TECHNIQUES

3-1-2 -Mechanical Characterization and Measurement Techniques II (ASME & JSME Technical Papers)

Rock (Room 207) 1:30pm - 3:00pm

Session Chair: **Koji Fujimoto**, *The University of Tokyo, Tokyo, Japan*
Session Co-Chair: **Li Ma**, *National Institute of Standards and Technology, Gaithersburg, MD, United States*

Two Stage S-N Curve in Corrosion Fatigue of Extruded Magnesium Alloy AZ31
JSME Technical Publication. MSEC_ICMP2008-72324
-***Md.Shahnewaz Bhuiyan, Yoshiharu Mutoh***, *Nagaoka University of Technology, Nagaoka, Niigata, Japan*, ***Thutomu Murai***, ***S. Iwakami***, *Sankyo Aluminium Industry Co., Ltd., Toyama, Japan*

Fatigue Crack Growth Behavior of Steels with Pearlite Particles Dispersed in Ferrite Matrix
JSME Technical Publication. MSEC_ICMP2008-72436
-***Mohammad Sukri Mustapa***, *Nagaoka University of Technology, Nagaoka, Niigata, Japan*, ***Jayaprakash Murugesan, Yoshiharu Mutoh***, *Nagaoka university of Technology, Nagaoka, Niigata, Japan*, ***T. Sadasue***, *Steel Research Lab., JFE Steel Corporation, Chiba, Japan*

3-2 -ADVANCES IN SENSORS, CONTROLLER, INTELLIGENT SYSYTEMS AND ROBOTICS FOR MATERIAL PROCESSING AND INSPECTION

3-2-1 -Advances in Sensors, Controllers, Intelligent Systems and Robotics for Material Processing and Inspection I (ASME Technical Papers)

Armadillo (Room 208) 1:30pm - 3:00pm

Session Chair: **Radu Pavel**, *TechSolve, Inc., Cincinnati, OH, United States*
Session Co-Chair: **Yasuo Suga**, *Keio University, Yokohama, Japan*

Calibration of a Milling Force Model Using Feed and Spindle Power Sensors
ASME Technical Publication. MSEC_ICMP2008-72315
-***Bryan Javorek***, *University of New Hampshire, Dover, NH, United States*, ***Barry K Fussell, Robert B Jerard***, *University of New Hampshire, Durham, NH, United States*

Force/Velocity Control of a Pneumatic Gantry Robot for Contour Tracking with Neural Network Compensation
ASME Technical Publication. MSEC_ICMP2008-72374
-***Mohammed Abu-Mallouh, Brian Surgenor***, *Queen's University, Kingston, ON, Canada*

Characterization of a Nano-Composite Sensor in Multiple Environmental Domains
ASME Technical Publication. MSEC_ICMP2008-72503
-***Swathi Chimalapati***, *Clemson University, Clemson, SC, United States*, ***Laine Mears***, *Clemson University, Greenville, SC, United States*, ***Andrew C., Clark***, *Sensor Tech, Inc., Greenville, SC, United States*

Characteristics Of Acoustic Emission Signals In Machining Using Diamond Coated Tools
ASME Technical Publication. MSEC_ICMP2008-72507
-***Jianwen Hu, Feng Qin***, *UA, Tuscaloosa, AL, United States*, ***Kevin Chou***, *The University of Alabama, Tuscaloosa, AL, United States*, ***Raymond Thompson***, *Vistae Engineering, Birmingham, AL, United States*

3-5 -DYNAMIC BEHAVIOR OF MATERIALS AND STRUCTURES (IN HONOR OF PROF. SHIOYA AND DR. OGAWA)

3-5-3 -Dynamic Behavior of Materials and Structures III (JSME Technical Papers)

Northwestern A (Room 202A) 1:30pm - 3:00pm

Session Chair: **Takayuki Kusaka**, *Ritsumeikan University, Kusatsu, Japan*
Session Co-Chair: **Imin Kao**, *Stony Brook University, Stony Brook, NY, United States*

Effect of Output Bar Supporting Methods on High Velocity Tensile Behavior for Steel Plate
JSME Technical Publication. MSEC_ICMP2008-72337
-***Masaaki Itabashi***, *Tokyo University of Science, Suwa, Chino, Nagano, Japan*

High Strain-Rate Compressive Stress-Strain Loops of Several Plastics
JSME Technical Publication. MSEC_ICMP2008-72401
-***Kenji Nakai, Takashi Yokoyama***, *Okayama University of Science, Okayama, Japan*

High Strain-Rate Compressive Response of Friction Stir Welded AA2024-T3 Joints
JSME Technical Publication. MSEC_ICMP2008-72428
-***Takashi Yokoyama, Kenji Nakai***, *Okayama University of Science, Okayama, Okayama, Japan*

Damped Vibration Response at Different Speeds of Wire in Slurry Wiresaw Manufacturing Operations
ASME Technical Publication. MSEC_ICMP2008-72213
-***Chunhui Chung, Imin Kao***, *Stony Brook University, Stony Brook, NY, United States*

TK 4 Micro and Nano Technologies

Track Chair: **Gloria Wiens**, *University of Florida, Gainesville, FL, United States*

4-4 -MINIATURIZATION OF MOLDING PROCESSES FOR MICROFABRICATION

4-4-2 -Miniaturization of Molding Processes for Microfabrication II (ASME & JSME Technical Papers)

Northwestern B (Room 202B) 1:30pm - 3:00pm

Session Chair: **Donggang Yao**, *Georgia Institute of Technology, Atlanta, GA, United States*
Session Co-Chair: **Kuniaki Dohda**, *Nagoya Institute of Technology, Nagoya, Japan*

Viscoelasticity Effects of Polymeric Material in Micro Injection Molding
ASME Technical Publication. MSEC_ICMP2008-72128
-***Peiman Mosaddegh, David C. Angstadt***, *Clemson University, Clemson, SC, United States*

Small Scale Molding System for Thermoplastic Materials using Strong Ultrasonic Vibration
JSME Technical Publication. MSEC_ICMP2008-72092
-***Takushi Saito, Motoki Noko, Tatsuya Kawaguchi, Isao Satoh***, *Tokyo Institute of Technology, Tokyo, Japan*

Effect of Tooling Surface Roughness in Micro Injection Molding
ASME Technical Publication. MSEC_ICMP2008-72093
-***SUNG-HWAN YOON***, *University of Massachusetts Lowell, Lowell, MA, United States*, ***Nam-Goo Cha***, *Northeastern University, Boston, MA, United States*, ***Jisun Im***, *University of Massachusetts Lowell, Lowell, MA, United States*, ***Xugang Xiong***, *Center for High-rate Nanomanufacturing, Boston, MA, United States*, ***Jun Lee***, *University of Massachusetts Lowell, Lowell, MA, United States*, ***Joey L. Mead***, *Plastics Engineering, Lowelll, MA, United States*, ***Carol M. F. Barry***, *Plastics Engineering, Lowell, MA, United States*

FRIDAY 3:30 – 5:00 PM

TK 1 Materials

Track Chair: **Hiroshi Asanuma**, *Chiba University, Chiba, Japan*

1-6 -SMART MATERIALS AND STRUCTURES

1-6-1 -Smart Materials and Structures (JSME Technical Papers)

WildCat B (Room 101B) 3:30pm - 5:00pm

Session Chair: **Hiroshi Asanuma**, *Chiba University, Chiba, Japan*
Session Co-Chair: **Satoshi Kishimoto**, *National Institute for Materials Science, Tsukuba, Ibaraki, Japan*

Damage Detection in CFRP Laminates by Broadband Lamb Wave Propagation Using MFC Actuator and FBG Sensor
JSME Technical Publication. MSEC_ICMP2008-72096
-***Nakayama Fumihiro***, *The University of Tokyo, Tokyo, Japan*, ***Yoji Okabe***, *The University of Tokyo, Institute of Industrial Science, Tokyo, Japan*

Shape Controllable Sandwich Structure Using SMA Honeycomb Core
JSME Technical Publication. MSEC_ICMP2008-72143
-***Hiroshi Sugiyama***, *University of Tokyo, Tokyo, Tokyo, Japan*, ***Yoji Okabe***, *The University of Tokyo, Institute of Industrial Science, Tokyo, Japan*

Mechanical and Damping Properties of Closed Cellular Materials Containing Polymer
JSME Technical Publication. MSEC_ICMP2008-72319
-***Satoshi Kishimoto, Kimiyoshi Naito***, *National Institute for Materials Science, Tsukuba, Ibaraki, Japan*, ***Zhenlun Song***, *Chinese Academy of Sciences, Ningbo, China*, ***Fuxing Yin***, *National Institute for Materials Science, Tsukuba, Japan*

Thermal Actuation Capabilities of the Sic Continuous Fiber/Aluminum Active Composite
JSME Technical Publication. MSEC_ICMP2008-72387
-***Hiroshi Asanuma***, ***Tatsushi Kaiho, Takamitsu Chiba, Kiyotada Kato***, *Chiba University, Chiba-shi, Chiba, Japan*

TK 2 Processing

Track Chair: **Brad Kinsey**, *University of New Hampshire, Durham, NH, United States*
Track Co-Chair: **Jaime Camelio**, *Virginia Tech, Blacksburg, VA, United States*

2-1 -PLASTIC FORMING OF METALS

2-1-7 -Plastic Forming of Metals: Processing IV (JSME Technical Papers)

Big Ten (Room 104) 3:30pm - 5:00pm

Session Chair: **Richard Onyancha**, *Rose-Hulman Institute of Technology, Terre Haute, IN, United States*
Session Co-Chair: **Norio Takatsuji**, *University of Toyama, Toyama, Japan*

Solidification and Forming Technology of Minute Scrap Metal by Semisolid Process
JSME Technical Publication. MSEC_ICMP2008-72097
-***Sumio Sugiyama, Jun Yanagimoto***, *The University of Tokyo, Tokyo, Japan*

Effective Temperature Distribution and Drawing Speed Control for Stable Dieless Drawing Process of Metal Tubes
JSME Technical Publication. MSEC_ICMP2008-72377
-***Tsuyoshi Furushima, Syuhei Hirose, Ken-ichi Manabe***, *Tokyo Metropolitan University, Tokyo, Japan*

Superplastic Joining of TZP Enhanced by Titania-doped TZP as an Insert Material
JSME Technical Publication. MSEC_ICMP2008-72379
-***Yorinobu Takigawa**, Department of Materials Science, Graduate School of Engineering, Osaka Prefecture University, Sakai, Osaka, Japan*, ***Hiroaki Takadama**, Cyubu University, Kasugai, Japan*, ***Kenji Higashi**, Japan*

Adjustment of Profile of Die Backplane with Employing Multiple Elastic Actuators
JSME Technical Publication. MSEC_ICMP2008-72394
-***Takahiro Ohashi**, Kokushikan University, Tokyo, Japan*

2-4 -ADVANCED WELDING AND BONDING

2-4-3 -Advanced Welding and Bonding Technology III (ASME & JSME Technical Papers)

WildCat A (Room 101A) 3:30pm - 5:00pm

Session Chair: **Shanglu Yang**, *Southern Methodist University, Dallas, TX, United States*
Session Co-Chair: **Motoo Asakawa**, *Department of Applied Mechanics and Aerospace Engineering, Waseda University, Tokyo, Japan*

Dissimilar Materials Micro Welding between a Stainless Steel and Plastics by using Pulse YAG Laser
JSME Technical Publication. MSEC_ICMP2008-72375
-***Yukio Miyashita**, Nagaoka University of Technology, Nagaoka, Niigata, Japan*, ***Masaru Takahashi, Masashi Takemi**, Nagaoka National College of Technology, Nagaoka, Niigata, Japan*, ***Kousei Oyama, Yoshiharu Mutoh**, Nagaoka University of Technology, Nagaoka, Niigata, Japan*, ***Hironori Tanaka**, NHK Spring, Aikawa, Kanagawa, Japan*

Effect of Friction Welding Condition on Joining Phenomena and Tensile Strength of Friction Welded Joint between Pure Copper and Low Carbon Steel
JSME Technical Publication. MSEC_ICMP2008-72025
-***Masaaki Kimura, Masahiro Kusaka, Koichi Kaizu**, University of Hyogo, Himeji, Japan*, ***Akiyoshi Fuji**, Kitami Institute of Technology, Kitami, Japan*

Effect of Nickel-Iron Mixture of Weld Metal on Hydrogen Permeability at Various Temperatures in Stainless Steel 316L
JSME Technical Publication. MSEC_ICMP2008-72100
-***Takahisa Yamazaki, Toshi-Taka Ikeshoji**, Tokyo Institute of Technology, Meguro-ku, Tokyo, Japan*, ***Akio Suzumura, Shumpei Kamono**, Tokyo Institute of Technology, Tokyo, Japan*

The Influence of the Chemical Composition of Welding Material Used in Semi-automatic Welding for Pipeline Steel on Mechanical Properties
ASME Technical Publication. MSEC_ICMP2008-72110
-***Lu Bai, Tong Lige, Ding Hongsheng, Wang Li, Kang Qilan**, University of Science and Technology Beijing, Beijing, Beijing, China*, ***Shiwu Bai**, Pipeline Research Institute of China National Petroleum Corporation, Langfang, China*

2-7 -MODEL-BASED MANUFACTURING CONTROL

2-7-2 -Process Modeling and Optimization (ASME Technical Papers)

Arch (Room 206) 3:30pm - 5:00pm

Session Chair: **Jaime Camelio**, *Virginia Tech, Blacksburg, VA, United States*
Session Co-Chair: **Laine Mears**, *Clemson University, Greenville, SC, United States*

Dynamic Optimization of the Grinding Process in Batch Production
ASME Technical Publication. MSEC_ICMP2008-72212
-***Cheol W. Lee**, University of Michigan - Dearborn, Dearborn, MI, United States*

Assessment of the Process Parameters and their Effect on the Chip Length when using CNC Toolpaths to Provide Chip Breaking in Turning Operations
ASME Technical Publication. MSEC_ICMP2008-72468
-***Bethany Woody**, UNC Charlotte, Charlotte, NC, United States*, ***K. Scott Smith, David J. Adams**, University of North Carolina at Charlotte, Charlotte, NC, United States*, ***William E. Barkman**, Y-12 National Security Complex, Oak Ridge, TN, United States*

Analytical Modeling of Metal Transfer for GMAW in the Globular Mode
ASME Technical Publication. MSEC_ICMP2008-72548
-***Ugur Ersoy, S. Jack Hu****, University of Michigan, Ann Arbor, MI, United States*, ***Elijah Kannatey-Asibu Jr.,*** *NSF Engineering Research Center for Reconfigurable Manufacturing Systems Ann Arbor, MI, United States*

TK 3 Properties and Applications

Track Chair: **Ikuo Ihara***, Nagaoka University of Technology, Nagaoka, Niigata, Japan*

3-2 -ADVANCES IN SENSORS, CONTROLLER, INTELLIGENT SYSYTEMS AND ROBOTICS FOR MATERIAL PROCESSING AND INSPECTION

3-2-2 -Advances in Sensors, Controllers, Intelligent Systems and Robotics for Material Processing and Inspection II (ASME & JSME Technical Papers)

Armadillo (Room 208) 3:30pm - 5:00pm

Session Chair: **Radu Pavel***, TechSolve, Inc., Cincinnati, OH, United States*
Session Co-Chair: **Yasuo Suga***, Keio University, Yokohama, Japan*

Welding Penetration Control of Fixed Pipe in TIG Welding Using Fuzzy Inference System
JSME Technical Publication. MSEC_ICMP2008-72103
-***Ario Sunar Baskoro, Masashi Kabutomori****, Graduate School of Science and Technology, Keio University, Yokohama, Japan*, ***Yasuo Suga****, Keio University, Yokohama, Japan*

Estimation and Control of Penetration Using Vision Sensor in TIG Welding of Thin Steel Plates
JSME Technical Publication. MSEC_ICMP2008-72299
-***Yasuo Suga****, Keio University, Yokohama, Japan*

Inferring Hardness from High-Speed Video of the Machining Process
ASME Technical Publication. MSEC_ICMP2008-72493
-***Don R. Hush, Matthew T. Bement, Tim K. Wong****, Los Alamos National Laboratory, Los Alamos, NM, United States*

Visual Simulation of Aristo Robot with Workspace Analysis
ASME Technical Publication. MSEC_ICMP2008-72484
-***Upendra Parghi****, Sardar Vallabhbhai National Institute of Technology, Surat, Gujrat, India*, ***Harit K. Raval****, S. V. National Institute of Technology, Surat, Gujarat, India*

3-5 -DYNAMIC BEHAVIOR OF MATERIALS AND STRUCTURES (IN HONOR OF PROF. SHIOYA AND DR. OGAWA)

3-5-4 -Dynamic Behavior of Materials and Structures IV (JSME Technical Papers)

Northwestern A (Room 202A) 3:30pm - 5:00pm

Session Chair: **Hidetoshi Kobayashi***, Osaka University, Toyonaka, Osaka, Japan*
Session Co-Chair: **Masahiro Nishida***, Nagoya Institute of Technology, Nagoya, Japan*

Visualization of Hydrogen Accumulation during Impact Deformation and Fracture of Aluminum Alloys
JSME Technical Publication. MSEC_ICMP2008-72058
-***Keitaro Horikawa****, Osaka University, Toyonaka, Osaka, Japan*, ***Hiyoyuki Yamada****, Osaka University, Machikayeyama, Japan*, ***Kenichi Tanigaki, Hidetoshi Kobayashi****, Osaka University, Toyonaka, Japan*, ***Masashi Daimaruya****, Muroran Institute of Technology, Muroran, Japan*

Material Ductility of PP/SEBS/SiO2 Nanocomposites at Impact Loading
JSME Technical Publication. MSEC_ICMP2008-72148
-***Hiroyuki Mae****, Honda R&D Co., Ltd., Tochigi, Japan*, ***Masaki Omiya****, Keio University, Kanagawa, Japan*, ***Kikuo Kishimoto****, Tokyo Institute of Technology, Tokyo, Japan*

Comparison of Tensile and Dart Impact Properties in Polypropylene Syntactic Foams
JSME Technical Publication. MSEC_ICMP2008-72149

-***Hiroyuki Mae***, *Honda R&D Co., Ltd., Tochigi, Japan*, ***Masaki Omiya***, *Keio University, Kanagawa, Japan*, ***Kikuo Kishimoto***, *Tokyo Institute of Technology, Tokyo, Japan*

Experimental Characterization of Dynamic Mode II Fracture Behavior of Zanchor Reinforced CF/Epoxy Composites Using SHPB Technique
JSME Technical Publication. MSEC_ICMP2008-72170

-***Takayuki Kusaka***, *Ritsumeikan University, Kusatsu, Japan*, ***Kinya Ogawa***, *Space Dynamics Laboratory, Kyoto, Kyoto Prefecture, Japan*, ***Keiko Watanabe***, *Osaka University, Toyonaka, Japan*, ***Masaki Hojo***, *Kyoto University, Kyoto, Japan*, ***Toshiyasu Fukuoka***, *Mitsubishi Heavy Industries, Nagoya, Japan*, ***Masayasu Ishibashi***, *Shikibo, Higashi-Oumi, Japan*

TK 4 Micro and Nano Technologies

Track Chair: **Gloria Wiens**, *University of Florida, Gainesville, FL, United States*

4-4 -MINIATURIZATION OF MOLDING PROCESSES FOR MICROFABRICATION

4-4-3 -Miniaturization of Molding Processes for Microfabrication III (ASME & JSME Technical Papers)

Northwestern B (Room 202B) 3:30pm - 5:00pm

Session Chair: **Donggang Yao**, *Georgia Institute of Technology, Atlanta, GA, United States*
Session Co-Chair: **Takushi Saito**, *Tokyo Institute of Technology, Tokyo, Japan*

Mechanical Properties and Fracture Mechanism of CF Flat Braided Composites with Dispersed Carbon Nanofibers in the Matrix
ASME Technical Publication. MSEC_ICMP2008-72017

-***Yuka Kobayashi***, *Kyoto Institute of Technology, Kyoto, Japan*, ***Mohamed S. Aly-Hassan***, *Kyoto Institute of Technology, Sakyo-ku, Kyoto, Matsugasaki, Japan*, ***Asami Nakai, Hiroyuki Hamada***, *Kyoto Institute of Technology, Kyoto, Japan*, ***Hiroshi Hatta***, *Institute of Space and Astronautical Science (ISAS), Japan Aerospace Exploration Agency (JAXA), Kanagawa-Ken, Sagamihara-Shi, Japan*

Discrete Microparts Production Using Through-Thickness Hot Embossing and Rubber-Assisted Ejection
ASME Technical Publication. MSEC_ICMP2008-72048

-***Ramasubramani Kuduva-Raman-Thanumoorthy, Donggang Yao***, *Georgia Institute of Technology, Atlanta, GA, United States*

Particle Distribution and Mechanical Properties of Silica-Filled PMMA Micro-injection Moldings
ASME Technical Publication. MSEC_ICMP2008-72056

-***Yew Wei Leong***, *Kyoto Institute of Technology, Kyoto, Japan*, ***Supaporn Thumsorn***, *Advanced Fibro Science, Kyoto Institute of Technology, Kyoto, Japan*, ***Asami Nakai, Hiroyuki Hamada***, *Kyoto Institute of Technology, Kyoto, Japan*, ***Hiroshi Ito***, *Yamagata*

FRIDAY 6:00 – 7:30 PM

TK 6 Other Conference Events

Track Chair: **John T. Roth**, *Penn State Erie, The Behrend College, Erie, PA, United States*

6-2 -GENERAL MEETINGS AND PLENARY TALKS

6-2-7 -ASME and JSME Planning Committee Wrap-up Meeting

Evans (Room 102) 6:00pm - 7:30pm

SATURDAY 8:00AM – 12:00PM

POST-CONFERENCE Short Courses on Fundamentals and New Opportunities of Materials – Tech Institute

SPONSORED BY NSF

Strengthening of Steels – M. E. Fine
Iron is made strong primarily by dispersions of nano-sized particles. In quenched and tempered steels, these particles are primarily carbides. There is also strengthening by the crystal defects from the phase transformation (austenite to martensite) that occurs on quenching. Low carbon is desirable for improved toughness and to obtain ductile welds. Recent research on strengthening low carbon steels by nanoscale precipitates will be presented.

Ceramics for Structural Applications – K. T. Faber
Ceramic materials, though intrinsically brittle, afford the highest stiffness and greatest temperature resistance of any material class. Forming and shaping methods of ceramics will be reviewed, including some recent advances in high solids loading, near-net shape techniques. The statistical nature of strength of ceramics will be discussed in light of ensuring reliability in brittle materials. Strategies for flaw-tolerant ceramics will be presented. Examples will also be provided of the design of ceramics as integral parts of power generation systems.

Manufacturing of Metallic Foams – D. N. Dunand
This talk will review various methods to fabricate metallic foams for applications as diverse as structural sandwiches, filters, heat-exchangers, catalyst substrates and medical implants. Examples of titanium, nickel and steel foams will then be presented, focusing on manufacturing and its effect on mechanical properties.

Shape Memory Alloys – L. C. Brinson
This talk will review the fundamental properties and applications of shape memory alloys. Emphasis will be on the underlying crystallographic phase transformation and the relationship to the materials unique macroscopic properties. The origins of the shape memory effect and pseudoelasticity will be presented along with best practices in ways to capture the constitutive behavior in mathematical models. Examples of applications of SMAs and the applications of the models will be presented

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Morris E. Fine is Member of the Graduate School and Technological Institute Professor at Northwestern University's McCormick School of Engineering and Applied Science. It was through his leadership that the first Materials Science Department in the United States was started ca. 1958 in Northwestern's Engineering School (then called the Technological Institute). Morrie's principal field of research is phase transformation in materials with emphasis on forming nanoscale precipitates in metals and ceramics, recently in steels. He has won many awards including membership in the National Academy of Engineering and the American Academy of Arts and Sciences.

Katherine Faber, Walter P. Murphy Professor of Materials Science and Engineering, has published more than 120 papers and edited one book in the area of fracture, toughening mechanisms and thermal shock in ceramics, glasses, cement-based materials, coatings, and ceramic-matrix composites. Among Professor Faber's awards are the NSF Presidential Young Investigator Award, Fellow of the American Ceramic Society and of ASM International, the Charles E. MacQuigg Award for Outstanding Teaching at Ohio State, the Society of Women Engineers Distinguished Educator Award, and the YWCA Achievement Award for Education. She is an ISI Highly Cited Author in Materials, and recently completed a term as President of the American Ceramic Society.

David C. Dunand is the James and Margie Krebs Professor in the Department of
Materials Science and Engineering at Northwestern University. He received his doctorate from MIT in 1991, where he was a faculty member before joining NU in 1997. He has published over 160 journal articles on physical, mechanical and process metallurgy, about 40 of which are on metallic foams. He was recently named Fellow of ASM International and received Teacher of the Year award in 1998 from the MSE department.

L. Cate Brinson is currently the Jerome B. Cohen Professor of Engineering at Northwestern University and Chair of the Mechanical Engineering Department with a secondary appointment in the Materials Science and Engineering Department. She received her Ph.D. in 1990 from Caltech, was a postdoc in Germany at the DLR, then joined the Northwestern faculty in 1992. She has authored one book and over 70 journal publications on topics surrounding the modeling and characterization of advanced material systems, including polymers, nanocomposites and intelligent materials. Among Dr. Brinson's significant awards are the 2006 Friedrich Wilhelm Bessel Prize of the Alexander von Humboldt Foundation, the 2003 ASME Special Achievement Award for Young Investigators, the NSF CAREER Award. She is also currently serving on the National Materials Advisory Board of the National Academies.

PLENARY TALKS

Plenary Talk – Wednesday 9:00am

Energy Technology and the Environment: Advances in Renewables

James R. Maughan, Ph.D.
General Manager, Product Service and Warranty
GE Wind Energy
Schenectady, NY

Abstract

In meeting society's increasing demand for energy, the environmental impact of any particular choice is emerging as a business factor as significant as efficiency, fuel availability, security, or even cost. This in turn is driving the development of new options that reduce environmental impact, often at the expense of other factors, forcing larger choices to be made.

This lecture will focus on the promise and perils of some of these new energy technologies under development at GE Energy and elsewhere. Options range from improving current applications such as steam-cooled gas turbines, coal gasification with CO_2 sequestration, nuclear power, and wind turbines to advancing newer potential solutions such as solid oxide fuel cell hybrids, organic photovoltaics, hot dry rock energy, superconducting electrical systems, and a broad hydrogen economy, possibilities all enabled through improvements in fundamental technologies such as materials, analysis, and modeling, and through applied technology such as lean manufacturing and rapid prototyping. Particular focus is given to wind turbine technology, the fastest growing renewable energy source today and where GE has recently built a $7B business.

No single technology is likely to be the entire answer. Each will challenge engineers well in to the future. Continuous technology development, however, will create the options from which to choose energy sources that are cost effective, secure, and environmentally sustainable.

Brief Bio: James R. Maughan, a second-generation GE employee, was born in Schenectady, NY. He received a B.S. from Brigham Young University, and a M.S. and Ph.D. from Purdue University, all in Mechanical Engineering. He joined GE in 1989 at the Corporate Research Center, in Schenectady, NY, working in the area of low emissions combustion research, aircraft engines combustion, and gas appliances. He joined GE Energy in 1997 to lead the introduction of low emissions combustion systems into GE gas turbines, and held subsequent leadership positions in Gas Turbine, Steam Turbine, and Energy Services. He was later global manager of energy-related research at GE's Research Center, and was General Manager of Controls and Power Electronics in Salem, VA until early 2007, when he moved into his current role as General Manager of Product Service and Warranty for GE Wind Energy. In this position, he is responsible for customer satisfaction and the reliable and efficient operation of GE's global and growing fleet of 9000 turbines.

He and his wife Sharon are the parents of four children, with whom he spends the bulk of his free time. He also enjoys a variety of social pursuits, volunteering with Scouting, and outdoor activities such as hiking, caving, and astrophotography.

Plenary Talk – Wednesday 9:45 am

The Estimation Theory of Creep Behavior on Fiber Reinforced Thermoplastics

Satoshi Somiya, Ph.D.
Visiting Lecturer
Keio University
Tokyo, Japan

Abstract

Structure and parts in some machines which was made with some engineering polymers usually shows creep deformation. In the case of delicate machine, the deformation according to time and temperature became a problem. Composition of reinforcements in resin is well known to decrease the creep progress but it was very difficult to estimate them with the theoretical analysis and calculation by FEM method recently. One of the reasons is this phenomenon sometimes shows non-linearity. Now some influences factors such as physical aging, crystallinity, polymerization, moisture, water absorption and filer composition on viscoelastic behavior have been found, but their effect on creep deformation have not obtained quantitatively.

The effect of filer composition on creep behavior was researched quantitatively at first. For GFRP of polycarbonate with perfectly physical aging treatment, creep compliance Dc(t) under some temperature conditions were measured and it was confirmed that all creep behavior were presented by master curves Dc(t') on specimens of each fiber volume fraction and also one grand master curve Dc(t'') on all master curves of several FRPS was obtained by some shift factors such as temperature shift factors and modulus shift factor. Because it was found "Time-Temperature superposition principle" was adaptive, creep strain curve to real time of several FRP is able to be calculated with the grand master curve and some shift factors, using linear visco-elastic theory as follows;

$$\varepsilon(t) = D_c(t)\sigma_0 + \int D_c(t-\tau)\frac{d\sigma}{d\tau}d\tau \qquad (1)$$

The effect of physical aging on creep deformation was researched on FRP of PC. From these results, it was found that the effect of these factors is able to present by shift factor as same as the effect of fiber contents. In addition we can estimate the creep process of FRPs, which are several fiber contents under some kinds of physical aging conditions on arbitrary temperature.

Brief Bio: Dr. Somiya received his PhD degree of Engineering from the graduate school of Keio university. He served as Assistant of Keio University in 1973. He then became Associate Professor, Assistant Professor and Professor and retired from Keio University at 2008. He is now a visiting lecturer of Keio University at 66 years old. He was a chair of the division of Material and Processing on Japan Society of Mechanical Engineers from 1994 to 1995.

Dr. Somiya's research fields; Fracture strength, Fracture mechanism and viscoelastic deformation of polymers and polymer matrix composite and the development of recycle method for fiber reinforced Plastics.

Plenary Talk – Thursday Lunch

Manufacturing Industries in South Asia and R&D in Singapore

Atsushi Danno, Ph.D.

Singapore Institute of Manufacturing Technology (SIMTech)
Agency for Science, Technology and Research (A*STAR),
Singapore

Abstract

While there was some slowdown in the G3 (US, Japan, European Union) economies in these few years, the economies of ASEAN countries and India continued to see robust expansion supported both by domestic demand and external trade. These economy in Asia has been mainly based on the transfer of production base for the components of transport (automobile), electrical/electric devices and plastic/chemical products, etc from G3 countries.
The main benefit of production in Asia was higher cost competitiveness of products, which was supported by a lower labor cost in Asian countries. However, the recent improvement in production technology was remarkable in Asian countries. The environment-friendly manufacturing is to be developed widely in Asian countries for keeping their higher competitiveness in global market in future.

Singapore manufacturing industry has held 25~30% of domestic GDP and been composed mainly of electronics products (30%), chemicals (30%) and biomedical/ precision engineering products (20%). Recently, it faces to a severe competitiveness in Asian countries because of relatively higher labor cost in Singapore and the remarkable expansion of manufacturing industries in other Asian countries. In such the situation, Singapore has strongly push forward with R&D in the chemicals/pharmaceutics, biomedical manufacturing, aerospace (repairer, component manufacturing, engine assembling, etc.), medical technology & devices, advanced material & its processing as well as automotive devices (Communication technology, etc.) for strengthening their global competitiveness in future manufacturing industry. These R&D are performed under collaborations of the national institutes, national universities and multi national companies in Singapore.

Brief Bio: Dr. Atsushi Danno has been engaged in R&D work on the high precision bulk-metal forming technology for automotive components in Toyota Central Res. and Develop. Labs, (Japan) for around 40 years since 1964. In 1981, he was granted a degree of Dr. Eng. from Osaka University (Osaka, Japan).
He was appointed as Director and board member of Toyota Central Res. and Develop. Labs, from 1995 to 2001, a Director of JSTP in 1996-1998, a vice president of JSME in 1999-2000 and the head of TOKAI branch office of JSME in 2001-2002. He has been the Fellow of JSME since 2001.
He continued his R&D work on the forming technology as a Visiting Senior Scientist in A* STAR-Singapore Institute of Manufacturing Technology in Singapore since 2003.

Merchant Medal Award Lunch Presentation – Friday Noon

The Deterministic Approach in Metrology and Manufacturing

James B. Bryan

Abstract

The basic idea is that automatic machine tools and measuring machines are perfectly repeatable just like the stars and the planets. They obey cause and effect relationships that are within our ability to understand and affordably control. There is nothing random or probabilistic about their behavior.

Everything happens for a reason. The list of reasons is small enough to manage by common sense, good metrology, and a reasonable investment of resources.

Brief Bio: James B. Bryan Retired in 1985 after 30 years as the Metrology Group Leader at the Lawrence Livermore National Laboratory, University of California.

Honorary Member of the International Academy for Production Engineering, (ClRP) the European Society for Precision Engineering, and the American Society for Precision Engineering. Fellow member of S.M.E. Inventor of the "Telescoping magnetic ball bar" for testing machine tools and the "Slow Tool Servo" for diamond tool facing of asymetric workpieces.

Presently James Bryan is an independent consultant in Precision Engineering.

ABSTRACTS

Track 1 Materials

Symp 1-1 POLYMER AND POLYMER MATRIX COMPOSITES

MSEC_ICMP2008-72039

EXPERIMENTAL STUDY ON EFFECTS OF ELASTOMER COATING ON THE VIBRATION-DAMPING PROPERTY OF STEEL AND CFRP PLATES FOR SHIP`S HULL

Shigemitu Kurano — *Technical Research & Development Institute The Ministry of Japan Defense*

VIbration-damping properties have been studied for steel and CFRP(Carbon Fiber Reinforced Plastics)plates coated with viscoelastic elastomer which are applied for ship`s hull materials with the aim of reducing the vibration noise. In the present study, vibration loss factor of the coated materials and original components have been measured by the standard method as determined in JIS G 0602.The loss factor and the Young`s modulus of the elastomer in a range of the frequency of the decrease object for reducing the vibration noise have been computed by the conversion frequency nomogram. In this calculation, The temperature-frequency conversion rule is used,which is obtained from the measurement of the loss factor and the resonance frequency characteristics. As a result of above experiments and calculations, a method for reducing the radiation noise by coating hull with elastomer is proposed.

MSEC_ICMP2008-72049

MODELING THE FLOW AND DISTRIBUTION OF NANAOPARTICLES IN FRICTION STIR PROCESSED POLYMERIC COMPOSITE MATERIALS

Yong Gan — *University of Toledo*

Friction stir processing is an advanced manufacturing process in which a specially designed rotating pin is first inserted into the adjoining edges of the materials to be processed with a proper nuting angle and then move all along the adjoining edges. The pin produces frictional and plastic deformation heating in the processing zone. As the tool pin moves, materials are forced to flow around the pin. Material flows to the back of the pin, where it is extruded and forged behind the tool, consolidated and cooled under hydrostatic pressure conditions. The primary research about friction stir processing has been focused on aluminum alloys. In recent years many researchers have been trying to apply this technology for processing other alloys and materials including stainless steels, magnesium, titanium, and copper. In addition, this technology has been used to modify the microstructure of reinforced metal matrix composite materials. However, friction stir processing polymeric based materials are much less studied. Friction stir processing has the advantage of reducing distortion and defects in materials. It has potential to be used in manufacturing nanoparticle-reinforced polymeric composite materials. In this work, modeling the flow pattern and the distribution of nanoparticles in friction stir processed polymeric composite materials was performed. The internal pressure in friction stir processed composite materials was also computed to predict the residual stress state in the nanocomposite materials.

MSEC_ICMP2008-72196

NUMERICAL AND EXPERIMENTAL STUDY ON THE INJECTION MOULDING OF A THIN-WALL COMPLEX PART

Catalin Fetecau — *Dunarea de Jos University of Galati*
Ion Postolache — *Universitatea Dunarea de Jos din Galati*
Felicia STAN — *Dunarea de Jos University of Galati*

The research presented in this paper involves numerical and experimental efforts to investigate the relative thin-wall injection molding process in order to obtain high dimensional quality complex parts. To better understand the effects of various processing parameters (the filling time, injection pressure, the melting temperature, the mold temperature) on the injection molding of a thin-wall complex part, the molding experiments are regenerated into the computer model using the Moldflow Plastics Insight (MPI) 6.1 software. The computer visualization of the filling phase allows accurate prediction of the location of the flow front, welding lines and air traps. Furthermore, in order to optimize the injection molding process, the effects of the geometry of the runner system on the filling and packing phases are also investigated. It is shown that computational modeling could be used to help the process and mold designer to produce accurate parts.

MSEC_ICMP2008-72281

INTERFACIAL STRENGTH EVALUATION IN GLASS FIBER REINFORCED COMPOSITES USING THE CRUCIFORM SPECIMEN METHOD

Shinji Ogihara — *Tokyo University of Science*
Hajime Kato — *Tokyo Unverstiy of Science*

In fiber reinforced composite materials, the interface between the fiber and the matrix plays a key role in mechanical properties of composite materials. Therefore, a more accurate evaluation method of the interface is necessary to develop better fiber reinforced composite materials. Many techniques are used for evaluating the interfacial properties. Recently, an experimental method of evaluating interfacial tensile strength that uses a cruciform shape specimen is proposed from such a viewpoint. In the cruciform specimen, a single fiber whose direction is perpendicular to the loading direction is embedded in the specimen central region where the specimen width is enlarged. This method can avoid the influence of interfacial stress singularity at the specimen edge on the debonding initiation. Although there are some studies on this method and it may be very useful in evaluating the interfacial tensile strength, it is not well established as an evaluation method and is not widely used yet. The purpose of the present study is to verify the validity of the cruciform specimen experimentally and analytically. A GF/Epoxy model composite is used. The initiation and propagation of interfacial debonding in both cruciform specimen and straight specimens are experimentally clarified. Moreover, stress analysis using finite element method (FEM) is conducted. Following results are experimentally obtained. In the straight specimens, debonding initiated from the free edge at a lower stress compared to the cruciform specimens. It was also observed that the debonding propagates gradually as the load increased. In the cruciform specimens, debonding initiated at a higher stress compared to the straight specimen. In cruciform specimens, no debonding initiation at the free edge was observed. It was also observed that the debonding propagation after initiation was much faster than in the straight specimens. From FEM, following results are found. In the straight specimens, it was seen that the influence of the stress singularity at free edge exists, and the interfacial normal stress was very high in the vicinity of the free edge. In the cruciform specimens, it was seen that the interfacial normal stress is vanishing in the vicinity of the free edge. This corresponds to the debonding initiation behavior obtained from the experiment. The interfacial strength was evaluated by the result of the experiment and FEM.

MSEC_ICMP2008-72339

FORMULATION OF TIME-TEMPERATURE DEPENDENT STRENGTH OF UNIDIRECTIONAL CFRP

Sho Yamashiro — *Kanazawa Institute of Technology*
Hongneng Cai — *Kanazawa Institute of Technology*
Masayuki Nakada — *Kanazawa Institute of Technology*
Yasushi Miyano — *Kanazawa Institute of Technology*

Recently carbon fiber reinforced plastics (CFRP) has been used for the primary structures of airplanes, ships, spacecrafts and others, in which the high reliability should be kept during the long-term operation. Therefore, it is strongly expected that the accelerated testing methodology (ATM) for the long-term life prediction of composite structures exposed under the actual environments of temperature and others is established. The mechanical behavior of polymer resins exhibits time and temperature dependence, called viscoelastic behavior, not only above the glass-transition temperature Tg but also below Tg. Thus, it can be presumed that the mechanical behavior of CFRP using polymer resins as matrices also depends on time and temperature even below Tg which is within the normal operating-temperature range. ?In our previous papers, the time and temperature dependence of the CSR, creep and fatigue strengths for various directions of CFRP laminates with various combinations of fiber and matrix were measured. The master curves of these CSR, creep and fatigue strengths of CFRP laminates were constructed by using measured data based on the time-temperature superposition principle (TTSP) to be held for the viscoelastic behavior of matrix resin. As results, it was cleared experimentally that the long-term CSR, creep and fatigue strengths of CFRP laminates can be predicted by using the short-term strengths measured based on TTSP for the viscoelastic behavior of matrix resin. ?Christensen and Miyano developed a lifetime prediction methodology based upon kinetic crack growth in polymers and polymer composites showing the viscoelastic behavior. Their formulations were theoretically and statistically performed and the characteristic of polymer and polymer composites for the fracture were statistically cleared. ?Time and temperature dependent CSR strengths for typical three directions of unidirectional CFRP, which are the tensile and compressive CSR strengths for the longitudinal direction and the tensile strength for the transverse direction, were measured at various strain rates and temperatures in our previous paper. By using these measured data, the master curves of these CSR strengths are constructed based on TTSP to be held for the creep compliance of matrix resin. Furthermore, the relationships between the viscoelastic behavior of matrix resin and these CSR strengths are evaluated on the viewpoints of failure mechanism.?Finally,

the quantitative characteristics of these CSR strength master curves are discussed using the formulation based on their failure mechanisms.

MSEC_ICMP2008-72340

INFLUENCE OF TEMPERATURE AND WATER ABSORPTION ON STATIC STRENGTHS FOR UNIDIRECTIONAL CFRP

Masahiko Murata — *Kanazawa Institute of Technology*
Masayuki Nakada — *Kanazawa Institute of Technology*
Yasushi Miyano — *Kanazawa Institute of Technology*

Recently carbon fiber reinforced plastics (CFRP) has been used for the primary structures of airplanes, ships, spacecrafts and others, in which the high reliability should be kept during the long-term operation. Therefore, it is strongly expected that the accelerated testing methodology for the long-term life prediction of composite structures exposed under the actual environments of temperature, water, and others is established. The mechanical behavior of polymer resins exhibits time and temperature dependence, called viscoelastic behavior, not only above the glass transition temperature Tg but also below Tg. Furthermore, the viscoelastic behavior of polymer resins also depends on the water absorption. Thus, it can be presumed that the mechanical behavior of polymer composites significantly depends on the water absorption as well as time and temperature. This paper is concerned with the influence of temperature and water absorption on the typical four kinds of constant strain-rate (CSR) strength of unidirectional CFRP. Unidirectional CFRP as well as neat resin plate used in this CFRP as matrix were treated under the two conditions; Dry and Wet. The CSR strengths in the four directions of unidirectional CFRP were measured at various temperatures at a single loading rate for Dry specimen. The CSR strengths in the four directions were measured at room temperature at a single loading rate for Wet specimen. The four directions were the longitudinal tension and compression, transverse tension and 20 degree off-axis tension, respectively. Furthermore, the creep compliance of neat resin plate were measured at various temperatures for Dry and Wet specimens. The influences of temperature and water absorption on these CSR strengths of unidirectional CFRP were discussed from the view points of failure mechanism of unidirectional CFRP and the viscoelastic behavior of matrix resin.

MSEC_ICMP2008-72359

VARIATIONS OF FATIGUE DAMAGE GROWTH IN CROSS-PLY AND QUASI-ISOTROPIC LAMINATES UNDER HIGH-CYCLE FATIGUE LOADING

Atsushi Hosoi — *Waseda University*
Narumichi Sato — *Toray Industries, Inc.*
Jiadi Shi — *Waseda University*
Hiroyuki Kawada — *Waseda University*

From the viewpoint of evaluation of the long-term durability of carbon fiber reinforced plastic (CFRP) laminates, the behavior of transverse crack growth and delamination growth under high-cycle fatigue loadings was investigated. Once transverse crack is initiated, the stress concentration is caused at the transverse crack tips. And then in the laminates that the free edge effect is caused conspicuously, the high out-of-plane stress is applied near the specimen edges. When these stresses are applied over 10^7-10^8 cycles in the laminates, it is thought that the damage growth behavior under high-cycle fatigue is different from that of under low cycle fatigue by interacting between transverse crack growth and delamination growth. Therefore, the growth behavior of transverse cracks and delamination was investigated under high-cycle fatigue loading with cross-ply [0/902]s & [0/906]s CFRP laminates and quasi-isotropic [45/0/-45/90]s CFRP laminates. As a result, it was observed that the behavior of damage growth was different depending on the applied stress level. The growth of local or edge delamination was promoted under the test conditions of a low applied stress level and high-cycle loading, because the parts of stress concentration were applied high cyclically. On the other hand, when the fatigue tests was conducted under the applied stress level of lower than 40% of the transverse crack initiation, the growth of transverse cracks was hardly observed until 10^8 cycles with [0/902]s, [0/906]s and [45/0/-45/90]s laminates.

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MESO-MACRO IMULATIONS OF TEXTILE COMPOSITE FORMING

Philippe Boisse — *INSA de Lyon*
Nahiene Hamila — *INSA de Lyon*
Sylvain Chatel — *EADS IW*

The composite textile reinforcement draping simulations allows the conditions for a successful process to be determined and, most importantly, the positions of the fibres after forming to be known. This last point is essential for the structural computations of the composite part and for resin injection analyses in the case of LCM processes. Because the textile composite reinforcements are multiscale materials, continuous (macro) approaches and discrete (meso) approaches that model the yarns have been developed. The finite element that is proposed in this paper

for textile fabric forming is composed of woven unit cells. The mechanical behaviour of these is analyzed by 3D computations at the mesoscale regarding biaxial tensions and in plane shear. The warp and weft directions of the woven fabric can be in arbitrary direction with respect to the direction of the element side. This is very important in the case of multi-ply deep drawing and when using remeshing. The element is efficient because it is close to the physic of the woven cell while avoiding the very large number of unknowns in the discrete approach. A set of validation tests and forming simulations on single ply and multi-ply are presented and show the efficiency of the approach.

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RHEOLOGICAL ASPECTS TO HORIZONTAL ROTATIONAL-FORMING OF THERMOPLASTIC MATERIALS

Petru/A Pop — *University of Oradea*
Petru Ungur — *University of Oradea*
Mircea Veres — *University of Oradea*
Cornelia Gordan — *University of Oradea*

The paper has presented some aspects of flow process for thermoplastic materials to rotational-forming process of revolution workpieces, type bushes. The heat of plastic material of melting point temperature has realized by High-Frequency Current Induction. The flow process has done at "Infratirea"Co. from Oradea on a centrifugal molding installation by High-Frequency Current Induction of bimetallic bushes. By experiment tests has observed that, between melting point temperature of thermoplastic material, revolution speed of mould and size mould existing a synchronism determined even of material density and whirl form of melting. The description of rheology process of melting thermoplastic by horizontal rotational-forming has required at resolving of simple and fast technology for revolution workpiece forming, type bushes. The knowledge of casting speed distribution and pressure at whirl moving of melting can due to determination of functional range. These can improved the process by rotational-forming of tube form of thermoplastic material, as polyamide-PA.6, for sliding bearing subjected at low pressures and light sliding speeds. The selection of revolution speed for metallic mould has made in function of workpiece size, type of material by technological attempts. The weight of loading is determined in dependence of thickness walls of parts. The new bearings had been obtained by attempts from polyamide-PA.6, has altering with success the bronze bearings, used at drilling machine tools.

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ORIENTATION DEPENDENCE OF IN-PLANE TENSILE PROPERTIES OF PAPERBOARD AND LINERBOARD: APPLICATION OF COMPOSITE THEORIES

Takashi YOKOYAMA — *Okayama University of Science*
Kenji NAKAI — *Okayama University of Science*

The in-plane tensile properties of commercial paperboard and linerboard for packaging containers or cartons were determined in a compact testing machine equipped with an optical extensometer and using a high-speed digital image sensor. Uncoated paperboard and two kinds of water-proof linerboard were tested in a controlled standard atmosphere specified in the ASTM D685-93. Constant-width strip specimens specified in the ASTM D828-97 were used in the tension tests. Thin strip tensile specimens were cut on a paper cutter in five different orientations between machine direction and cross-machine direction. Their thicknesses were carefully measured with a high-precision digital micrometer under a constant pressure. The in-plane Young's moduli, Poisson's ratios and tensile strengths as a function of orientation were measured and compared with predictions from both the orthotropic elasticity theory and the Tsai-Hill failure criterion. It was shown that changes in the elastic constants and tensile strengths with orientation can be analyzed using composite theories.

MSEC_ICMP2008-72466

IMPROVED PERFORMANCE OF POLYMETHYL METHACRYLATE FOR MINIMALLY INVASIVE ORTHOPEDIC IMPLANTS

Megan Schroeder — *University of Notre Dame*
Steven Schmid — *University of Notre Dame*

Polymethylmethacrylate (PMMA) based polymers are commonly used in orthopedic implant applications, and have been a successful cement for many decades. Recent implant designs use PMMA as a structural material, and additional applications are envisioned, but only if improvements in the PMMA mechanical properties, especially fatigue performance, can be attained. This paper presents a number of strategies for improving the performance of PMMA as an orthopedic structural polymer, including modification of the polymer chemistry, incorporation of acrylic reinforcement and the use of metal braids as reinforcement of a specimen exterior. Experimentally measured properties of the material are presented. Results include up to 100% increase in cycles to failure compared to commercially available medical grade PMMA through chemistry modifications, up to 800% increases due to fiber reinforcement, and further significant improvements due to metal braid reinforcement.

MSEC_ICMP2008-72483

EFFECT OF PHYSICAL AGING ON CREEP BEHAVIOR OF CARBON FIBER REINFORCED POLYIMIDE

Satoshi Somiya — *Keio University*
Reiji Nakamura — *Keio University*

Recently some polymers were using at high temperature circumstance in an engineering field. Polyimide resin was a typical heat proof engineering polymer.At high temperature condition, not only thermal degradation but also thermal deformation was problem, because this deformation caused the change of the shape and decreased the stability of productions. In this report, creep behavior of thermoplastic polyimide polymer was researched. Polyimide resin was a typical heat proof engineering polymer. In this report, the effect of crystallization and physical aging phenomena on creep deformation of CFRP of Polyimide have been researched. And the ability of "linear visco-elastic theory" and "Physical aging time and creep time super position principle" on creep behavior was discussed.

Symp 1-2 METAL AND METAL MATRIX COMPOSITES

MSEC_ICMP2008-72046

AN EXPERIMENTAL STUDY ON SHEAR FRACTURE OF ADVANCED HIGH STRENGTH STEELS

Hua-Chu Shih — *United States Steel Corporation*
Ming Shi — *United States Steel Corporation*

Fracturing in a tight radius during stretch bending has become one of the major manufacturing issues in stamping advanced high strength steels (AHSS), particularly for those AHSS with a tensile strength of 780 MPa or higher. Computer simulations often fail to predict this type of fracture, since the predicted strains are usually below the conventional forming limit curve. In this study, a laboratory stretch-forming simulator (SFS) is used to simulate the stretch bending of AHSS in stamping to develop a possible failure criterion for use in computer simulations. The SFS simulates the stamping process when sheet metal is drawn over a die radius with tension applied. Various sizes of die radius are used during the experiment, and the shear fracture phenomenon can be re-created using this test for a given material and gauge. It is found that shear fracture depends not only on the radius-to-thickness ratio but also on the tension/stretch level applied to the sheet. The experimental data show that a critical radius-to-thickness ratio for shear fracture exists for any given material and gauge, but this ratio is not unique and it depends upon the amount of tension imposed during the bending.

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GRAIN REFINEMENT OF IRON BARS BY TORSION PROCESSES AND HEAT TREATMENTS

Li-Bin Niu — *Shinshu University*
Naoki Yamaguchi — *Graduate School of Shinshu University*
Tomohiro Shima — *Graduate School of Shinshu University*
Akihiko Nagasaka — *Nagano National College of Technology*

To improve the mechanical properties of metallic materials for better economical efficiency, a new grain refinement technique has been attempted by torsion processes and heat treatments. Annealed pure iron bars, which have a simple ferritic structure and an ideal ductility, are used in the test. Two types of torsion process, i.e., torsion to rupture or torsion interrupt processes, are conducted on the specimen bars having a diameter of 8mm. Then the heat treatments on the torsion deformed specimens are performed at temperatures of 500?, 550? and 600? for 1h, 3h and 8h, respectively. After the above grain refinement processes, the microstructures obtained and mechanical properties of the specimens are investigated and discussed. In this work, the fine-grained microstructures particularly the microstructures with a grain size of nearly 1/48 of the as-annealed material are obtained. The grain refinement behavior is confirmed to be closely related with the torsion deformations as well as the heat treatment conditions. It is confirmed that under certain conditions of torsion processes and heat treatments the strengths and the Vickers hardness of the grain refinement processed specimens are increased by virtue of their fine microstructures.

MSEC_ICMP2008-72091

A COMPARATIVE ASSESSMENT OF AUSTEMPERED DUCTILE IRON AS A SUBSTITUTE IN WEIGHT REDUCTION APPLICATIONS

Ashwin Polishetty — *AUT University*
Sarat Singamneni — *AUT University*
Guy Littlefair — *AUT University*

Manufacturing engineering has had to undergo drastic changes in the approach to material selection in order to meet new design challenges. In the automotive industry, researchers in their effort to reduce emissions and satisfy environmental regulations, have shifted their focus to new

emerging materials such as high-strength aluminium alloys, metal matrix composites, plastics, polymers and of late, Austempered Ductile Iron (ADI). ADI is a good choice for design where the criterion is high performance at reduced weight and cost. The unique, ausferrite microstructure gives the material desirable material properties and an edge over other materials. A comparative study of ADI in terms of materials properties and machining characteristics with other materials is desirable to highlight the potential of the material. This paper focuses on a comparative assessment of material and machining characteristics of ADI for different applications. The properties under consideration are machinability, weight and cost savings and versatility. ADI has a higher strength-to-weight ratio than aluminium making it a ready alternative for material selection. In terms of machinability, there are some problems associated with machining of ADI due to its work hardening nature. This paper attempts to identify the possible potential applications of ADI, by critically reviewing specific applications such as machinability, overall economics and service.

MSEC_ICMP2008-72157

INFILTRATION ANALYSIS OF MOLTEN METAL TO FIBROUS PREFORM BY LOW- PRESSURE CASTING AND EXPERIMENTAL EVALUATION

Yongbum Choi — *Hiroshima University*
Gen Sasaki — *Hiroshima University*
Kazuhiro Matsugi — *Hiroshima university*
Sorida Naoki — *Kolbenschmidt K.K*

This paper explains how a computer simulation of the infiltration behavior of molten alloy in a porous preform was conducted. Pores were formed inside the composite produced through the infiltration of molten alloy into a preform. Furthermore, the pores inside the composite were generated due to the lack of applied pressure, inferior wettability of the fiber in the molten alloy, air remaining inside the preform and the collision of the molten alloy. Hence, in this study, we explain how a computer simulation was designed so as to complex shape model the infiltration behavior of molten alloy when all of the remaining air inside the preform is extracted through the air vent and the molten alloy does not collide. We consider that any change in these parameters by computer simulation, namely the air vent position and the presence of the barrier plate, will have an effect. The optimum conditions for low-pressure infiltration, which control the flow of the molten alloy inside the preform, were determined. In the results, In case of the infiltration behavior of the molten alloy inside the preform with a barrier plate on and the air vent in contact with the right mold. The infiltration flow should be laminar inside the preform, because it did not collide with itself as it infiltrated the preform. The influence of the barrier plate on the generation of pores in the composites was studied by experimental to comparison with computer simulation results. The purpose of the barrier plate was to suppress the generation of pores by controlling the flow of the molten alloy inside the preform. It was clarified that shows the porosity of the composite produced with and without the barrier plate. The composite produced without the barrier plate had 3~6% porosity. But the composite produced with the barrier plate had 0.3~0.78% porosity. Therefore, the barrier plate effectively reduced the porosity. Therefore, if a barrier plate is introduced to ensure the unidirectional flow of the molten alloy inside the preform, the generation of porosity can be suppressed.

MSEC_ICMP2008-72166

EFFECTS OF DEFORMATION-INDUCED MARTENSITE ON?RESISTIVITY OF DEFORMING STAINLESS STEEL

Hidefumi Date — *Tohoku Gakuin University*

To estimate the volume fraction of martensite induced in the austenitic stainless steel during tensile deformation, the electric resistance of the deforming specimen was measured using the four-point-probes method at the temperatures of 77, 196 and 293 K. Two types of the austenitic stainless steel, 304ss and 316ss, were used in the experiment. The ranking order of stability of the austenite phase was 316ss>303ss. The 310ss that the stability is higher than 316ss was also used to examine the deformation mechanism of 304ss and 316ss. The magnetic permeability method was accepted to measure the volume fraction of the martensite induced in the specimen. It has been known that the formation of the martensite decreases the resistivity of the specimen. However it is clarified by the comparison with the results of 310ss that the increase of the resistivity of 304ss and 316ss induced by the formation of the martensite was much larger than the increase of the resistivity by the strain-hardening of the austenite phase. Accordingly, the observed resistivity increased with the increase of the martensite phase. Since it was also found that the resistivity of the deforming specimen was a linear function of the volume farction of the martensite measured by the magnetic permeability, the volume fraction of the deformation-induced martensite was able to estimate by using the linear relation.

MSEC_ICMP2008-72238

A COMPARATIVE STUDY ON HYDRAULIC BULGE TESTING AND ANALYSIS METHODS

Eren Billur — *Virginia Commonwealth University*
Muammer KOC — *Virginia Commonwealth University*

Hydraulic bulge testing is a material characterization method used as an alternative to tensile testing with the premise of accurately representing the material behavior to higher strain levels (~70% as appeared to ~30% in tensile test) in a biaxial stress mode. However, there are some major assumptions (such as continuous hemispherical bulge shape, thinnest point at apex) in hydraulic bulge analyses that lead to uncertainties in the resulting flow stress curves. In this paper, the effect of these assumptions on the accuracy and reliability of flow stress curves is investigated. The goal of this study is to determine the most accurate method for analyzing the data obtained from the bulge testing when continuous and in-line thickness measurement techniques are not available. Specifically, in this study the stress-strain relationships of two different materials (SS201 and Al5754) are obtained based on hydraulic bulge test data using various analysis methods for bulge radius and thickness predictions (e.g., Hill's, Chakrabarty's, Panknin's theories, etc.). The flow stress curves are calculated using pressure and dome height measurements and compared to the actual 3-D strain measurement from a stereo optical and non-contact measurement system ARAMIS. In addition, the flow stress curves obtained from stepwise experiments are compared with the ones from above methods. Our findings indicate that Enikeev's approach for thickness prediction and Panknin's approach for bulge radius calculation result in the best agreement with both stepwise experiment results and 3D optical measurement results.

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MODELING MACHINABILITY PARAMETERS OF TURNING AL-SIC(10P) MMC BY ARTIFICIAL NEURAL NETWORK

Muthu Krishnan N. — *Sri Venkateswara College of Engineering*
Ravi Mohan — *Sri Venkateswara College of Engineering*
Thiagarajan M.S. — *Sri Venkateswara College of Engineering*
Venugopal J — *Sri Venkateswara College of Engineering*

The paper presents the results of an experimental investigation on the machinability of fabricated Aluminum metal matrix composite (A356/SiC/10p) during continuous turning of composite rods using medium grade Polycrystalline Diamond (PCD 1500) inserts. Metal Matrix Composites (MMC's) are very difficult to machine and PCD tools are considered by far, the best choice for the machining of these materials. Experiments were conducted at LMW-CNC-LAL-2 production lathe using PCD 1500 grade insert at various cutting conditions and parameters such as surface roughness, and specific powers consumed were measured. The present results reaffirm the suitability of PCD for machining MMCs. Though BUE formation was observed at low cutting speeds, at high cutting speeds very good surface finish and low specific power consumption could be achieved. An Artificial Neural Network (ANN) model has been developed for prediction of machinability parameters of MMC using feed forward back propagation algorithm. The various stages in the development of ANN models VIZ. selection of network type, input and out put of the network, arriving at a suitable network configuration, training of the network, validation of the resulting network has been taken up. A 2-9-9-2 feed forward neural network has been successfully trained and validated to act as a model for predicting the machining parameters of Al-SiC (10p) –MMC. The ANN models after successful training are able to predict the surface quality; and specific power consumption for a given set of input values of cutting speed and machining time. Key Words: Metal Matrix Composites, Machining, Specific Power Consumption, Surface Finish, and ANN

MSEC_ICMP2008-72371

EFFECT OF MICROSTRUCTURE ON TORSIONAL FATIGUE ENDURANCE OF MARTENSITIC CARBON STEEL

Shunsuke Toyoda — *JFE Steel Corporation*
Yasuhide Ishiguro — *JFE Steel Corporation*
Yoshikazu Kawabata — *JFE Steel Corporation*
Kei Sakata — *JFE Steel Corporation*
Akio Sato — *JFE Steel Corporation*
Jun'ichi Sakai — *Waseda University*

The microstructural influence of martensitic carbon steel on torsional fatigue endurance was investigated, taking into consideration the application of high strength steel electric resistance welded (ERW) tubes to automotive structural parts. The chemical composition of the base steel alloy was 0.1-0.2%C–0.2-1.5%Si–1.3-1.9%Mn–0.01%P–0.001%S–(Cr,Mo,Ti,Nb,B). Laboratory vacuum-fused ingots were hot-rolled, heated to 1023 or 1223K in a salt bath, and then water- quenched and tempered at 473K. Consequently, three types of microstructure, martensite (M), martensite and ferrite (M+F), and ferrite and pearlite (F+P), were prepared. Fully reversed torsional fatigue testing was conducted with 6mm diameter round bar specimens. Torsional fatigue endurance was found to monotonously increase with increases in the tensile strength of the

specimen from 540 to 1380 MPa. The martensitic single structure and the M+F dual-phase structure showed a similar level of fatigue endurance at a tensile strength of approximately 950 MPa. However, fatigue micro-crack morphology varied slightly between them. At the surface of the M+F specimen, many small cracks were observed in addition to the main crack. Conversely, in the martensitic specimen, these small cracks were rarely observed. DK decreasing/increasing crack growth testing with compact tension (CT)-type specimens was also conducted. Based on these experimental results, the effect of microstructure and stress level on the initiation/propagation cycle ratio is discussed. In addition to fatigue properties, some practical properties, such as low-temperature toughness and hydrogen embrittlement resistance, were also evaluated in view of actual applications for automotive structural parts.

MSEC_ICMP2008-72413

EFFECT OF AGING ON MICROSTRUCTURE OF ALUMINUM BORATE WHISKER REINFORCED AZ91D MAGNESIUM ALLOY COMPOSITE

Gen Sasaki — *Hiroshima University*
Koji Maruo — *Hiroshima University, Dept. of Mech. Eng.*
Yongbum Choi — *Hiroshima University*
Kazuhiro Matsugi — *Hiroshima university*

Aluminum borate whisker reinforced AZ91D magnesium alloy composite (Al18B4O33/ AZ91D composite) has not only good mechanical properties but also good age hardening behavior. The quantities of precipitates (Mg17Al12) in peak-aged composites were almost equal to that in peak aged monolithic alloy. The quantities of precipitates in over-aged composites are almost equal to that of peak aged composites. The shortening of the time to reach the highest hardness was observed in composites because of the dislocation around the interface between Al18B4O33 and AZ91D matrix introduced by the difference of CTE. Around the interface in peak-aged composites, there were many small sized precipitates. Although peak aged composites had high strength, strength degraded dramatically as increasing aging. The over aged composites has lower strength than the solution treated composites. As increasing aging time after peak age, the precipitates became to grow and its aspect ratio decreased, and. The monolithic layer generated with 100nm in thickness around the interface. In peak-aged composite, crack destroys the whisker. But in over-peaked composites, crack propagates along the whisker. The weak strength of monolithic layer around interface causes the degradation of the strength after peak age.

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STUDY OF THE SANDWICH SHEET METAL CUP DRAWING CHARACTERISTICS

Jun Chen — *Shanghai Jiao Tong University*
Yong Wang — *Shanghai Jiao Tong University*
Haibo Li — *Shanghai Jiao Tong University*

The sandwich sheet is a novel laminated sheet material with advanced vibration damping advantages, The sheet metal is composed with 2 outer thick metal layers and 1 thin polymer layer in between. In order to investigate its drawing characteristics, an improved cohesive model between the skin sheets was developed using a contact/interface approach. Based on the proposed model, a cup drawing process was numerically simulated using commercial FEM code ABAQUS. Numerical simulation shows that the thickness strain distribution and thinning phenomenon have similar modes on the top layer and bottom layer except at the cup bottom corner, and cohesive strength does not have severe effect to the drawing force. The drawing experiments were conducted on a hydrauic press in order to analysis the whole sheet and two skin sheets thickness distribution of sandwich sheet metal cup drawing, FEM simulation result fits well with the experiment.

MSEC_ICMP2008-72433

THEORETICAL AND PRACTICAL ASPECTS REGARDING OF ELECTRONIC EFFICIENCY IMPROVING OF POWER MAGNETRONS WITH CONTINUOUS WORKING AND BIMETAL ANODE

Petru Ungur — *University of Oradea*
Petru/A Pop — *University of Oradea*
Cornelia Gordan — *University of Oradea*
Mircea Gordan — *University of Oradea*

Direct heated, with resonator cavity anode of body magnetrons, in former structure, with similar functional parameters, differs from each other in the construction of anode body, cathode, side polar lid, range of another-cathode interaction space, resonant cavity space and specific materials. The type, which stands of the basis structure modifications of the magnetron presented in this paper, is the 800 W types with indirect heated cathode, symmetrical vane type resonant cavities, developed at Oradea University, by the Microwave Research Team. Construction modifications, which lead to the new solution, had made on the anode body after consulting finite element method of analysis results of magnetic field distribution in anode-cathode interaction space of the 800W magnetron. The paper has presented the modular structure of coaxial 800W magnetron, it has designed and builds at our university with its main characteristics and secondary parameters, the electronic efficiency diagram in function of

number of resonant cavities, bimetallic anode block, distribution of magnetic induction for enhanced efficiency magnetron, multiple resonant coaxial magnetron with bimetal anode body, etc. The constructive modification is simple and its can be applied to the other magnetrons too. From constructive modification of the anode body at higher flux density fields created in the cathode-anode interaction space, which is constant and homogenous. Bimetal anode construction has lead to a greater reliability in magnetrons working process, by reducing the overheating of cathode due to elimination of side electron's axial oscillation effect.

MSEC_ICMP2008-72464

INTERNAL FRICTION AT HIGH TEMPERATURES AND MICROPLASTICITY OF ALUMINUM MATRIX COMPOSITES

Katsuhiro Nishiyama
Shigenori Utsumi — *Tokyo University of Science, SUWA*
Takanobu Nakamura — *Tokyo University of Science*
Hironori Nishiyama — *Tokyo University of Science*

Aluminum matrix composites (70vol%SiC/Al, 55vol%-SiC/Al, 60vol%Al2O3, 70vol%AlN/Al, and 30vol%SiC/Al) were prepared by the infiltration and the casting methods. The internal friction and the microplasticity of these composites were measured with a Föppel-Pertz torsion pendulum apparatus over the temperature range of 303 K to 853 K and the strain range of 3?10-5 to 3?10-3. The internal friction of these composites increases with increasing temperature and increases rapidly over 600 K to 800 K, while their shear modulus gradually decrease and rapidly decrease over 600 K to 800 K. The internal friction of the composites at high temperatures is caused by relaxations due to the interfacial diffusion between a reinforcement phase and Al and due to the plastic flow at grain boundaries. The activation energy of the interfacial diffusion is 40.7-56.7 kJ/mol for SiC/Al, 62.1 kJ/mol for Al2O3/Al, and 27.7 kJ/mol for AlN/Al, respectively. The activation energy of the plastic flow is 42.3-119 kJ/mol. The internal friction of the infiltration composites remarkably depends on strain amplitude rather than that of the casting composites. The G-L plots of the composites show a linear relationship, indicating that the increase in internal friction with increasing shear is caused by the vibration energy loss due to the dislocation damping mechanism. The dislocation mobility of the infiltration composites is larger than that of the casting composites. The specific damping capacity and Young's modulus of 70vol%SiC are higher than those of 70vol%AlN.

MSEC_ICMP2008-72521

COMPOSITE MAGNESIUM POWDER COATED WITH UN-BUNDLED CARBON NANOTUBES (CNT) AND CHARACTERISTICS OF ITS EXTRUDED MATERIAL

Fukuda Hiroyuki — *Osaka university*

The uniform dispersion of carbon nanotube (CNT) into metals strongly promises to improve the mechanical and thermal properties of the composite materials because of its high Young's modulus of 270~950 GPa and superior thermal conductivity of 1000 W/(m?K) or more. It is, however, necessary to disassemble the CNT bundles due to their Van der Waals forces between carbon atoms of the outermost surface of CNTs when employing them as the additive reinforcements of powder metallurgy. Magnesium (Mg) powders coated with CNTs were prepared via wet process by using a few kinds of the surfactants (surface active agent), having both hydrophobic and hydrophilic groups. Each CNT was independently dispersed in the surfactant solution because the electric affinity between positive and negative charges at the top of hydrophilic groups became larger than Van der Waals forces between CNTs. By dipping the Mg powders into this solution, the un-bundled CNTs covered on the powder surface. Mg powders coated with CNTs were consolidated into Mg composite with CNTs by hot extrusion. Microstructures, mechanical and thermal properties of the composite materials including CNTs were investigated in detail.

Symp 1-3 CERAMICS AND CERAMIC MATRIX COMPOSITES

MSEC_ICMP2008-72006

AMORPHOUS SILICA ORIGINATED FROM RICE HUSKS AND ITS CHARACTERISTICS

Katsuyoshi Kondoh — *Osaka University*
Junko Umeda — *Osaka University*

The environmentally benign, harmless to human and economical process to prepare amorphous silica particles with high-purity of 99% or more from rice husks, typically agricultural wastes, has been established. Citric acid leaching on rice husks before burning them is employed, instead of the conventional sulfuric acid washing, for both the hydrolysis of organics and removal of metallic impurities in rice husks. The effects of the leaching parameters such as the concentration and temperature of the acid solutions, and water-rinsing conditions on the purity of

rice husk ashes are evaluated. In particular, GCMS (Gas Chromatograph Mass Spectrometer) analysis is carried out to investigate the hydrolysis reaction of cellulose and hemi-cellulose of rice husks. A dependence of the crystallization of the ashes on the burning temperature of acid-leached husks in air is also examined by XRD (X-ray Diffraction) analysis.

MSEC_ICMP2008-72348

PREPARATION AND MICROSTRUCTURE OF CARBON NANOTUBE-TOUGHENED ALUMINA COMPOSITES

Go Yamamoto — *Tohoku University*
Mamoru Omori — *Tohoku University*
Toshiyuki Hashida — *Tohoku University*
Hisamichi Kimura — *Tohoku University*

Carbon nanotubes (CNTs) have extremely high tensile strength and stiffness, good flexibility and low density. These superior properties make CNTs attractive for many applications and technologies. Engineering ceramics have high stiffness, excellent thermostability and relatively low density, but their brittleness impedes their use as structural materials. Incorporating CNTs into a brittle ceramic might be expected to produce CNT/ceramics composite with both high toughness and high temperature stability. Until now, however, materials fabrication difficulties have limited research on CNT/ceramic composites. The mechanical failure of CNT/ceramic composites reported previously is primarily attributed to poor CNTs-matrix connectivity and severe phase segregation. The connectivity with, and uniform distribution within the matrix are essential structural requirements for the stronger and tougher CNT/ceramic composites. Here we show that a novel processing approach based on precursor method for synthesis of alumina and chemically modified multi-walled carbon nanotubes (MWCNTs) can diminish the phase segregation, and render MWCNT/alumina composites highly homogeneous. Combined with mechanical interlock induced by the acid treatment of MWCNTs, this approach leads to improved mechanical properties. Mechanical measurements revealed that only 0.9 vol.% acid-treated MWCNT addition results in 27% and 25% simultaneous increases in bending strength (689.6 ± 29.1 MPa) and fracture toughness (5.90 ± 0.27 MPa•m1/2), respectively. Microstructural observations revealed that the acid-treated MWCNTs uniformly dispersed in the matrix without any evidence of phase separation. Furthermore, numerous individual MWCNTs protruded from the fracture surface, which had not been obtained until now for CNT/ceramic composites. In addition, numerous stretched MWCNTs that bridged the about 1 ?m wide cracks were observed. These MWCNTs may have been pulled out during the deformation and fracture of the composites. Our present work may give a promising future for application of MWCNTs in reinforcing structural ceramic components and other materials systems as well. The acid-treated MWCNT/alumina composites may have potential applications to tribomaterials such as joint prosthesis and micro electro mechanical systems (MEMS), because of the CNTs' good lubrication properties.

MSEC_ICMP2008-72470

FRACTURE ANALYSIS BASED ON QUANTITATIVE EVALUATION OF MICROCRACKING IN CERAMICS USING AE SOURCE CHARACTERIZATION

Kohei Ishiwata — *Tokyo Metropolitan University*
Shuichi Wakayama

Strength of the brittle materials such as ceramics is strongly dominated by microcrackings. In the present paper, quantitative detection of microcracks in fracture process of alumina ceramics was carried out by AE source characterization which yields the quantitative characterization of the size, nucleation velocity and fracture mode as well as nucleation time and location of individual microcracks. Fracture toughness tests of SENB specimens of two type of alumina with different grain size and purity, ADS-11 and SAPPHAL , were carried out in air and water. The notch tips were sharpened using a razor blade and diamond slurry. During the test, stable crack propagation was observed, and AE signals emitted from microcracking were detected by piezoelectric transducers. The combined response function of the specimen and measurement system was determined using a pencil lead breaking as a simulated source. It was assumed in the analysis that AE from penny-shaped mode I microcrackings were detected by a transducer at the epicenter of the source. Then AE source function which describes the nature of microcrack nucleation was also determined by inverse calculation using obtained response function and detected signal. Radiuses and nucleation velocities of individual microcracks could be determined from the source functions. For ADS-11, the ranges of distribution of microcrack radius were 4.3-15.1 micrometers in air and 8.1-19.9 micrometers in water, respectively, whereas the distribution range were 7.1-42.6 micrometers in air and 8.1-43.5 micrometers for SAPPHAL in water, respectively. Cumulative AE event was less in water than in air for both alumina. Fracture resistance was also lower in water than in air for both alumina. Consequently, it was clarified that the size of microcrack in water was larger than that in air for both alumina and larger microcracks nucleated in water resulted in the degradation of fracture resistance.

MSEC_ICMP2008-72471

ASYMPTOTIC CHARACTERISTIC OF EXACT DISTRIBUTION OF FRACTURE STRENGTH BASED ON GAMMA DISTRIBUTION AS INITIAL FLAW SIZE DISTRIBUTION

Chisato Wakabayashi — *Tokyo Institute of Technology*
Kouichi Yasuda — *Tokyo Institute of Technology*
Tadashi Shiota — *Tokyo Institute of Technology*

In this paper, an exact distribution of fracture strength was derived from extreme value statistics for an initial distribution of flaw size, via conversion to an exact distribution of largest flaw size. Gamma distribution was shown as a better function to approximate the initial distribution data measured by immersion liquid technique. The exact distribution of fracture strength was obtained as a function of the number of links in the weakest link theory. With increasing the number of links, the exact distribution gradually became linear on Weibull plot, and almost coincided to Weibull distribution at the number of links larger than 1000. Compared to actual distributions of fracture strength, the number of links in the specimens was estimated to be in the range from 104 to 105. The above discussion showed a verification of this theory.

Symp 1-4 ADHESION AND INTERFACES

MSEC_ICMP2008-72061

SIMULATION OF CRACK INITIATION AT THE INTERFACE EDGE BETWEEN SUBMICRON THICK FILMS UNDER CREEP BY COHESIVE ZONE MODEL

Truong Do Van — *Kyoto University*

Micro-electronic device consists of multi-layers of submicron thick film, in which many bi- material interfaces exist. It is well known that stress concentrates at the free edge of an interface in a bi-material due to deformation mismatch and, hence, the interface edge is the most common site of crack initiation. On the other hand, film materials with low melting point such as solder and polymer have been widely used in the micro-electronic device, and can be deformed due to creep in room temperature. Therefore, predicting the crack initiation between film layers at the interface edge under creep is a necessary task in order to improve the adhesion properties between the film layers and the mechanical reliability in the devices. Recently, the cohesive zone model approach has emerged as a popular tool for simulating fracture process in materials and structures. However, most of the studies have focused on the crack initiation under time-independent deformation and few studies have been interested in the sub-critical crack growth under time-dependent deformation. In particular, no studies have reported on prediction of crack initiation between sub-micron thick films under creep. In this study, the cohesive zone model is developed to predict the crack initiation between sub-micron thick films under creep, in which cohesive law is proposed based on the damage mechanics concept. A micro-cantilever specimen with Sn and Ta2O5 films are conducted in order to calibrate the parameters charactering the cohesive law. In addition, the singularity stress field near the interface edge varied due to time is explored well.

MSEC_ICMP2008-72309

INTERFACE EFFECTS ON COATING FAILURE OF DIAMOND COATED CUTTING TOOLS

Jianwen Hu — *UA*
Kevin Chou — *The University of Alabama*
Raymond Thompson — *Vistae Engineering*

Despite the superior tribological and mechanical properties, the advantages of diamond coated tools have been largely compromised by the insufficient adhesion. Interface characteristics play a vital role in the failure and performance of diamond coated tools. Thus, quantitative modeling of the coating-substrate interface is important to the design and usage of diamond coating tools. In this study, a cohesive zone model was incorporated to investigate the diamond coating on a tungsten carbide substrate. The cohesive zone model is based on the traction-separation law, and is represented by four parameters, determined from the tungsten-carbide fracture properties. The cohesive zone model was implemented in finite element codes to simulate the indentation process, using a spherical diamond indenter. The model was applied to examine the interface effects during indentation and the coating property effects on different coating failure modes. The simulation results are summarized as follows. (1) Normal mode delamination is the dominant mechanism of interface failure and takes place during unloading if the substrate yielding occurs during the loading stage. (2) The cohesive zone interface does not affect the critical load for coating surface tensile cracking, but affects the plastic strain during loading. In addition, for thin coatings, the maximum stress location changes between the perfect interface and cohesive zone interface cases. (3) Elasticity has a complex effect on coating failure. As the coating elasticity increases, the critical load for coating cracking decreases, but the critical load for substrate yielding increases slightly. Moreover, the interface delamination size will decrease with increasing coating elasticity.

MSEC_ICMP2008-72360

SIMPLIFIED METHOD TO PREDICT THE STRENGTH OF DOUBLE LAP ADHESIVELY BONDED JOINTS SUBJECTED TO BENDING MOMENT

Chiaki Sato — *Tokyo Institute of technology*

This paper presents a simplified method to predict the strength of double lap joint subjected to bending moment. Double lap joint configuration is very useful to reduce stress concentration. However, the stress situation of the joint subjected to bending loads is unknown because less research on the topic is still scarce. The stress analysis of the joint configuration was carried out using the three dimensional liner-elastic finite element method considering loading conditions of tension and bending. The stress distribution in the adhesive layers was highly depended on the different loading modes. The failure criterion of the adhesive layers was determined comparing the calculated stress to a critical load of the joint obtained experimentally. Several criterions based on von Mises equivalent stress and principal stress were investigated, and it was confirmed that principal stress is the most suitable as the criterion. The obtained failure criterion was applied to the joint in bending situation to predict the critical bending load. The bending strength of the joint could be predicted well by this method although the stress state under bending situation is totally different from that under tensile situation. The influence of adhered contact was also investigated analytically and experimentally. The stress distribution and strength of a joint having not contacted adherends was slightly deferent from those of the joint in which the adherends were contacted each other.

MSEC_ICMP2008-72370

A DIAGRAM FOR EVALUATING DELAMINATION OF GFRP/STAINLESS-STEEL ADHESIVE JOINTS BY USING STRESS SINGULARITY PARAMETERS

Masaaki Iwasa — *Hitachi,Ltd.*

We performed static tests on double-lap and T-type adhesive joints. We developed a device that applies contact pressure to glass-fiber reinforced plastics/stainless-steel double-lap adhesive joints. The device is composed of a bolt adhered to a strain gauge for controlling contact pressure. Using this device, we investigated the effect of contact pressure on the delamination strength of double-lap adhesive joints. We applied tensile shear loading to double-lap adhesive joints under contact pressure to their adhesive interfaces. We found that the delamination strength of the double-lap adhesive joints increased with increasing contact pressure. On the contrary, when we applied compressive shear stress to them, the delamination strength stayed constant. We therefore concluded that the delamination strength of double-lap adhesive joints is dominated by normal stress when contact pressure under tensile shear loading is applied. On the other hand, it was dominated by shear stress when contact pressure under compressive shear loading was applied. We then analyzed stress singularity parameters for double-lap and T-type adhesive joints by the FEM. Stress distributions near the bonding edge could be expressed by the stress singularity parameters. Finally, we developed a delamination evaluation diagram using stress singularity parameters. This diagram enables us to evaluate the delamination strength of adhesive joints using this diagram.

MSEC_ICMP2008-72410

STRESS ANALYSIS AND STRENGTH EVALUATION OF SCARF ADHESIVE JOINTS SUBJECTED TO IMPACT TENSILE LOADINGS

He Dan — *Hiroshima University*
Sawa Toshiyuki — *Hiroshima University*
Iwamoto Takeshi — *Hiroshima University*
Nagai Toshimasa — *Hiroshima University*

In practical application, scarf adhesive joints are subjected to not only static but also impact loadings. It is significant to know the stress distribution and the strength of scarf adhesive joints under impact loadings as well as static loadings. In this paper, impact tensile tests were carried out for the scarf adhesive joints using the split Hopkinson pressure bar (SHPB). The input and output strain history was recorded and the joint strength was estimated using the value of transmitted stress when the stress in the joint reached failure stress. Furthermore, three-dimensional FEM calculations employing LS-DYNA were also carried out to predict the joint strength and singular stress distributions in the joint. The effects of some factors on the interface stress distributions were shown in the FEM calculations. It was found that the maximum principal stress at the interfaces decreased as the scarf angle was increased. The result of joint strength was compared between the experiments and the FEM calculations and fairly good consistence was found.

MSEC_ICMP2008-72473

APPLICATION OF HIGH HOMOGENIZATION TECHNIQUE TO FABRICATION OF ELECTRIC TESTING PROVE DISK USING MICRO-FIBRILLATED BACTERIA CELLULOSE

Kaho Matsuoka — *Japan-DoshishaUniversity*

Ceramics are currently selected for the material of prove disk which is the device for testing of electric properties of semiconductor, because low thermal expansion and low electric conductivity are expected in the test. However, the

ceramic disk often introduces engineering problems in which the part was chipped due to the brittle behavior of the material. Alternative materials are now strongly desired, which satisfy the strength and low coefficient of thermal expansion. The purpose of current study is to propose an effective technique in fabrication of prove disk for semiconductor testing device using cellulose as an alternative material of ceramics. In this study, three kinds of cellulose (BCV, BCN and BF) were prepared as materials of the disk. The BCV was with bacterial cellulose produces during vinegar fermentation and the BCN was processed with the bacterial cellulose of Nata de coco (available in food market). Micro-fibrillated cellulose from both of bacterial cellulose (BCV and BCN) and bamboo fiber (BF) was extracted using a high speed-grinding machine and a high-pressure homogenizing machine. To compare the testing results, bamboo fiber was also prepared for the material of specimen. The coupon type specimens were then prepared by hot pressing technique using the processed BCV, BCN and BF materials. The difference of bending strength, thermal expansion and hardness of samples were examined by using 4 types of cellulose. For discussion of a practicable process, the effect high homogenization technique on the bending strength and coefficient thermal expansion was investigated. The test result shows that the process-homogenization was effective as the pre-process before high-pressure homogenization to reduce the coefficient of thermal expansion. The BCs (bacterial celluloses), which contained few or no lignin, were useful for the materials of prove disks to reduce the coefficient of thermal expansion. The bending strength of the specimen fabricated with Bacterial Cellulose was about 205MPa that was equivalent to that of an aluminum alloy and was enough for applications of prove disk. Excellent mechanical property was obtained when the high-pressure homogenizing technique was applied to the fabrication of prove disk for semiconductor testing device.

Symp 1-6 SMART MATERIALS AND STRUCTURES

MSEC_ICMP2008-72096

DAMAGE DETECTION IN CFRP LAMINATES BY BROADBAND LAMB WAVE PROPAGATION USING MFC ACTUATOR AND FBG SENSOR

Nakayama Fumihiro — *The University of Tokyo*
Yoji Okabe — *The University of Tokyo, Institute of Industrial Science*

In Recent years, carbon fiber reinforced plastic (CFRP) laminates have been applied to lightweight structures such as aircrafts. However, since CFRP laminates have complex fracture process, structural health monitoring technologies are attracting attention. The technologies use sensors pre-installed into composite members and diagnose the structural health easily in real time. As one of the techniques, Lamb waves propagating along the laminates are used for the diagnosis. Damages in the laminates can be detected from the change in the received waves. In general, bulk piezo-electric ceramics (PZTs) are used to send and receive the ultrasonic waves. In that case, since the bulk PZTs have the resonance frequency, the generated ultrasonic waves are limited within the narrowband. However, since the macro fiber composite (MFC) actuator developed at NASA Langley Research Center and a fiber Bragg grating (FBG) sensor, which is a kind of optical fiber sensors, do not have resonance frequency, the system combining these elements can employ broadband ultrasonic waves. Thus more information can be extracted from the received waves. In addition, there are some other advantages such as the directional propagation and the ability of the sensor to be embedded into CFRP. In this research, the authors constructed the system consisting of an MFC actuator to generate broadband Lamb waves from 0 MHz to 2 MHz and an FBG sensor to receive the propagated waves. Then this system was applied to an aluminum plate and a CFRP laminate to examine the broadband characteristic. As a result, this system proved to be able to send and receive more broadband ultrasonic wave than conventional ultrasonic systems using bulk PZTs. Moreover, we investigated the frequency dispersion characteristics of Lamb waves in more detail by sending narrowband ultrasonic waves with different center frequencies from 50 kHz to 900 kHz and comparing the obtained results with the dispersion curves calculated theoretically. As a result, we were able to identify the mode of Lamb waves by using this system, since the frequency dispersion curves obtained from the measured results were almost similar to the theoretical dispersion curves. In the future, we try to investigate the relation between the damage size and the change in the frequency components by introducing artificial defect in the CFRP laminates for the precise identification of the damage size.

MSEC_ICMP2008-72143

SHAPE CONTROLLABLE SANDWICH STRUCTURE USING SMA HONEYCOMB CORE

Hiroshi Sugiyama — *University of Tokyo*
Yoji Okabe — *The University of T*okyo, Institute of Industrial Science

In recent years, morphing airfoils that can change the shape of wing structures have been researched to increase the weight saving and the flight performance of airplanes. However, it is difficult to develop shape-changeable

structure systems that possess enough lightweight property and bending stiffness. In this research, we proposed a sandwich structure that consists of a shape memory alloy (SMA) honeycomb core and carbon fiber reinforced plastic (CFRP) facesheets as a geometric variable structure. This actuator structure can be bent by heating, even though it is lightweight and has a high specific bending stiffness. First, the CFRP facesheets are bonded to the SMA honeycomb core and pre-shear-strain is applied to the SMA core. Then the ends of the upper and lower facesheets are fixed together. After that, the SMA core is heated to generate the recovery shear stress. As a result, the sandwich panel curves in the out-of-plane direction. This method has the better ability to bend facesheets with high in-plane stiffness compared with the conventional methods that apply compressive force to only one facesheet, because the recovery shear force can be applied uniformly to the facesheets from the inner core. The SMA honeycomb core was made of 50micron Ti-Ni SMA foils. However, it is difficult to give shear strain to the honeycomb core, because the out-of-plane shear stiffness of the core is very high. Hence, we rotated the honeycomb core by 90o to decrease the out-of-plane shear stiffness. Facesheets were unidirectional CFRP laminates with 0.7mm in thickness. The dimensions of the sandwich beam specimen used in this research were 180mm in length, 14mm in width, and 21mm in thickness. The weight of this specimen is only 8.7g. Pre-shear-strain was applied to the sandwich beam, and the one end or both ends of the two facesheets were fixed. Then the beam was heated at 80oC to generate bending deformation. We measured the out-of-plane displacement of the facesheets with a laser displacement gauge. As a result, the vertical displacement of the beam tip was 5.7mm in the one-end fixed case and 6.8mm in the both-ends fixed case. Furthermore, it was verified that the beam was able to uplift 150g weight. In addition, we analyzed qualitatively the deformation of the sandwich beam with finite element method. The calculation result showed that the shear stress simulating the recovery stress deformed the beam in the same shape as the results of the experiments.

MSEC_ICMP2008-72319

MECHANICAL AND DAMPING PROPERTIES OF CLOSED CELLULAR MATERIALS CONTAINING POLYMER

Satoshi Kishimoto — *National Institute for Materials Science*
Kimiyoshi Naito — *National Institute for Materials Science*
Zhenlun Song — *Chinese Academy of Sciences*
Fuxing Yin — *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 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 material containing polymer was fabricated by penetrating polymer into a metal foam. An aluminum foam was selected as the metal foam, and epoxy resin and polyurethane resin were selected as the penetrated polymer. The mechanical and damping properties of this material were measured. The results of the compressive tests showed that this material has different stress-strain curves among the specimens that include different materials in the cells. Also, these results showed that this material has a high-energy absorption property. The internal friction of this material was measured and the result showed that the internal friction of this material is greater than that of a pure aluminum closed cellular material and changes with the increasing temperature.

MSEC_ICMP2008-72387

THERMAL ACTUATION CAPABILITIES OF THE SIC CONTINUOUS FIBER/ALUMINUM ACTIVE COMPOSITE

Hiroshi Asanuma
Tatsushi Kaiho — *Chiba University*
Takamitsu Chiba — *Chiba University*
Kiyotada Kato — *Chiba University*

This paper presents thermal actuation capabilities of the SiC continuous fiber/aluminum active composite plate where mono-layer fiber filaments are placed closer to one surface of the plate to enable the actuation. In this study, the effects of fiber spacing and number of thermal cycles on curvature change of the composite during the thermal cycles between room temperature and 712K up to three times were examined, and enhancement of its actuation capability was also examined by heat treatment. As a result, it was clarified that 1) the curvature of the active composite at room temperature increases with decreasing fiber spacing from 8 to 1 mm, 2) the curvature change during the thermal cycles becomes reproducible after one cycle when the fiber spacing is 8 mm and after two cycles when it is 4 mm or less, 3) the room temperature curvature can be increased by a heat treatment at 833K and its actuation capability can be improved to a much higher level, and 4) the high room temperature curvature can be recovered by the same heat treatment even after a severe plastic deformation.

Symp 1-7 MATERIAL SELECTION, PROCESSING, REUSE AND RECYCLE FOR SUSTAINABLE MANUFACTURING

MSEC_ICMP2008-72034

DISASSEMBLY PLANNING AND TIMING THROUGH PETRI NET APPROACH

Han Bao — *Old Dominion University*
Chun Hsi Lei — *Old Dominion University*

Disassembly planning and costing is a major task in the achievement of sustainable manufacturing. This paper presents a systematic approach to identify the feasible ways to disassemble a product then to select the most economical one using reliable cost data gathered from experimental and practice-oriented sources. The disassembly process is modeled after a Petri Net approach, a technique that has proven to be fairly popular with the research community in the last few decades. The result of our systematic approach is a reliable derivation for a cost-effective disassembly plan.

MSEC_ICMP2008-72130

AN ECONOMIC MODEL FOR THE MAINTENANCE OF A DEVICE SUBMITTED TO MINOR AND MAJOR REPAIRS

Hrishikesh Phadke — *Old Dominion University*
Han Bao — *Old Dominion University*
Anthony Dean — *Old Dominion University*

ABSTRACT In this report, a Markov model is used for a continuously operating repairable device. In addition to periodic maintenance, it incorporates deterioration failures and Poisson failures. The derivation of the steady state probabilities follows the steps in many of the previous papers. The novel aspect of this paper is the introduction of operating costs and capital recovery costs to determine the equivalent total cost for keeping the device for a specific amount of time. The optimal value of the mean time to preventive maintenance is determined by minimizing the unavailability of the device due to the combined effect of preventive maintenance, Poisson failures, deterioration failures. After determining the optimum time to preventive maintenance at each stage, it is substituted back into the total cost equation to get absolute values for operating costs, capital recovery cost, preventive maintenance and as a result the optimum total equivalent monthly cost of the device. For a higher ratio of deterioration cost over repair cost, the best policy appears to be one that treats any required maintenance as a major maintenance. This strategy has been adopted in this paper, resulting in the optimal total cost being determined for a particular number of time stages in the system. The equivalent total cost is calculated considering all the costs associated with keeping the machine like operating cost, capital investment cost and the various maintenance costs. From the series of total cost curves determined for various cost driver values, it was shown that the total cost decreases as the number of time stages increases, reaches a minimum value, and then increases again with the increase in time stages. Hence we get the lowest total cost of keeping the machine at a particular stage from this curve. The operating cost per stage is a function of deterioration cost and repair cost. By increasing the deterioration cost and repair cost, the total cost curve shifts upwards and its lowest point shifts towards the left side. This indicates that as the operating cost increases the machine reaches its optimum cost of keeping the machine at a lesser value of the time stage, and its magnitude is increased as well.

MSEC_ICMP2008-72376

PRODUCTION CONDITIONS OF WOOD PLASTIC RECYCLED COMPOSITE (EFFECTS OF MIXING TEMPERATURE AND WOOD POWDER SIZE)

Tsunehisa Miki — *National Institute of AIST*
Hiroyuki Sugimoto — *National Institute of AIST*
Keisuke Kojiro — *AIST*
Kozo Kanayama — *National Institute of AIST*
Ken Yamamoto — *Hiroshima Prefectural Technology Research Institute*

In this study, wood (cedar) powder ranging from 53 ?m to 1 mm sizes, recycled polypropylene (PP) / polyethylene (PE) and acid-modified PP as a compatibilization agent were used to produce a wood-plastic recycled composite (WPRC). For discussing the effects of the wood powder sizes on the mechanical properties of the WPRC, a mixing process of the wood powder and the plastics in a constant wood content of 50% weight was firstly performed by a mixing machine controlled temperature and rotation of mixing blade. And then, to obtain WPRC panels the wood and plastics mixtures were compressed in a mould under a constant pressure and temperature for a certain holding time. WPRC specimens for mechanical tests were cut from the WPRC panels, and tensile strength and size stability were acquired. The results show that the successful mixing process runs above 180°C, where the mixing torque required compounding keeps constant or slightly increases. The tensile strength of the WPRC increases when the smaller size of wood powder is used for wood/plastic compound under successful mixing conditions. It is shown from thickness change rate of specimens that mixing temperature of wood/plastic compound affects a size stability of the WPRC.

MSEC_ICMP2008-72490

ECONOMIC AND ENVIRONMENTAL ASSESSMENT OF AUTOMOTIVE REMANUFACTURING: ALTERNATOR CASE STUDY

Hyung-Ju Kim — *University of Michigan*
Vineet Raichur — *University of Michigan*
Steve Skerlos — *University of Michigan*

Remanufacturing is a process that restores old products to perform like new, while saving energy, reducing consumption of natural resources, and lowering environmental emissions. By extending the product life cycle, remanufacturing approaches enable closed loop material cycles that are ultimately necessary for a sustainable society. This paper provides some description of the current automotive remanufacturing enterprise, with a particular emphasis on key vehicle components that are currently remanufactured. The analysis yields two major conclusions. First, market price of a remanufactured component in the automotive sector is surprisingly uncorrelated with the number of companies engaged in remanufacturing that component – at least for companies registered with the Automotive Parts Remanufacturing Association (ARPA). Second, and less surprisingly, we find that remanufacturing reduces environmental burden significantly over new production. This improvement, for the case of the alternator used as a case study, can easily exceed one order of magnitude in the categories of material use, energy consumption, and greenhouse gas (GHG) emissions that are considered here.

Track 2 Processing

Symp 2-1 PLASTIC FORMING OF METALS

MSEC_ICMP2008-72023

TRANSCRIPTION OF ROLL SURFACE TEXTURE ONTO DEFORMED MILD STEEL SHEET IN TEMPER ROLLING

Ikuo Yarita — *Chiba Institute of Technology*
Naoki Nagase — *Idemitsu Kosan Co.,Ltd.*

The surface texture has considerable effect on sheet press formability and image clarity after coating automotive body parts. However, the transcription mechanism of surface texture from a roll to a deformed sheet has not been clarified, because of the complexity of elastic-plastic deformation on the rolled sheet in temper rolling. In this work, temper rolling experiments for as-annealed low carbon steel sheet and high carbon steel sheet have been conducted in the reduction range from 1.0 to 8.0% using a laboratory-scale rolling mill. A shot dull roll (SDR) and a electric-discharged roll (EDR) were employed. Dry, soluble oil and mineral oil were applied to the rolling experiments as lubrication states. Surface microstructures of temper rolled sheets were observed, and surface textures in terms of mean roughness (Ra), maximum profile peak height (Rp) and minimum profile valley depth (Rv), and material ratio (Rmr) curves were measured. The probability density of roughness was analyzed from the material ratio curve for both rolls and deformed sheets. Thus, transcriptions of roll surface textures onto the temper-rolled sheets were discussed. Thus, the results obtained are as follows; The SDR has a partiality with deep valleys and high peaks in the surface roughness, and the EDR has mild roughness shown as approximately normal distribution for its probability density. So, the EDR shows higher transcription of the surface texture than the SDR. The effect of lubrication on the transcription is not distinct in small reduction of less than 3.0% as ordinary temper rolling reduction, but in the case of more than 4.0% reduction, the effect of lubrication becomes distinct. Dry lubrication state brings the highest transcription of surface texture.

MSEC_ICMP2008-72060

EFFECT OF LUBRICATING CONDITIONS ON TRANSFER OF ROLL SURFACE TEXTURE IN TEMPER ROLLING

Naoki Nagase — *Idemitsu Kosan Co.,Ltd.*
Ikuo Yarita — *Chiba Institute of Technology*

One of the important qualities of cold rolled steel sheet is the surface texture. The surface roughness of carbon steel sheet is obtained by imprinting of dull roll surface in temper rolling. In temper rolling process, a steel sheet is rolled with, or without using a lubricant. However, the effect of lubricant on surface imprinting has not been clarified. In this study, temper rolling of as-annealed low carbon steel strips have been performed using a 4-high rolling mill, and the effects of lubricating conditions on surface imprinting and roll microwear are evaluated. The three lubricating conditions adopted in this study are as follows: without using any lubricants (dry), using a water soluble lubricant, and using a mineral oil.

MSEC_ICMP2008-72097

SOLIDIFICATION AND FORMING TECHNOLOGY OF MINUTE SCRAP METAL BY SEMISOLID PROCESS

Sumio Sugiyama — *The University of Tokyo*
Jun Yanagimoto — *The University of Tokyo*

Abstract. With the growing demand for zero emissions, material usage efficiency has to be increased substantially in the near future. The idea of metals recycling or the reuse of the metal scrap is also being put in the same path as the zero emission. Regarding metal scrap, comparatively large metal scrap, such as automobiles, steel-frame of buildings and home electric appliances, or scrap coming from beverage cans and dry-cell batteries, collection system is ongoing, and recycling rate is already high. However, regarding minute metal scrap such as machining shavings, grinding dust, burr, welding dust, and foil debris, the recycling rate is still low. Main reason of this low recycling rate is the cost involved in the recovery process. Moreover, because impurity contents level, the quality of the resulting recycled material is inferior. Therefore, effective recycling technology of such kind of metal scrap is needed. The purpose of this study is to pursue a possibility of the recycling of the metal grindings such as minute metal scrap by semisolid process. Grindings of aluminum alloy, copper alloy and iron alloy produced by lathe machining was used as raw material. The solidification forming consists of the following three processes: compression process of the grindings at the room temperature, heating at the semisolid extrusion range and extrusion. In order to shorten the whole cycle in this manufacturing process, sintering process generally used in powder metallurgy was omitted.

Moreover, hot extrusion was carried out in order to compare with the semisolid extrusion. Process and products characteristics were examined and compared to each other.

MSEC_ICMP2008-72101

DRAWABILITY IMPROVEMENT OF TITANIUM WIRE AND FABRICATION OF MICROPARTS OF MEDICAL APPLICATIONS

Kazunari Yoshida
Masayuki Kojima — *Tokai University*

Titanium has great advantages, such as nontoxicity and high biocompatibility. Recently, it has begun to be used with high expectations in the medical field, such as for fabricating guide wire, orthodontic wires and microparts of medical appliances. However, because the plastic workability of Titanium is inferior to that of other metals, there is difficulty in manufacturing Titanium products, such as extrafine wires and microscrews, without cracks and other defects. Moreover, although the effects of small amounts of O and N in a pure Ti wire on its mechanical properties have been discussed, the effects on plastic workability, such as drawability, have not been clarified yet. In this study, we examined the effects of the amounts of O and N on workability and product strength during drawing, heading and rolling, and clarified the optimal conditions for cold drawing. We can infer the magnitude of the drawing limit on the basis of the break strain of mother wire. The fabrication of the guide wire, microspring and microscrews in medical fields as an application of the obtained drawn wire are also targeted in this study. The fabrications of these products were found possible by the metal forming which is selected an appropriate conditions.

MSEC_ICMP2008-72133

HOT DRAW MECHANICAL PREFORMING OF AN AUTOMOTIVE DOOR INNER PANEL

George Luckey — *Ford Motor Company*
Peter Friedman — *Ford Motor Company*

A novel sheet metal forming technology based on aspects of both warm forming and superplastic forming has recently been developed. The new forming process, referred to as hot draw mechanical preforming (HDMP), uses two sequential steps to form a panel within a single tool at elevated temperature. In the first step, the cushion system acts on a binder and upper die to draw the blank over a punch which serves to draw in metal from the perimeter of the blank. In the second step gas pressure is applied to finish the panel details. This two step process of drawing in metal followed by gas forming can result in a significant expansion of the forming envelope for conventional AA5xxx series aluminum sheet alloys commonly used within the automotive industry. Similar to SPF, the HDMP process is performed within a single forming press equipped with heated platens and using gas pressure to shape the component during elevated temperature forming. However, the HDMP process utilizes a blankholder to control the flow of material into the forming cavity during the drawing stage and therefore requires the addition of an integrated cushion system in the bed of the press. HDMP dies are of interest in automotive applications because they maintain the low-investment attributes of SPF tooling while also significantly reducing the forming time as compared to conventional SPF. This work details the CAE based design of an HDMP die to form a one-piece aluminum door inner that can not be formed with conventionally forming processes. Critical aspects addressed in the development of the die include manufacturing targets, part design for manufacturing, and die design for operation at elevated temperature.

MSEC_ICMP2008-72136

THE EFFECT OF MODEL PARAMETERS ON PREDICTED STRESS BASED FAILURE CRITERION FOR SHEET METAL

Brad Kinsey — *University of New Hampshire*
Matthew Derov — *University of New Hampshire*
Igor Tsukrov — *University of New Hampshire*

Tearing failure in sheet metal forming has traditionally been predicted based on the strain state of the material. However, a concern with this failure prediction method is that the strain based forming limit curve exhibits significant strain path dependence. A stress based failure criterion has been proposed and shown to be less sensitive to the strain path through numerical simulations and by analytically converting strain based data to stress space. However, a means to predict this stress based failure criterion without prior knowledge of the strain based forming limit curve for sheet metal is required. In this paper, an analytical prediction of the stress based forming limit curve is derived and compared to experimental and numerical results. The effects of model parameters are also investigated.

MSEC_ICMP2008-72137

A SMART ACTUATOR DESIGN FOR MULTIPLE BIO-REAGENT MIXING IN A HIGH PRESSURE OPTICAL CELL FOR BIO-PHYSICAL RESEARCH APPLICATIONS

Oliver Xie — *Drexel University*
Jack G. Zhou — *Drexel University*
Parkson Chong — *Temple University Medical School*

During the past two decades, bio-physicists have had an increasing interest in finding out what happens when two bio-material solutions are mixed under high pressure. Compared to temperature, pressure makes more contributions to our fundamental understanding of the structure-function relationship of biological systems, because pressure produces only volume changes under isothermal conditions, and pressure results can then be interpreted in a more straightforward manner. Window-type High Pressure Optical Cell (HPOC) such as the one designed by Paladini and Weber have provided biophysicists with a powerful tool to understanding the structure-function relationships of biological molecules. However, the conventional HPOC is only good for single solution testing and does not allow for quick mixing and stirring of additional components while the specimen is under pressure. This research is to thoroughly study the feasibility of Shape Memory Alloy (SMA) as an actuator to perform mixing and agitation functions; and five types of SMA actuators were designed, simulated and tested for unplugging and mixing purposes. To conduct this research, SMA helical springs were fabricated in house according to the design requirements. With different combinations of SMA tensile springs, SMA compressive spring and biasing spring, significant ranges of vibration were developed. To further improving mixing process, a unique hybrid design of SMA as an actuator to unplug the stopper and micro-motor as a stir device to agitate the solutions was developed. Rapid mixing of 95% of total solution in 10 seconds was achieved under 300 bars. A new HPOC was designed according to the new cuvette with its new unplug and mixing mechanism. Our industrial partner, ISS, further modified our design for easy manufacturing reason and fabricated the HPOC which made SMA actuator mixing test under pressure possible. A complete testing of the new HPOC system to observe bio-reagent mixing and reaction under high pressure was conducted and the results were satisfactory.

MSEC_ICMP2008-72139

INVESTIGATION OF FATIGUE PROPERTIES FOR WELDED ALUMINUM FORGING PREFORMS

William P Harris — *Cooper Power Systems*
Joseph Domblesky — *Marquette University*

While welded forging performs offer potential benefits for producing forged parts, work to date has concentrated on assessing static mechanical properties. As dynamic properties are an important consideration, the objective in the current study was to assess the high cycle fatigue properties of 6061-T6 aluminum forging performs which were prepared using friction welding. A metallurgical evaluation of the weld zone was also performed. Monolithic and friction welded specimens were prepared and hot worked using a laboratory press. Fatigue data was then generated using a rotating beam test machine. The results showed that forged performs demonstrated superior fatigue life when compared to as-friction welded performs in the same temper condition. Fatigue performance was also found to be comparable to that obtained from monolithic forging performs which had an identical thermomechanical processing history.

MSEC_ICMP2008-72155

EFFECT OF SHEAR STRESS ON TWIST IN U SECTION PRODUCT OF HIGH STRENGTH STEEL SHEET

Masashi Sakata — *Waseda University*
Motoo Asakawa — *Department of Applied Mechanics and Aerospace Engineering, Waseda University*
Yuu Hirose — *Waseda University*
Keisuke Nakamichi — *Waseda University*
Ikuhiko Hayashi — *Waseda University*
Hideyuki Sunaga — *RIKEN*
Hiroshi Yano — *UNIPRES*

Lightness and high rigidity are required for automotive body structure. To achieve these requirements, high tensile strength steel sheet is used for car reinforcement parts. However, processing high tensile strength steel sheet becomes more difficult as its strength is raised, and the dimensional inaccuracies of product cause trouble, such as spring back. This paper deals with U section product with a curved part in the longitudinal direction. Twist in longitudinal direction is the most typical and serious of dimensional inaccuracies. This research focuses on the influencing factors of the twist in the longitudinal direction. Some parts of die shoulder radius are varied to control the mechanism of occurring twist in the longitudinal direction. The twist moment can be classified into in-plane shear stress and out-of-plane shear stress. It has been observed

that in-plane shear stress plays an important role from out-of-plane shear stress by finite elemental method.

MSEC_ICMP2008-72173

FORMING FOR INSIDE SPIRAL MULTI-GROOVED TUBE BY HOT EXTRUSION

Norio Takatsuji — *University of Toyama*
Satoshi Murakami — *Aisin Keikinzoku Co.,Ltd*
Kenji Matsuki — *University of Toyama*
Tetsuo AIDA — *University of Toyama*
Kazuo Murotani — *University of Toyama*

The spiral extrusion processing method which forms inside spiral multi-grooved tube by the hot extrusion is proposed. The spiral extrusion processing method is the compound dies extrusion method that installed a rotary plug at the exit of the die mandrel of the porthole dies. In this paper, the effects of the extrusion conditions and rotary plug shapes on the groove torsion angle, the section groove angle and the groove depth in the inside spiral multi-grooved tube is investigated. As a result, good inside spiral multi-grooved tube is able to form so that extrusion temperature is low and extrusion ram speed is slow. Even if working height of rotary plug increases, only the outside diameter of the extruded inside spiral multi-grooved tube increases, and therefore it is understood that the predetermined inside spiral multi-grooved tube is not provided.

MSEC_ICMP2008-72250

ANALYTICAL MODEL FOR THE CHARACTERIZATION OF THE GUIDING ZONE TRIBOTEST FOR TUBE HYDROFORMING

Gracious Ngaile — *North Carolina State University*
Chen Yang — *North Carolina State Univeristy*

Common part failures in tube hydroforming include wrinkling, premature fracture, and unacceptable part surface quality. Some of these failures are attributed to the inability to optimize tribological conditions. There has been an increasing demand for the development of effective lubricants for tube hydroforming, due to widespread application of this process. This paper presents an analytical model of the guiding zone tribotest commonly used to evaluate lubricant performance for tube hydroforming. Through a mechanistic approach, a closed-form solution for the field variables contact pressure, effective stress/strain, longitudinal stress/strain, and hoop stress can be computed. The analytical model was validated by the finite element method. In addition to determining friction coefficient, the expression for local state of stress and strain on the tube provides an opportunity for in-depth study of the behavior of lubricant and associated lubrication mechanisms. The model can aid as a quick tool for iterating geometric variables in the design of a guiding zone, which is an integral part of tube hydroforming tooling.

MSEC_ICMP2008-72279

EXPERIMENTAL STUDY ON A NEW METHOD OF DOUBLE SIDE INCREMENTAL FORMING

Yongjun Wang — *Northestern Polytechnical University*
Ying Huang — *Northwestern University*
Jian Cao — *Northwestern University*
N Venkata Reddy — *Indian Institute of Technology Kanpur*

This paper presents a new configuration for sheet metal incremental forming using DSIF (Double Sided Incremental Forming) to overcome the limitation of single point incremental forming. The new process can produce geometrical features on either side of the initial plane of the sheet without changing setup. A component having such challenging features is selected to demonstrate the capabilities of the proposed method and a contour tool path is generated using Unigraphics surface machining module and formed by mounting the new setup on a CNC milling machine. The final formed shape was scanned and compared to the designed profile. In addition, two more components having cylindrical and spherical geometries are formed to study the effect of geometry on the accuracy of the component that can be produced by using the proposed method. A simple analysis model is developed to predict the elongation of sheet metal along the generatrix in the DSIF process.

MSEC_ICMP2008-72377

EFFECTIVE TEMPERATURE DISTRIBUTION AND DRAWING SPEED CONTROL FOR STABLE DIELESS DRAWING PROCESS OF METAL TUBES

Tsuyoshi Furushima — *Tokyo Metropolitan University*
Syuhei Hirose — *Tokyo Metropolitan University*
Ken-Ichi Manabe — *Tokyo Metropolitan University*

A dieless drawing technique that can achieve a large reduction in area of metal tubular materials in single pass by local heating and cooling, is a flexible metal drawing process with out dies and tools. Compared with the conventional die process, dieless drawing has a major advantage that no tools such as dies, plugs and mandrels are required. In previous study, the local heating of the tube has been essential condition to make the dieless drawing process a successful. However, the researchers have not consider to categorize the forming limit by instable

deformation occurred at early drawing stage and deformation limit of the material. In this study, we suggested the acceleration effect of drawing speed at early drawing stage, which the drawing speed increase gradually, as a method of separating off the fracture by instable deformation. The pure deformation limit of the material was evaluated by coupled thermo-mechanical finite element analysis using MSC Marc/Mentat and experiment of the dieless drawing. Metal tubular materials used in the experiment are SUS304 alloy tubes with outer diameter of 2mm. A high-frequency induction heating apparatus with water-cooling box is used for the dieless drawing. As a result, the acceleration effect of drawing speed enhances the forming limit in dieless drawing. Moreover, Effect of heating length, which affects temperature ditribution, on deformation behavior was investigated under condition of separating off the fracture by instable deformation at early drawing stage. It is found that the forming limit slightly improves with increasing heating length. Consequently, we clarified that it is possible to make the dieless drawing process a successful even if the local heating is not realized necessarily.

MSEC_ICMP2008-72379

SUPERPLASTIC JOINING OF TZP ENHANCED BY TITANIA-DOPED TZP AS AN INSERT MATERIAL

Yorinobu Takigawa — *Department of Materials Science, Graduate School of Engineering, Osaka Prefecture University*
Hiroaki Takadama — *Cyubu University*
Kenji Higashi

Superplastic joining of 3mol% Yttria stabilized tetragonal zirconia polycrystal (3Y-TZP) is examined using 5wt%TiO2-doped 3Y-TZP as an insert material, in order to decrease the joining temperature and stress, and to realize the local deformation near the joining surface. The joining tests are conducted by uniaxial compression in the temperature range of 1523 to 1723K. The joined specimen is characterized by scanning electron microscopy (SEM), showing a clean interface with no cavitation. Four point bending tests are conducted to evaluate the joining strength, resulting that an average flexural strength of 960MPa is obtained in the specimen compressed at 1573K by 10MPa for 30 min, which is the 80% of the strength in 3Y-TZP matrix. The temperature of 1573K is 100K lower to obtain similar strength without the insert. Fracture occurs not from joining surface but from matrix in bending tests. Residual stress must be introduced during joining process.

MSEC_ICMP2008-72394

ADJUSTMENT OF PROFILE OF DIE BACKPLANE WITH EMPLOYING MULTIPLE ELASTIC ACTUATORS

Takahiro Ohashi — *Kokushikan University*

The elastic deformation of dies in large sheet metal forming, such as in the production of automobile panels, become one of the most important problems in 'trial-less' production due to the recent improvement of forming simulation. In this paper, authors present new die supporting structure employing multiple elastic actuators to adjust the profile of die backplane. The actuator contains the elastic load-bearing-structure and hydraulic pressure cavity. Strain gauges are bonded on elastic load bearing structure and the structure works as both structural part and load or displacement transducer. Pressurizing into the cavity elongate the actuators because of elastic deformation of the load-bearing-structure. We can evaluate the deformation of die back plane as deformation of distributed load-bearing-structure, and adjust its profile by pressurizing each of actuators. The authors develop the above structure for the full-sized inner door panel die and evaluate product shape with using 3D scanner to confirm its efficency.

MSEC_ICMP2008-72395

EXPERIMENTAL AND NUMERICAL STUDY ON BLANKING PROCESS WITH A NEGATIVE CLEARANCE

Kenji Hirota — *Kyushu Institute of Technology*
Hiroyuki Yanaga — *Kyushu Institute of Technology*
Katsunori Fukushima — *Kyushu Institute of Technology*

This study summarizes the characteristics of blanking behavior with a negative clearance. Several experiments were performed for two aluminum sheets over a wide range of clearances including negative values. Blanking with negatively large clearances was found to produce fine cut edges with less roll-over and no fracture zone even for a brittle material. The influence of die radius and material properties on the blanked edge quality was also investigated; the die radius increased the roll-over and delayed fracture initiation. The material with lower ductility exhibited less roll over and more fractured zone under same tool conditions. Corresponding simulations were performed using the Ayada's criterion for predicting ductile fracture initiation. Each zone of blanked part edges such as roll-over and fractured zone agreed well with that obtained in the experiments except a few cases accompanied by secondary shear. The influences of the clearance on fracture initiation was studied considering the

change of damage value during blanking operation; in the negative clearance blanking, the damage value calculated was found to be kept low and no fracturing was predicted. This is because the mean stress, which dominates the damage value for the criterion used, became low (compressive) around the die edge where fracture initiated. Contrary in conventional blanking, the damage value increased, reached the threshold for the material and resulted in fracture initiation since the mean stress became tensile. The influences of parameters on load-stroke curves were also investigated. The curves for negative clearances showed gradual increase in load toward the end of stoke. The earlier fracture initiated, the load reached a peak earlier. Simulated curves showed the same tendency and in good agreement with the experimental ones quantitatively.

MSEC_ICMP2008-72403

TOWARD UNDERSTANDING IN ATOMISTIC SCALE OF GRAIN BOUNDARY PLASTICITY

Tokuteru Uesugi — *Department of Materials Science, Graduate School of Engineering,* Osaka Prefecture University
Kenji Higashi

The ideal shear strength for the grain boundary sliding is calculated from the first principles to study the effect of the sliding direction, the grain boundary structure concerning different grain boundary energies, and the segregation of solute atoms on the grain boundary sliding. The ideal shear strength for the grain boundary sliding is given by the maximum in the slope of the grain boundary gamma-surface. By ideal we mean the shear strength of ideally planer grain boundaries of bicrystals without any dislocations. The ideal shear strength was calculated for the three symmetric tilt grain boundaries, which are low, middle and high energy boundaries, respectively. The smaller energy boundary exhibited the larger ideal shear strength. The ideal shear strength for sliding in the direction parallel to the tilting axis was much smaller than that in the direction perpendicular to the tilting axis. A specific segregated solute element such as Zr increased the ideal shear strength because the segregated solute atoms increased the charge density on the grain boundary.

MSEC_ICMP2008-72419

EFFECT OF COMPRESSION PROPERTIES ON POROUS MATERIAL WITH MG-AL-ZN-CA SYSTEM ALLOY

Tetsuo AIDA — *University of Toyama*
Norio Takatsuji — *University of Toyama*
Kenji Matsuki — *University of Toyama*
Yuukou Horita — *University of Toyama*
Kazunori Takeuchi — *University of Toyama*

We investigated the fabrication process and its mechanical properties of extruded magnesium form with AZX912 alloy machined chips and gas forming. At this time, porous material of the AZX912 alloy was created using the celltetra powder. Relative density, ?, of 0.34 were obtained by foaming the volume ratio, V/V0, to be 4 at 963K. However, it was proven to foam from aggregation part of the celltetra powder in the triple junction of the interfaces of the machined chips. On the other hand, by compression test result at the room temperature, it was possible to obtain the stable plateau stress in the extrusion direction at the strain rate of?=100 s-1. Generally, it is difficult to check an internal pore visually. Therefore, by using the X-rays CT equipment, details pore information can be acquired as CT image in this study. Pore's feature and the material characteristic are related in analyzing the CT image by using the image processing technique. By analyzing the pore features of each xy-, yz-, zx-coordinate surface, we obtain the material characteristics of porous metals. It was proven that uniformity and pore shape of the inside sectional structure influenced for plateau region and stress.

MSEC_ICMP2008-72439

FINITE ELEMENT ANALYSIS OF DEFORMED GEOMETRY IN THREE-ROLLER PLATE BENDING PROCESS

Vishal K Tailor — *Sardar Vallabhbhai National Institute of Technology, Surat*
A. H. Gandhi — *C. K. Pithawalla College of Engineering & Technology,*
R.D Moliya — *Larsen & Toubro Limited, Hazira – Surat*
Dr. Harit K. Raval — *S. V. National Institute of Technology*

In pyramid type three-roller bending process, it is difficult to deform the plate perfectly to the required circular shape and it mainly depends on the skill of the operator. Presented work shows the finite element (FE) simulations of three-roller plate bending process to study the influence of different parameters, such as roller position, rolling speed, plate material, plate length and friction (at roller plate interfaces) on the bending quality of the deformed plate. FE simulations were performed based on the elastic-

plastic explicit dynamic finite element method under the Hyperform LS-DYNA environment. FE simulation results were verified with the experimental results. Parametric studies were carried out to investigate the effect of various parameters on the quality of the final shape. Reported work will be helpful to process engineers in predicting the final radius of curvature and deviation of plate prior to manufacturing. This will reduce the trail and error in achieving the final geometry.

MSEC_ICMP2008-72454

MATHEMATICAL MODELLING AND FINITE ELEMENT SIMULATION OF PRE-BENDING STAGE OF THREE-ROLLER PLATE BENDING PROCESS

A. H. Gandhi — *C. K. Pithawalla College of Engineering & Technology,*
H. V. Gajjar — *Larsen & Toubro Ltd.*
H. K. Raval — *Sardar Vallabhbhai National Institute of Technology*

Continuous three roller bending process is widely used in practice to bend the plates into cylinders. Bending load for plate material under bending is affected by plate thickness, width and shell diameter combinations. Maximum top roller load is encountered during the edge pre-bending stage as top roller is set at an offset distance from its mid position. Shell diameter, thickness and material for cylindrical structural element to be produced are fixed by design. Width of the plate for roller bending decides number of cylindrical segments required to achieve the designed shell length. Maximum pre-bending width depends on maximum top roller load imparting capacity. Looking to the above considerations, maximum width which can be pre-bend at limiting top roller load (for designed shell diameter, thickness and material combinations) specifies the capacity. Presented work aims at developing the mathematical model of top roller load for pre-bending. Top roller offset for pre-bending were calculated based on practical top roller pre-bending load data, for different grades of C-Mn steel plates (as per ASME sec II part-A). Based on these top roller offsets, finite element analysis (FEA) of pre-bending stage were performed using Hyperform LS-DYNA. Effect of co-efficient of friction at roller plate interfaces was analyzed. FE simulation of pre-bending of cladded plate (54 mm thick C-Mn steel plate of material grade SA-387Gr11Cl2 having 3 mm thick layer of stain less steel material grade SS-308) was performed. FEA load results were found in good agreement with the practical load results and can be used for capacity assessment and analysis of roller bending machines.

MSEC_ICMP2008-72476

DEVELOPMENT OF MICRO-DIMPLE FORMING PROCESS

Masaru Futamura — *Nagoya Institute of technology*
Kuniaki Dohda
Takehiko Makino — *Nagoya Institute of technology*
Tetsuya Suzuki — *Sugino Machine Ltd.*

With recent increasing demands on longer service life, more advanced performance and environmental consciousness of mechanical components, attention has been focused on employing dimples that are intentionally formed on the surface of the sliding portions of components. From the tribological point of view, these dimples reduce frictional resistance and improve anti-seizure properties of mechanical components. A micro dimple forming process using a forming tool was developed to improve the anti-seizure properties of sliding surfaces of mechanical components and reduce frictional resistance. This process combines a roll-burnishing and a ball-burnishing process. The characteristics of the process are as follows. The micro dimple forming tool is a metal forming tool allowing intermittent ball-burnishing so as to form regular alignment of micro dimples of several-micrometers depth on the inner wall of pipes. The rolls in the micro dimple forming tool come into contact with the inner wall of the pipe before the balls when the tool is fed forward, and rolls contact the wall after the balls when the tool is fed backward to flatten the bump around the dimples. The results are summarized as follows. Burnishing the inner wall of an A2017 pipe with an original surface roughness of 2 ?m Rz produces a surface roughness of 0.5 ?m Rz. For A2017 pipes, the bump-free dimples with 3 ?m depth can be formed by using proposed dimple-forming tool. For S45C pipes, the bump-free dimples, similar to the case of A2017, can be formed by dimple forming utilized at previously roller-burnished surface. It was confirmed that the tool feed speed controls the pitch of the dimples. The depth of indentation of rollers and balls controls the depth of the bump-free dimples. Advanced control of the dimple formation condition and the surface characteristics of the workpiece is important and they should be cleared in the future.

MSEC_ICMP2008-72494

INFLUENCE OF FRICTION AND ANISOTROPY ON CUBE- AND RING- COMPRESSION TEST

Motoki Terano — *Nagoya Institute of Technology*
Kazuhiko Kitamura — *Nagoya Institute of Technology*
Takaaki Fukatsu — *Nagoya Institute of Technology*
Takaji Mizuno — *Nagoya Institute of Technology*

An extruded or rolled material such as a bar and a tube naturally possesses plastic anisotropy like a sheet. The property influences the metal flow in bulk forming as well as in sheet metal forming. In this paper, some examples of anisotropic bulk deformations in a cube- and a ring-compression test were illustrated. A cube with edges of 1 mm long, which was cut out from a round bar and a tube, was compressed in z-axis under well-lubricated condition by applying beef-tallow. After the compression test, the ratios of ?y to ?x were 0.83 and 0.76 for A1050 and A6063 respectively. They indicated normal anisotropy, because the ratios of ?y/?x keep unity if they are isotropic materials. Furthermore, the friction also affects the metal flow for the anisotropic material. The ratios of ?y/?x changed when the cubes were compressed under different frictional conditions by using some lubricants such as beef-tallow, VG460, VG100, castor oil, and no lubrication. The anisotropic deformation was restrained by the higher-frictional die-surface. Also the ring compression test as another example was investigated, which is a well-established test to measure the friction by measuring the changing inner diameter. The plastic anisotropy and the friction influenced the reduction in inner diameter, so that the coefficient of friction was decided with an appropriate diagram to be considered the anisotropy of material.

MSEC_ICMP2008-72530

SINGLE- AND MULTI-STAND CHATTER MODELS FOR TANDEM ROLLING MILLS

Huyue Zhao — *Argonne National Laboratory*
Kornel Ehmann – *Northwestern University*

In this paper, a state-space representation of single- and multi-stand chatter models will be proposed in a rigorous and complete mathematical form for stability analysis of the various chatter mechanisms. At first, a dynamic model of the rolling process that includes the material strain-hardening and work roll flattening effects will be established based on homogeneous deformation theory. By coupling this new dynamic rolling process model with suitable structural models of a mill stand, single- and multi-stand chatter models in state-space representation will be constructed. The multi-stand chatter model will also incorporate inter-stand tension variations and the time delay effects caused by strip transportation delays. A dynamic simulation program for the study of the dynamic rolling process in the time domain and for the verification of the results from stability analysis will also be described.

MSEC_ICMP2008-72540

PLASTIC WORKING METHOD FOR ENLARGING DIAMETER WITH A FINAL OUTER SHAPE

Yoshitaka Kuwahara — *Ehime University*
Xia Zhu — *Ehime University*
Nagatoshi Okabe — *Graduate School of Science and Engineering Ehime University*
Fumiaki Ikuta — *Neturen Co.Ltd.,*
Keiji Ogi — *Ehime University*

A new method of plastic working, which we had developed with notice of mechanical ratchet phenomenon and called “JIKUHIDAI processing”could enlarge incrementally a partial diameter of steel shaft subjected to a constant axial compressive load with alternative stresses of tension and compression due to rotating bending. This processing method is a novel plastic deformable working with some great merits that the partial diameter enlarging of a steel shaft can be performed without raising temperature due to plastic working heat only in a short time within 20 to 30 seconds by slight energy at room temperature, and so can be deformed economically compared with cutting out from a bigger bar. On the other hand, most of shafts have a hexagonal shape, a gear and a multi-stair on their largest diameter. Therefore, this processing method would be respected furthermore to deform a partial diameter into the near net outer shapes of their final enlarging parts. In present work we studied the way to deform a partial diameter into the near-net outer shape required for practical machine parts. The way was clarified experimentally to be actualized by controlling the final outer shape of a partial enlarging diameter using the metal mold with a hole of final outer shape, which was fixed on the rotating side holder and rotated together with a shaft of work. The diameter enlarging behaviors were investigated experimentally by measuring the changes of the length between holders and the shaft diameter outside the metal mold. On the base of mathematical modeling of their deformation behaviors, the effects of processing conditions on the enlarging shape were researched and an estimating equation to clarify the engineering optimization of processing conditions was gotten by mathematical model analysis.

MSEC_ICMP2008-72544

POTENTIAL THEORY BASED BLANK DESIGN FOR DEEP DRAWING IRREGULAR SHAPED COMPONENTS

Jianjun Wu — *Northwestern Polytechnicl University*

potential theory based blank design for deep drawing parts

MSEC_ICMP2008-72545

STUDIES OF SIZE EFFECT ON THE FORMABILITY OF A DOMED PART IN INCREMENTAL FORMING

Ying Huang — *Northwestern University*
Jian Cao — *Northwestern University*
K. Scott Smith — *University of North Carolina at Charlotte*
Bethany Woody — *University of North Carolina at Charlotte*
John Ziegert
Ming Li — *Alcoa Technical Center*

The failure strain level in a single point incremental forming (SPIF) process is found to be much higher than that in the traditional stamping process. Based on the assumption that forming limits in SPIF are dominated by fracture failure, the Oyane ductile fracture criterion is introduced in this paper to predict the fracture initiation site, and hence the forming limit, given the stress and strain values obtained from finite element simulations. The predicted results are compared well with those obtained from the SPIF experiments. Furthermore, this fracture criterion is used to study the size effects in SPIF. Analytical equations are derived to comprehensively consider the effects of design and process parameters on sheet formability including sheet thickness, tool diameter and incremental depth. Comparisons have also been conducted with experiments in the past literatures to verify the feasibility of the proposed size effect equation.

MSEC_ICMP2008-72547

A GENERIC TOOL PATH GENERATION METHODOLOGY FOR INCREMENTAL FORMING

Rajiv Malhotra — *Indian Institute of Technology, Kanpur*
N Venkata Reddy — *Indian Institute of Technology Kanpur*
Jian Cao — *Northwestern University*

This paper presents a generic methodology for tool path generation for an arbitrary component that can be formed by single point incremental forming (SPIF) to obtain required geometrical accuracy. Adaptive slicing concepts used in layered manufacturing have been modified and used for generating tool path for SPIF. Experiments and FEA have been carried out to study the effectiveness of the proposed methodology. Results indicate that the proposed methodology enhances the accuracy achievable in SPIF. KEY WORDS: SPIF, automatic generation of contour and helical tool paths, accuracy and surface finish

MSEC_ICMP2008-72555

SHEET METAL FORMING LIMIT UNDER STRETCH-BENDING

Cedric Xia — *Ford Motor Company*
Danielle Zeng — *Ford Motor Company*

The Forming Limit Diagram (FLD) as developed by Keeler etc. has been widely used to assess sheet metal failure during variety of forming operations. It's theoretical and empirical foundation is based on localized necking under biaxial loading for the sheet metal. While the in-plane deformation is generally the dominant mode for most forming operations, sheet metal bending is inevitably coupled to the deformation process, and the traditional Forming Limit Diagram has to be modified to take into account the bending effect, especially when the bending radius becomes smaller. This paper presents a theoretical formulation for the bending-enhanced Forming Limit model. The deformation theory of plasticity is employed for the instability analysis, and only the bending is assumed in the direction along one principal loading. The obtained results show that the forming limit is enhanced by the bending effect, consistent with experimental observations.

MSEC_ICMP2008-72592

FORMABILITY OF ANISOTROPIC ALUMINUM TUBES

Yannis Korkolis — *University of Texas at Austin*
Stelios Kyriakides — *University of Texas at Austin*

Tube hydroforming is an attractive manufacturing process, of special interest to the automotive industry. The process can aid in developing light, fuel efficient and reduced emission vehicles, especially when applied to modern aluminum alloys. In this method, a thin-walled tube is inflated inside a rigid die and hence expands and conforms to the shape of the surrounding cavity. Apparently, since expansion leads to thinning, burst will be one of the major limiting factors of the process. Comparison between numerical simulations and hydroforming experiments has revealed an inadequacy of the classical J2 plasticity in predicting this failure. The present study aims to address

tube formability both numerically and experimentally and to develop a constitutive framework capable of predicting burst in tube hydroforming. A series of Al-6260-T4 tubes were loaded under internal pressure and axial load along constant engineering stress ratios, and taken to failure. The results of these radial paths were used to calibrate a number of anisotropic yield functions and assess their performance in predicting burst. It is shown that burst can be ultimately predicted successfully, albeit using a complicated calibration procedure. The study is expanded by examining the effect of a changing loading path on the failure stresses and strains. Tubes from the same stock were loaded under bilinear (corner) paths in the engineering stress space. As expected, the failure strains differ widely between the corner paths and the corresponding radial ones. Interestingly, it was discovered that for the most extreme of the corner paths, the failure stresses were also path-dependent.

Symp 2-3 ADVANCED POWDER PROCESSING

MSEC_ICMP2008-72007

HIGH STRENGTHENED AND TEXTURE-CONTROLLED P/M MAGNESIUM ALLOYS AND THEIR ISOTROPIC TENSILE PROPERTIES

Katsuyoshi Kondoh — *Osaka University*

Roll Compaction (RCP) process, consisting of twin rolls, is available to assist grain refinement and texture control of coarse magnesium powders by severe strain hardening to them by all direction. P/M wrought magnesium alloys consolidated by extrusion in employing RCPed powder show a good balance of tensile strength and elongation. In applying RCP process with 50 cycles to AZ31B powder, the extruded wrought alloy reveals the extremely small grain less than 1~2 Âμm, and superior mechanical properties of 380 MPa TS, 310 MPa YS and 15% elongation. Grain growth of RCPed powder was hindered due to the pinning effect by refined oxide dispersoids and intermetallics at grain boundaries when annealed at 673K for 3.6 ks. Anisotropy of their mechanical properties are significantly improved due to both of activated basal and non-basal slips by grain refinement and texture control by severe plastic deformation by all direction.

MSEC_ICMP2008-72102

EXPERIMENTAL ANALYSIS OF METAL FLOW AND STRAIN DISTRIBUTION IN ROLLING OF SN-PB POWDER

Yoshimi MURATA
Eiji Yuasa — *Musashi Inst. Tech.*
Masahito Tanaka — *Meiji University*

Metal flow and strain distribution in the flat rolling of Sn-Pb powder are experimentally analyzed by the modified visioplasticity method. Sn-Pb powder is packed in a container of 10mm square made of aluminum foil and rolled up to 80%. After the rolling? distorted shapes of the powder particles are measured experimentally. As a result, it was made clear that the test piece can be classified into three areas;?(1)pore decreasing area (2)particle deforming area and (3)plastic flow area.

MSEC_ICMP2008-72150

MECHANICAL PROPERTIES OF COMPOSITE MATERIAL USING COAL ASH AND CLAY

Isao Fukumoto — *University of the Ryukyus*
Yasuyuki Kanda — *University of the Ryukyus*

Coal ash is industry waste exhausted lots of amount by electric power plant. The particle sizes of coal ash especially fly coal ash are very fine, and their chemical component are extremely resemble with clay. From the point of view that clay is composed of particles which also have a micro meter size in diameter, we should try their application for fabrication of composite material using fly coal ash and clay. The comparison with the mechanical properties of composite material using clay and fly coal ash were performed among electric furnace burning and spark plasma sintering (SPS). SPS known as pulsed electric current sintering was carried out in vacuum using Dr sintering SPS-2050 apparatus. As a result, the bending strength of composite material including the coal ash 10 mass % and burned at 1423 K using the electric furnace after press forming at 30 MPa showed the highest value of 48 MPa. This phenomenon suggests an enforcement role of coal ash particles to clay matrix. On the other hand, the bending strength of the composite material adding the clay 5-10 mass% with spark plasma sintering at 1473 K and pressure at 20 MPa showed the highest value of 86 MPa by a binder role of clay according to the liquid phase sintering effect of melted clay to coal ash particles.

MSEC_ICMP2008-72305

RESIN/METAL EXTRUSION FOR FABRICATING POROUS ALUMINUM

Masato Hirai — *Kagawa University*
Kazunari SHINAGAWA — *Kagawa University*
Yutaka Mihara — *Kagawa University*

To fabricate porous products, such as heatsink devices or ultra-light structural parts, a method of producing straight channels in aluminum is proposed. Cylindrical billets containing aluminum powder with some kinds of resin inserts are extruded at elevated temperatures. First, it is found that aramid inserts successfully act as a space holder, which thin down without breakage during extrusion, while the aluminum powder matrix consolidates. The aramid inserts are burned out in the subsequent firing process, and the penetration in the extruded bar is confirmed. Secondary, the influence of different extrusion conditions on the deformation behavior of the inserts is investigated. The reduction in diameter of the aramid inserts varies in a certain extent, but its average is almost stable under the test conditions and slightly smaller than that of the billet. Thirdly, tensile tests of an aramid fiber at high temperatures are conducted to compare the flow stress with that of the aluminum matrix. Simple compression tests of the aramid fiber in the lateral direction are also performed to confirm the ductility under compression. The strength level of aramid is similar to that of aluminum matrix at elevated temperatures, and the compressive ductility is higher compared with the tensile elongation. These results may demonstrate the validity of the extrusion of the aluminum powder in combination with the aramid fibers.

MSEC_ICMP2008-72321

EFFECT OF PARTICLE SIZE ON THE PROCESSING PARAMETERS AND PROPERTIES OF COMPACTS BY MICRO MIM

Toshiko Osada — *Kyushu University*
Hideshi Miura — *Kyushu University*

Producing micro size parts by metal injection molding (MIM) needs more sophisticated technique than conventional MIM. Especially, in order to fill the micro groove cavities which size are smaller than 10Âμm with feedstock by micro MIM (Âμ-MIM) technique, much smaller particle size of powders than that of conventional MIM are required. Also, various properties such as powder loading, viscosity of feedstock, debinding behavior, sintered density, and mechanical properties would be changed by using small powders. In this study, the effects of particle size on the several properties of stainless steel (SUS316L) compacts are investigated for Âμ-MIM processing.

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MICROSTRUCTURE AND MECHANICAL PROPERTIES OF ZRO2 (Y2O3)-AL2O3 NANOCOMPOSITES PREPARED BY SPARK PLASMA SINTERING

Shufeng Li — *Nihon University*
Hiroshi Izui — *Nihon University*
Michiharu Okano — *Nihon University*
Weihua Zhang — *Xi'an University of Technology*
Taku Watanabe — *Nihon University*

Zirconia (Y2O3)-alumina ceramic nanocomposites were fabricated by spark plasma sintering (SPS). A commercially available nanocomposite powder TZP-3Y20A used as starting powder, the other from conventionally mechanical mixed powder 3YSZ-20A used for comparison. The effect of sintering temperature on the densification, sintering behavior, mechanical properties, and microstructure of the composites were investigated. The results show that the density increase with increasing of sintering temperature, and thus mechanical properties were strengthened with enhancing of densification. The nanocomposite powder TZP-3Y20A was easily sintered and good mechanical properties achieved, compared with the powder from conventionally mechanical mixed, where the maximum strength and toughness of composites are 967 MPa and 5.27 MPam1/2, respectively. Keywords: Alumina-zirconia; Nano-composite; Spark plasma sintering (SPS); Mechanical properties; Micro hardness; Fracture toughness; Densification;

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SYNTHESIS AND CHARACTERISTICS OF WC-CO ALLOY FABRICATED BY MECHANICAL ALLOYING AND PRESSURE SINTERING

Kazuo Isonishi — *Faculty of Education, Shiga University*

Cemented tungsten carbide (WC-Co alloy) is the useful material for cutting and drilling tools, wear resistant parts and dies material. Generally, the WC-Co alloys have been produced by the liquid phase sintering using fine WC and Co powder. Therefore, the sintering temperature exceeds about 1600K where is the liquid phase formation temperature of WC-Co system below the melting point of Co. In this paper, the synthesis of WC-Co alloy by solid-state process, especially the attempt to form WC phase at the sintering stage was discussed. Chemical composition of WC-Co was chosen to be WC-20vol%Co by its moderate volume fraction of binder phase and alloy performance. The powder mixture of stoichiometric quantities of elemental powders was mechanical alloyed by using low energy ball mill under Ar atmosphere. After 1800ks milling, the elemental phase remained and any carbides did

not synthesized. The X-ray diffraction profile of 1800ks milled powder showed only W peak. In addition, the crystalline size of the 1800ks milled powder is about 35nm obtained by XRD line broadening. The DTA analysis, up to 1273K, was performed to examine formation of objective phase, tungsten carbide. The exothermic reaction, about 1140K, W2C and Co6W6C phase were formed from well mixed elemental phases. Therefore, in this study, it is considered that the WC phase synthesized at the sintering process, not milling stage like other investigations. It is expected that the WC particle would become finer in comparison with the conventional liquid phase sintering and high energy milling process. 1800ks milled powder was consolidated by using pulse current sintering method at the temperature of 1373K, which temperature was below the liquid formation temperature. The consolidated material consisted mainly of WC with Co and W3Co3C phases. The compact obtained here showed fine WC grain sized less than 500nm with showing plate-like grain shape. The properties of the consolidated material were examined by the hardness test and 3 points bending test. The hardness of the compact was HV1648 and HRA91.8. The bending strength was 2.0GPa.

MSEC_ICMP2008-72368

PROCESSING OF ZRW2O8-ZRO2 CONTINUOUS FUNCTIONALLY GRADED MATERIALS BY CO-SINTERING ZRO2 AND ZRO2+WO3 MULTI-LAYER COMPACTS

Li Sun — *Michigan State University*
Patrick Kwon — *Michigan State University*
Samuel Baldauf — *Michigan State University*

A powder mixture of ZrO2+WO3 and ZrO2 powder were stacked, compacted and sintered in the processing steps commonly used to fabricate multi-layer materials. However, the observation of the cross-sectional microstructures as well as the measurement of the radial thermal expansion provided the evidence that the sintered samples are continuous Functionally Graded Materials (FGMs) made of ZrW2O8 and ZrO2, Because of the discrepancy in the sintering potentials between two constituent materials, the sintered samples does not retain the original cylindrical shapes of the green compacts. This problem has been resolved by choosing the appropriate powder mixture for each layer of the compacts. The formation of the continuous FGM structure is due to three factors: 1) the diffusion of WO3, 2) the sublimation of WO3 and 3) the reaction between ZrO2 and WO3. The continuous variation in the radial coefficient of thermal expansion can be utilized to reduce the thermal stress induced from a thermal gradient loading within a material system. This study shows that the processing steps typically used in processing stepwise FGMs can also be used to create continuous FGMs for some special powder mixtures.

MSEC_ICMP2008-72440

EFFECT OF FE OR CR ADDITION ON THE STRENGTHENING TI-6AL-4V ALLOY BY METAL INJECTION MOLDING

Yoshinori Itoh — *Hamamatsu Technical Support Center Industrial Research Institute of Shizuoka Prefecture*
Hideshi Miura — *Kyushu University*
Toshiaki Uematsu — *Hamamatsu Technical Support Center Industrial Research Institute of Shizuoka Prefecture*
Toshiko Osada — *Kyushu University*
Kenji Sato — *Hamamatsu Technical Support Center Industrial Research Institute of Shizuoka Prefecture*

In the previous paper, the strengthening of sintered Ti-6Al-4V alloy compacts were available by addition of fine Mo powder, because of microstructural modification on the sintered compacts. In this study, the metal injection molding process has been applied to strengthen Ti-6Al-4V alloy compacts by addition of fine Fe or Cr powders. Fe and Cr are the same beta stabilizing element as Mo. The microstructures of sintered compacts were consisted of acicular alpha phases and intergranular beta phases. The tensile strength of sintered compacts was increased with increasing Fe or Cr contents, and the effect of Fe addition for strengthening the sintered compacts was larger than Cr addition. Eventually, the tensile strength of sintered compacts added 2mass% of Fe was improved to be 980MPa with 14.8% of elongation, and the compacts added 4mass% of Cr showed the excellent tensile strength of 1030MPa with 15.1% of elongation.

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PHASE TRANSFORMATION BEHAVIOR OF TI-NI-CU SHAPE MEMORY ALLOY BY P/M PROCESS

Hideki Kyogoku — *Kinki University*
Akira Terayama — *Hiroshima Prefectural Technology Research Institute*

Ti-Ni-Cu shape memory alloy was fabricated by elemental powders using a pulse-current pressure sintering equipment. The effect of Cu addition on the phase transformation behavior of the sintered alloys was investigated. An increase in Cu content changed the crystal structure of the alloy. The alloys of 5at%Cu and 10at%Cu consists of B2 and B19' phases, but the alloys of 15 at%Cu and 20 at%Cu consists of B2, B19' and B19 phases. Especially, the alloy of 20 at%Cu clearly shows the two-step transformation. The transformation hysteresis of the alloy of 20at%Cu was approximately 10 K as narrow as that of the wrought alloy. It was found that the P/M alloy obtained has sufficient shape recovery property.

Symp 2-4 ADVANCED WELDING AND BONDING

MSEC_ICMP2008-72025

EFFECT OF FRICTION WELDING CONDITION ON JOINING PHENOMENA AND TENSILE STRENGTH OF FRICTION WELDED JOINT BETWEEN PURE COPPER AND LOW CARBON STEEL

Masaaki Kimura — *University of Hyogo*
Masahiro Kusaka — *University of Hyogo*
Koichi Kaizu — *University of Hyogo*
Akiyoshi Fuji — *Kitami Institute of Technology*

This paper describes the effect of the friction welding condition on the joining phenomena and tensile strength of friction welded joint between pure copper (OFC) and low carbon steel (LCS). When the joint was made with friction pressure of 30 MPa, OFC transferred to the half radius region of the weld interface on the LCS side, and then transferred toward the entire weld interface. The temperatures at the centerline, half radius and periphery portions on the weld interface of the LCS side were almost the same after the initial peak. When the joint was made at a friction time of 2.4 s, i.e. the friction torque was close to the initial peak, it had approximately 40% joint efficiency and fractured from the weld interface with a little OFC adhering to the weld interface on the LCS side. The joint efficiency increased with increasing forge pressure, and it reached approximately 80% at a forge pressure of 180 MPa. This joint fractured at the softened OFC region adjacent to the weld interface. On the other hand, OFC transferred to the peripheral region of the weld interface on the LCS side when the joint was made with friction pressure of 90 MPa. However, OFC transfer was not obtained at the central region because the temperature at the periphery portion was higher than that of the other portions. The joint efficiency increased with increasing friction time, and it obtained approximately 74% at a friction time of 1.2 s. Moreover, all joints fractured between the OFC side and the weld interface, although the joints were made with higher forge pressure. To obtain higher joint efficiency and fracture in the OFC side, the joint should be made with low friction pressure and high forge pressure, and with the friction time at which the friction torque reaches the initial peak.

MSEC_ICMP2008-72071

DIMENSIONAL VARIATION ANALYSIS OF T-NODE JOINTS USING ALUMINUM 6063-T52 EXTRUSION MATERIAL IN GAS METAL ARC WELDING (GMAW)VJOINING PROCESS

Ramakrishna Koganti — *Ford Motor Company*
Armando Joaquin — *Ford Motor Company*
Chris Karas — *Metro Technologies*

The development of manufacturing processes for joining and assembling of lightweight aluminum vehicles requires detailed process capability studies as well as dimensional variation analysis studies to ensure process controls are in place. These manufacturing processes not only have to provide cycle time viability but also need to maintain or surpass product safety and quality. T-Nodes joint designs are an integral of aluminum architectures based on hybrid designs, i.e those fabricated from mixed aluminum products consisting of castings, stampings and extrusions. The purpose of this study was to find optimum parameters for minimum distortion for the gas metal arc welding (GMAW) of 6063-T52 T-Nodes. The welding factors considered were locators (4-way and 2-way pins verses net surfaces), the welding equiment process factors (power input, pulse frequency, gas flow rate, torch angle and arc intensity), the use of simultaneous welding, and welding sequence order. A partial factorial design of experiment (DOE) was conducted to understand the effects of these factors on T-node joint distortions. A total of 14 points were considered for dimensional distortion measurements. Results showed power (heat) input is the only statiscally significant factor on joint distortion. Locators type as well as welding sequence and simultaneous welding also had a measurable affect on part deviation during welding.

MSEC_ICMP2008-72088

LAP WELDABILITY OF PURE TI AND 5052 ALUMINUM ALLOY SHEETS USING PULSED YAG LASER

Kan Watanabe — *Nihon university*
Toshikatsu Asahina — *Nihon university*

5052 Al alloy and pure Ti sheets were lap welded by YAG laser using pure Zr or pure Ni foils as an insert metal at various welding conditions. Tensile shear test, hardness test, microstructure observation and EDX line analysis of the welded joints were investigated. Without insert metal, there were many blowholes retained in the weld interface. Because, Mg as one of an alloy composition of 5052 Al alloy, evaporate during welding. Intermetalic compound were formed in the fusion zone. However, using either Zr or Ni foil, blowholes were decreased in weld interface. The penetration shapes become shallow by using Zr foil. In the case of Ni foil employed, the tensile shear load of joints

improved than that of joints without insert metal. Zr (or Ni) peaks were detected at narrow area of weld interface of Ti side when low laser power, whereas Ti, Al, Zr (or Ni) were mixed at fusion zone when comparatively high laser power range.

MSEC_ICMP2008-72100

EFFECT OF NICKEL-IRON MIXTURE OF WELD METAL ON HYDROGEN PERMEABILITY AT VARIOUS TEMPERATURES IN STAINLESS STEEL 316L

Takahisa Yamazaki — *Tokyo Institute of Technology*
Toshi-Taka Ikeshoji — *Tokyo Institute of Technology*
Akio Suzumura — *Tokyo Institute of Technology*
Shumpei Kamono — *Tokyo Institute of Technology*

For establishment of the infrastructure handling hydrogen safely, for example, a tank of natural gas, a hydrogen gas cylinder, a hydrogen fuel cell and an ultra high vacuum chamber, hydrogen permeation phenomena into various materials have been investigated. These tanks and chambers are assembled by welding and they are needed to be airtight. Low carbon stainless steel of 316L was selected for the parent material for welding, and it contains 12-15% nickel. It is important to prevent from hydrogen embrittlement cracking in the heat affected zone of welded steels. The hydrogen permeation rate at high temperature of nickel is higher than stainless steels, although at low temperature it becomes lower than those. We investigate the work of nickel element near neat affected zone from the view of the hydrogen catalysis. We had performed hydrogen permeation test of bead on plate specimens using nickel filler. The hydrogen permeation technique using an orifice and a quadrupole mass spectrometer (QMS) is utilized to measure the hydrogen gas flux through the stainless steel. The hydrogen pressure difference which applied to the specimen was able to maintain constant by constant gas flow rate from the orifice in low pressure vessel. A stationary hydrogen flux through the stainless steel was obtained by using the system with the orifice of which diameter is suitable to maintain the constant gas flux. The diameter of orifice was 3mm at high temperature measurement and it was 1.3 mm at low temperature measurement. The value of hydrogen permeability, K, at 670K of the bead on plate specimen using nickel filler is 7.05 times 10-12 m2s-1Pa1/2, and it is 4.10 times 10-12 m2s-1Pa1/2at 620K. It is 2.2 times grater than the measured value of 316 stainless steel substrate as received. The value at 570 K of the bead on plate specimen using nickel filler is 4.03 times 10-13 m2s-1Pa1/2. These plotted data of log K with 103/T (Temperature) could not interpolate linearly. The value of the specimen at 570 K is smaller than interpolated one between the value at 620 K and the value at 520K of the 316 stainless steel substrate as received.

MSEC_ICMP2008-72110

THE INFLUENCE OF THE CHEMICAL COMPOSITION OF WELDING MATERIAL USED IN SEMI-AUTOMATIC WELDING FOR PIPELINE STEEL ON MECHANICAL PROPERTIES

Lu Bai — *University of Science and Technology Beijing*
Tong Lige — *University of Science and Technology Beijing*
Ding Hongsheng — *University of Science and Technology Beijing*
Wang Li — *University of Science and Technology Beijing*
Kang Qilan — *University of Science and Technology Beijing*
Shiwu Bai — *Pipeline Research Institute of China National Petroleum Corporation*

In the welding process, the chemical composition is an important influence factor for the chemical composition of welding joint. The program to predict mechanical properties - yield strength, tensile strength, elongation and average Charpy impact toughness - of welding material is established by Visual C + + 6.0 based on improved BP arithmetic with momentum factor, in which one input layer with 13 nodes, one hidden layer with 23 nodes, one output layer with 4 nodes, and Sigmoid activation function are included. The 20 samples are from the experimental data of semi-automatic welding material of X70. Standard deviation and average absolute error are the criterion to ensure network optimization. The average maximum relative error of the 4 mechanical properties is less than 0.5%. Based on the program, influence of the chemical composition, such as C, S, P, Si, Mn, Cr, Ni and Al on the mechanical properties was analyzed. The results showed that the different element has different influence on the mechanical properties. For non-metallic elements, the mechanical properties are becoming worse with the increase of composition, in which the influence of C is primary, then P and then S. For metallic elements, the influence is greater and more complex than that of non-metallic ones.

MSEC_ICMP2008-72114

BRAZING OF CARBON/CARBON COMPOSITES TO TITANIUM WITH ACTIVE FILLER METAL

Toshi-Taka Ikeshoji — *Tokyo Institute of Technology*
Nariaki Kunika — *Tokyo Institute of Technology*
Akio Suzumura — *Tokyo Institute of Technology*
Takahisa Yamazaki — *Tokyo Institute of Technology*

The carbon/carbon composites (C/C composites) are considered to be one of the candidates for the structural material of huge space structures. In the space, the brazing will be the suitable joining method for C/C composites. The fusion welding, e.g., TIG or MIG/MAG, could destroy the material's composites structure and could not be applied to C/C composites. And the adhesive pastes are difficult to deal in the high vacuum space. In this research, the brazing of carbon/carbon composites to titanium alloys is conducted and the characteristics of its joint are investigated. The provided carbon/carbon composites are 2D woven C/C composites plate and the felt C/C composites plate. A square-plate piece of C/C composites is put between the bars of grade 2 titanium. In their interfaces, sheets of active filler metal of Ag-Cu-Ti are inserted. This assembly is heated up in the vacuum chamber. The brazing temperature is 850º C and the brazing time is 300s. The active brazing filler wets well with both C/C composites and titanium and their interface forms metallurgical firm joint. However, the discrepancy in the thermal expansion rate of C/C composites and titanium prevent to form the mechanically sound joint. The obtained joints have crack inside of C/C composites, which along the boundary between plys. The metallurgical observations of the cross section of the obtained interface reveal the deep infiltration of brazing filler metal into C/C composites. The provided C/C composites are relatively porous and include many cavities inside it. The molten brazing filler is considered to flow into those cavities by the capillary action. On the other hand, at the interface, the brazing filler metal does not remained and only thin layer of Cu-Ti spreads. According to these results, the method to form the sound joint between C/C composites and titanium will be presented.

MSEC_ICMP2008-72127

INFLUENCE OF METAL INERT GAS (MIG) WELDING FACTORS WIRE FEED RATE AND WELD TRAVEL SPEED ON ALUMINUM WELD JOINT STRENGTH

Ramakrishna Koganti — *Ford Motor Company*
Armando Joaquin — *Ford Motor Company*
Chris Karas — *Ford Motor Company*
Matt Zaluzec — *Ford Motor Company*

The purpose of the study was to understand effects of weld travel speed and wire feed rate in metal inert gas (MIG) welding on the aluminum materials joint strength. Initial experiments indicated a noticeable positive effect of travel speed on weld strength with an over 95% statistical significance. Nonetheless further experimentation at a significantly lower wire feed rate proved the opposite with similar statistical significance. A negative effect of welding travel speed on joint strength was measured at lower wire feed rates. In order to understand the weld travel and wire feed rate on the joint strength, a Design of Experiment (DOE) was conducted. For this experiment, weld system process factors were set constant (wave control, gas flow rate, torch angle, trim and wave type) except for travel speed and wire feed rate. A two-factor two-level full factorial design of experiment (DOE) was conducted in order to understand the effects of these two factors on weld strength. Additional welding at higher wire feed rates were conducted in order to confirmed the trend found. Results showed travel speed effects on joint strength as a result of its direct interaction with wire feed rate. This occurrence can have significant economic implications if proven to be repeatable and will be the subject of this and future MIG welding studies as they relate to aluminum structures.

MSEC_ICMP2008-72197

FATIGUE PROPERTIES OF FRICTION STIR WELDED 2024-T3 ALUMINUM ALLOY

Masako Suzuki — *Graduate School of Fundamental Science and Engineering, Waseda University*
Motoo Asakawa — *Department of Applied Mechanics and Aerospace Engineering, Waseda University*
Takao Okada — *Aviation Program Group, Japan Aerospace Exploration Agency*
Haruka Miyake — *Graduate School of Fundamental Science and Engineering, Waseda University*
Toshiya Nakamura — *Aviation Program Group, Japan Aerospace Exploration Agency*
Shigeru Machida — *Aviation Program Group, Japan Aerospace Exploration Agency*

For application of FSW (Friction Stir Welding) to aircraft structure, the structure made by that technology must comply with the damage tolerance requirement. In response, the location of fracture origin and the crack growth rate in the FSW structure need to be evaluated. This research focuses on the fracture origin of the joint. Most of the researches use comparatively thick specimens of 4-6mm, while the thinner skin is widely used for the aircraft structure. Therefore, in the present study, FSW butt joint of 2024-T3 Aluminum alloy sheets of 2.0mm thickness are used and the characteristic of hardness, fatigue properties and the location of fracture are investigated. Hardness profile on the section perpendicular to the weld line is obtained to evaluate the susceptible location for the fracture. In this research, no local decreasing of hardness on the weld section was observed which means that the location of fatigue fracture is hardly correlated with the hardness distribution. In the fatigue test, direction of FSW is perpendicular to the loading direction and its weld line locates at the center of the specimen. To eliminate the effect of tool mark and burr on crack nucleation, both surfaces of the specimen are first ground and finally polished. The same preparation is applied to both sides of the specimen to prevent crack nucleation from its sides. The specimens are subjected to cyclic loading with constant stress amplitude. From fatigue tests, it is found that the crack nucleates at the kissing bond, of which thickness is less than about 0.15mm, located at the bottom of the weld line. The remaining kissing bond can become the origin of multiple small fatigue cracks that coalesce into a large fatigue crack. This feature of the fracture surface of the kissing bond is quite different from that far from the bottom surface and is either different from that observed in usual fatigue tests. On the other hand, in case the kissing bond is polished out, the location of crack nucleation appears 5mm or 8mm away from the weld line. Two types of fracture surface are observed: fracture originating from the surface precipitate and fracture from the inside of the material. The?latter type of the fracture only occurred at 5mm away from the weld line where the tool shoulder edge passes through.

MSEC_ICMP2008-72207

E-DESIGN TOOL FOR FRICTION STIR WELDING

Harish Bagaitkar — *Missouri University of Science & Technology*
Venkat Allada — *Missouri University of Science & Technology*

This paper describes efforts to develop a web-based E-Design tool for the Friction Stir Welding (FSW) technique. The input parameters to the E-Design tool are the joint specifications. The output parameters of the E-Design tool are process parameters such as tool geometry details, tool rpm, plunge depth, etc. The heart of the E-Design tool is the FSW database. The FSW database contains mappings of various input parameters and output parameters that have been captured by referring to various experimental studies cited in the literature. The proposed E-Design tool deals with lap joints and butt joints between similar aluminum alloys.

MSEC_ICMP2008-72224

MONITORING OF THE SPATTER FORMATION IN LASER WELDING OF GALVANIZED STEELS IN LAP JOINT CONFIGURATION BY THE MEASUREMENT OF THE ACOUSTIC EMISSION

Shanglu Yang — *South*ern Methodist University
Wei Huang — *Research Center for Advanced Manufacturing*
Dechao Lin — *Southter Methodist University*
Fanrong Kong — *Research Center for Advanced Manufacturing*
Radovan Kovacevic — *3101 Dyer Street*

Galvanized steels have been widely used in the different industries such as automotive, aerospace and marine industry, due to their high corrosion resistance and excellent mechanical properties. However, the zinc coating on the metal sheet offers a big challenge to the welding operation, specifically in the high-power laser welding process of the lap joint if the metal sheets are installed in a gap-free configuration. Spatters, one of the critical problems for the weld quality, is readily generated by the high-pressurized zinc vapor developed at the interface of two metal sheets. It takes extra procedures to clean the weld surface or repair the blowholes generated by the spatters. Therefore, it is important to on-line monitor the welding process in order to characterize the spatters and eventually help to understand their formation. In the past

few years, acoustic emission (AE) technique has been applied to monitor different manufacturing processes. This paper will highlight its application in the laser welding of galvanized steels. An AE signal acquisition system is developed for real-time monitoring of the welding process. The results of the investigation show that the amplitude of AE signals varies with the welding process status. When the welding process is stable, the amplitudes of AE signals are almost constant and with the low intensity compared to the AE emission signals when the weld defects are presented. When the spatter is formed, a sharp spike with the high amplitude is shown in the collected acoustic emission signal. In order to extract the features of the weld defects induced AE signals in frequency domain, the acquired signal in time domain is further processed using Short-time Fourier Transformation (STFT). The STFT processed results indicated that the spatter-induced AE signals cover a wide range of frequencies and the background noise is mainly presented in the range below 100 Hz.

MSEC_ICMP2008-72375

DISSIMILAR MATERIALS MICRO WELDING BETWEEN A STAINLESS STEEL AND PLASTICS BY USING PULSE YAG LASER

Yukio Miyashita — *Nagaoka Uni*versity of Technology
Masaru Takahashi — *Nagaoka National College of Technology*
Masashi Takemi — *Nagaoka National College of Technology*
Kousei Oyama — *Nagaoka University of Technology*
Yoshiharu Mutoh — *Nagaoka University of Technology*
Hironori Tanaka — *NHK spring*

Recently, there is hard competition to decrease size of a component. Mechanical joining or brazing is usually used for dissimilar materials joint. However in the case, additional parts and materials will be needed only for the joint purpose. It can not be realized to minimize the size of a component by only minimizing of parts but also important to minimize the size of joint part. In the present work, direct joint of dissimilar materials between SUS304 stainless steel and a plastic was studied by using pulse YAG laser. Plastics used were PC and PET. Weldability and sear-tensile strength were investigated for the joints. Welding configuration was lap joint and thicknesses of the materials were 0.1mm and 1 mm for SUS304 and the plastics. It was possible to make a joint for both combination of materials, SUS304/PC and SUS304/PET. Weldable condition range was wide in case of SUS304/PET joint compared to SUS304/PC joint. The difference in the weldability may be due to difference in glass transition temperature of the plastics. Pores were observed at the interface of the joint for both combinations of the materials when the joint welded with welding conditions of higher heat input. Size and number of pores increase with increase in heat input. Sear-tensile test was carried out for the joints. Failure load and welding area were measured. Size of welding area increased with increase in heat input. However, strength calculated by failure load and welding area is almost constant for the joints welded with welding conditions of lower heat input and which has no pores at the interface. Higher strength was observed for the joint which includes pores at the interface. However, strength decreased with increasing of heat input. Higher pressure occurs by occurrence of pores at the interface and it makes joining well. On the other hand, if large size and number of pores are existing at the interface, pores play as a defect and causes degradation of the strength.

MSEC_ICMP2008-72502

SPOT FRICTION WELD STRENGTH IMPROVEMENT THROUGH IN-PROCESS METAL MATRIX FORMATION

Senthil Arul — *Ford Motor Company*
Grant Kruger — *University of Michigan*
Scott Miller — *The University of Hawaii*
Tsung-Yu Pan — *Ford Motor Company*
Albert Shih — *The University of Michigan*

The effects of metal matrix composite (MMC) on the joint strength of Spot Friction Welded (SFW) specimens made of Al 1100 and Al 6111 alloys are studied. The MMC-SFW joints were created by sandwiching metal reinforcing powder (<75μm mesh) between the upper (1.3mm thick) and lower (1.5mm thick) Al coupons, at the center of the SFW joint. To maximize the heat input into the specimen, a Zirconium (ZrO2) ceramic anvil was used. Depth of penetration of the tool played an important role in determining the distribution of the reinforcing material within the MMC during plastic mixing in the SFW joint, and hence its influence on the joint strength. At a lower depth of penetration, 2.1 mm, the results showed that the MMC-SFW reinforced with Ancorsteel 1000, copper or Al12Si powders did not increase the joint strength since they did not spread uniformly in the stir zone. However, at a higher depth of penetration, 2.5 mm, the MMC-SFW joint reinforced with Ancorsteel 1000, copper, or Al12Si did increase the joint strength compared to that of the base SFW specimens. Using steel powder as the reinforcement material, the MMC showed the maximum increase in the lap shear joint strength. For example, at 2.5 mm depth of penetration, the SFW joint strength increased by 19% and 24% compared to that of the base SFW specimen made of Al 1100 and Al 6111 alloys respectively.

Symp 2-5 COATING AND THERMAL SPRAYING

MSEC_ICMP2008-72015

INFLUENCE OF THE EXPANSION RATIO OF THE GUN NOZZLE AND GAS PRESSURE ON PROPERTIES OF COLD SPRAYED COPPER COATINGS

Kazuhiko Sakaki — *Shinshu University*
Kazuya Takeda — *Graduate School?Shinshu University*
Koichi Takada — *Graduate School?Shinshu University*
Takashi Hosono — *Shinshu University*
Yasuo Shimizu — *Shinshu University*

Cold spray is a new coating process and its process uses the kinetic energy of unmelted sprayed particles to produce coating. One of the most important elements of cold spray system is the nozzle used to accelerate the particles. So the optimization of the nozzle and mechanisms of coating process aren't adequately revealed. In this study, simple numerical simulation and experiments investigated the influence of the expansion ratio of the nozzle and gas pressure on properties of cold sprayed copper coatings. And we got the result that there is a suitable expansion ratio of nozzle appropriate for nozzle intake gas pressure. The optimal expansion ratio increases with increasing nozzle intake gas pressure. The good correlation of particle velocity with the coating deposition efficiency, microstructure and microhardness confirmed the optimal nozzle design method.

MSEC_ICMP2008-72044

DEPOSITION OF COPPER FINE PARTICLE ONTO METALLIC SUBSTRATE IN COLD SPRAY PROCESS

Masahiro Fukumoto — *Toyohashi University of Technology*
H. Terada — *Toyohashi Univ. of Technology*
M. Mashiko — *Toyohashi Univ. of Technology*
Kazunori Sato — *Toyohashi University of Technology*
Motohiro Yamada — *Toyohashi University of Technology*
E. Yamaguchi — *Shintobrator, Ltd.*

In-flight behavior of an particle by cold spray process was analyzed by computer simulation and optimization in nozzle design was performed based on the simulation result. High pressure and high temperature cold spray equipment with optimized radial injection type nozzle was installed in the laboratory. Maximum velocity of the particle sprayed by the equipment with air showed more than 650 m/s. High density thick coating was made and the electric resistance of the coating was almost equivalent to the bulk material. To inhibit the velocity decrease of the particle due to bow shock on the substrate surface, specialization of nozzle design was performed. The deposition efficiency was effectively improved by the special nozzle even in the case of air instead of He as the working gas. Deposition mechanism was fundamentally observed by investigating the deposition behavior of an individual particle onto the substrate surface.

MSEC_ICMP2008-72145

IMPROVING THE SURFACE ROUGHNESS OF A CVD COATED SILICON CARBIDE DISK BY PERFORMING DUCTILE REGIME SINGLE POINT DIAMOND TURNING

Deepak Ravindra — *Western Michigan University*
John Patten — *Western Michigan University*

Silicon carbide (SiC) is one of the advanced engineered ceramics materials designed to operate in extreme environments. One of the main reasons for the choice of this material is due to its excellent electrical, mechanical and optical properties that benefit the semiconductor, MEMS and optoelectronic industry respectively. Manufacture of this material is extremely challenging due to its high hardness, brittle characteristics and poor machinability. Severe fracture can result when trying to machine SiC due to its low fracture toughness. However, from past experience it has been proven that ductile regime machining of silicon carbide is possible. The main goal of the subject research is to improve the surface quality of a chemically vapor deposited (CVD) polycrystalline SiC material to be used in an optics device such as a mirror. Besides improving the surface roughness of the material, the research also emphasized increasing the material removal rate (MRR) and minimizing the diamond tool wear. The surface quality was improved using a Single Point Diamond Turning (SPDT) machining operation from 1158nm to 88nm (Ra) and from 8.49Âμm to 0.53Âμm (Rz; peak-to-valley).

MSEC_ICMP2008-72179

STRESS HISTORIES OF YTTRIA-STABILIZED ZIRCONIA AND CONICRALY COATINGS DURING THERMAL SPRAYING

Hiroyuki Waki — *Osaka Electro-Communication University, Dept. Mechanical Engineering*
Akira Kobayashi — *Osaka University, Joining and Welding Research Institute*

Thermal barrier coating (TBC) systems which are used for insulating the substrates of gas turbine blades from high temperatures can be made by thermal spraying. The TBC system has residual stresses because of high temperature deposition and the thermal expansion mismatch in the system. In this study, how the residual stress occurs in TBC system was examined by both experimental measurement and FEM analysis. The Yttria-stabilized zirconia (YSZ) top coating was deposited by atmospheric plasma spraying (APS). CoNiCrAlY bond coatings were deposited by high velocity oxygen-fuel (HVOF) spraying and APS. The temperatures of YSZ, CoNiCrAlYs and substrates were measured during thermal spraying. The temperature of YSZ was highest and that of CoNiCrAlY(HVOF) was lowest among the three types of spray processes. The residual stresses were elastically calculated by FEM based on the measured temperature histories. The residual stress of YSZ and CoNiCrAlYs on two types of substrates were also measured by X-ray diffraction method. It was confirmed from FEM analysis that residual stress consisted of primary quench stress and secondary thermal mismatch stress. The quench stress was caused by the quenching of coating particles during deposition which occurs due to the huge thermal capacity of the substrate. The thermal mismatch stress was caused by the difference in linear expansion coefficients between coating and substrate. It was found that not only these two mechanisms but also microcrack formation caused by quench played an important role in the residual stress. The temperatures at which residual stresses might begin to occur in the coatings were shown based on the stress relaxation by microcrack formation. It was also found that peening effect played an important role in the residual stress of HVOF sprayed coating.

MSEC_ICMP2008-72234

SURFACE INTEGRITY OF END MILLED TI-6AL-4V USING THE TIALN COATED TOOL

Jie Sun — *Shandong University*
Y.B. Guo — *The Univ. of Alabama*

End milling titanium Ti-6Al-4V has wide applications in aerospace, biomedical, and chemical industries. However, milling induced surface integrity has received little attention. In this study, a series of end milling experiment were conducted to comprehensively characterize surface integrity at various milling conditions. The experimental results have shown that the milled surface shows the anisotropic nature with a surface roughness range in 0.6 μm – 1.2 μm. Surface roughness increases with feed and radial depth-of-cut (DoC), but varies with the cutting speed range. Compressive residual normal stress occurs in both cutting and feed directions, while the influences of cutting speed and feed on residual stress trend are quit different. The microstructure analysis shows that ? phase becomes much smaller and severely deformed in the very near surface with the cutting speed. The milled surfaces are at least 60% harder than the bulk material in the subsurface.

MSEC_ICMP2008-72312

FABRICATION OF TITANIUM DIOXIDE PHOTOCATALYST COATINGS BY COLD SPRAY

Motohiro Yamada — *Toyohashi University of Technology*
Kazunori Sato — *Toyohashi University of Technology*
Yuko Kandori — *Toyohashi University of Technology*
Masahiro Fukumoto — *Toyohashi University of Technology*

Titanium dioxide (TiO2) is a promising material for photocatalyst coating. However, it was difficult to fabricate TiO2 coatings which have excellent photocatalyst property by thermal spray processes. Because anatase phase of TiO2 transforms into rutile phase under high temperature i.e. the photocatalyst property of TiO2 declines by heating. In this study, TiO2 photocatalyst coatings were fabricated by cold spraying. Agglomerated TiO2 powder with 100% anatase phase was injected into nitrogen or helium gas stream and deposit onto steel substrate. It was possible to fabricate TiO2 coatings with anatase phase and dense microstructure. The deposition efficiency was increased with gas temperature. The photocatalytic property of the coatings was evaluated by NOx elimination test. From the results, it became clear that cold sprayed TiO2 coatings had excellent photocatalyst property.

MSEC_ICMP2008-72316

FABRICATION OF YTTRIA-STABILIZED ZIRCONIA THIN FILM UNDER ROOM TEMPERATURE AND ATOMOSPHERIC PRESSURE CONDITION

T. Sone — *Tohoku university*
K. Sato — *Tohoku university*
K. Yashiro — *Tohoku university*
Kazuhiro Ogawa — *Tohoku University*
T. Kawada — *Tohoku university*
T. Kuriyagawa — *Tohoku university*
T. Hashida — *Tohoku university*
J. Mizusaki — *Tohoku university*

Powder jet deposition (PJD) method is one of physical vapor film forming techniques such as thermal spray, cold spray method, PLD, aerosol deposition method and so on. Ceramics films can be fabricated by the PJD method. However, the detail of film forming principle of the PJD method hasn't been revealed yet. Based on this current situation, yttria-stabilized zirconia (YSZ) thin films were deposited on various substrates by the PJD method. YSZ thin films were fabricated in systemically changed substrates, particle sizes and carrier gas pressures. The microstructures of YSZ films were observed by scanning electron microscope (SEM). From this study results, the amount of deposition rate by the PJD method and films structure varies according to substrate hardness and powder size. Additionally, the electrical conductivity of YSZ film on Al2O3 substrate by the PJD method was measured as a function of temperature by using a.c. impedance method. From this measurement, the amount of this film's electrical conductivity is good agreement from other studies of YSZ bulks electrical conductivity. This result shows probability of application to high temperature ceramics devices such as Solid Oxide Fuel Cells (SOFCs), gas sensors.

MSEC_ICMP2008-72441

EFFECT OF BIAS VOLTAGE ON FATIGUE BEHAVIOR OF CRN FILM DEPOSITED ON TI-6AL-4V ALLOY

Md. Shamimur Rahman — *Graduate School of The University of Tokushima*
Takeshi Katsuma — *The University of Tokushima*
Daisuke Yonekura — *The University of Tokushima*
Ri-Ichi Murakami — *The University of Tokushima*

ABSTRACT PVD technique incorporating CrN coating was applied to the titanium alloy (Ti-6Al-4V) and its effects on the fatigue life and fatigue strength were studied in this paper to explore the fatigue behavior of Ti-6Al-4V specimens. A CrN film deposited by arc ion plating (AIP) improved the mechanical properties; specially hardness and fatigue life of Ti-6Al-4V specimens. The properties were studied using XRD, hardness and fatigue testers. The fatigue life of CrN-coated Ti-6Al-4V specimens was improved significantly compared to those of un-coated specimens. The enhanced fatigue life can be attributed to the improved hardness of CrN film due to change of bias voltage during the film deposition. The initiation of fatigue cracks is likely to be retarded by the presence of hard and strong layers on the substrate surface. It has been determined that the fatigue fracture of the substrate-coating composite is dominated by the fracture of the CrN film since fatigue cracks have been observed to form first at the surface of the film and subsequently to propagate towards the substrate. It has also been concluded that the increase in fatigue properties of the coated substrate is associated mainly with the changing of bias voltage during the coating observed in most of the maximum alternating stress range explored in this work. Keywords: PVD, CrN Film, Titanium alloys, Surface treatments, Fatigue.

MSEC_ICMP2008-72528

DEVELOPMENT OF THERMAL BARRIER COATING SYSTEM WITH WITH AN INTERMEDIATE LAYER CONTAINING MOSI2 WITH SUPERIOR THERMAL CYCLIC PROPERTIES

Keiji Sonoya — *Shibaura Institute of Technology*
Shogo Tobe — *Ashikaga Institute of Technology*

The authors have developed a successful method for improving the thermal cyclic resistance of the thermal barrier coating system that is deposited on gas turbine components. Conventional thermal barrier coating consists of duplex systems, top coating and bond coating. The developed system introduces a protective intermediate layer of MoSi2 for preventing oxidation of the bond coating. Conventional duplex plasma sprayed coating was delaminated after 20 thermal cycles. On the other hand the developed triple layered coating system was not delaminated up to 60 cycles. The reason for the enhanced resistance to thermal cycle of the developed triple layered coating system is that the MoSi2 layer existing between the top coating and the bond coating has the self-repairing property. Here, MoSi2 oxidizes to form SiO2 which seals the cracks and pores formed between the top coating and the bond coating. Thus, the formation of TGO which leads to coating delamination is prevented and the thermal cyclic resistance is improved.

MSEC_ICMP2008-72536

DIFFERENCE IN HIGH-TEMPERATURE OXIDATION BEHAVIOR BETWEEN COLD-SPRAYED AND LOW-PRESSURE PLASMA-SPRAYED MCRALY COATING

Yuji Ichikawa — *Tohoku University*
Kazuhiro Ogawa — *Tohoku University*
Tetsuo SHOJI — *Tohoku University*

Thermal-sprayed MCrAlY coatings are widely used for land-based gas turbine applications against high-temperature oxidation and hot corrosion. Cold spray is a new technique that provides dense and low oxide content metallic coating instead of conventional thermal spray technique. Recently, the MCrAlY coating deposited by the cold spray process has been demonstrated. In order to evaluate the high temperature oxidation behavior of cold-sprayed MCrAlY coatings, high temperature exposure tests of cold-sprayed and low-pressure plasma sprayed MCrAlY coatings were performed. The cold-sprayed MCrAlY coatings are much denser than low-pressure plasma-sprayed MCrAlY coatings. From the results of exposure tests in 1100 ÂºC atmospheric environment, it can be seen that cold-sprayed MCrAlY coatings have a lower oxidation ratio than that of low-pressure plasma-sprayed coatings in this environment, as cold-sprayed coatings are denser than the low-pressure plasma sprayed coatings. Therefore, the cold spray technique improves the high-temperature oxidation behavior of the MCrAlY coatings

MSEC_ICMP2008-72550

TRIBOLOGICAL PROPERTIES OF AMORPHOUS BORON NITRIDE FILMS PREPARED BY NANOPULSE PLASMA CVD

Masanori SAITO — *Tokyo Institute of Technology*
Toshiyuki YASUHARA
Hiroya MURAKAMI — *Tokyo Institute of Technology*
Naoto OHTAKE — *Nagoya University*

Boron nitride (BN) films were deposited by nanopulse plasma chemical vapour deposition (CVD) method using borane-ammonia complex as a source gas. Fourier transform infrared (FTIR) spectroscopy and atomic force microscopy indicate that the BN film is smooth amorphous structure. Deposited BN films mainly have very smooth surface that the surface roughness (Ra) were under 0.5 nm. The film deposited at room temperature have high adhesion strength evaluated by scratch tests. Ball on disk tests were carried out to evaluate the tribological properties of deposited films. And some BN film films exhibit high friction coefficient over 1.0 and low specific wear rate (order of 10-7 mm3/Nm) close on that of DLC. Annealing test were performed to evaluate thermal stability. The deposited BN films have high thermal stability at 500 degrees in air compared to DLC film.

Symp 2-6 ENVIRONMENTALLY SUSTAINABLE MANUFACTURING SYSTEMS

MSEC_ICMP2008-72029

AN INTEGRATED DECISION ANALYSIS FOR THE SUSTAINABLE PRODUCT DESIGN

Jun-Ki Choi — *The Ohio State University*
Karthik Ramani — *Purdue University*

Engineering designers consider many aspects surrounding a product's life in order to meet safety, reliability, quality, manufacturing, and cost requirements. Most of the time this is done in an excellent way and the resulting products offers broad functionality with high quality and reasonable price. However serious considerations of integration of environmental requirements are often missed in the product development process. All products contribute to a range of environmental problems. These problems arise through the entire life cycle of products from the creation to the disposal of products. Design for environment (DfE) is the systematic consideration of design performance with respect to environmental, health, and safety objectives over the full product and process life-cycle. It takes place early in a product's design or upgrade phase to ensure that the environmental consequences of a product's life cycle are considered. The key issue to success is how to select the most appropriate and effective strategy for a particular product to reduce environmental impacts without disregarding the business strategies in the decision making process. In this paper, a general framework is proposed to integrate the life cycle assessment and decision analysis for prioritizing the design for environment strategy by considering uncertainty issues exist in the decision making process. A case study is illustrated focusing in the product upgrade phase. The ultimate goal is to provide a design advisory tool for product designers in the hopes of facilitating their complex decision making processes by considering the environmental issues in mind.

MSEC_ICMP2008-72129

INTRODUCING SUSTAINABILITY EARLY INTO MANUFACTURING PROCESS PLANNING

Mahesh Mani — *National Institute of Standards and Technology*
Kevin W. Lyons — *National Institute of Standards and Technology*
Sudarsan Rachuri — *National Institute of Standards and Technology*
Eswaran Subrahmanian — *National Institute of Standards and Technology*
Ram D. Sriram — *National Institute of Standards and Technology*
Gaurav Ameta — *National Institute of Standards and Technology*
Shaw C. Feng — *National Institute of Standards and Technology*

In response to the global trend towards implementing sustainable manufacturing practices, we put forth an exploratory approach that uses energy monitoring as a means to introduce sustainability criteria early into manufacturing process planning. Typically cost, quality and time are the indices for manufacturability assessment in generating manufacturing process plans. In this paper, we propose the idea of introducing sustainability to complement cost, quality and time to arrive at alternative sustainable plans in identified manufacturing processes. To be sustainable, it is pertinent that manufacturing firms understand the energy consumption of different manufacturing equipment used to produce products. This will enable industry to implement energy reduction processes in a more effective manner and pave the way for improved and alternate manufacturing solutions. The paper presents the potential utility of energy usage readings in the interest of continuing dialogue and collaboration.

MSEC_ICMP2008-72223

METRICS FOR SUSTAINABLE MANUFACTURING

Corinne Reich-Weiser — *University of California at Berkeley*
Athulan Vijayaraghavan — *University of California*
David Dornfeld — *University of California*

In this paper a methodology is developed for determining appropriate metrics relevant to the sustainability of manufacturing processes and facilities. The three basic questions to be answered before choosing a metric are (1) what is the concern to be addressed (2) what is the geographic scope of this concern (3) what is the scope of the study. Four general types of metrics are introduced, which can be tailored to a specific objective and scope: environmental impact per functional unit, environmental return on investment, years remaining of a non-renewable resource, fractional consumption of a renewable resource. Utilizing this methodology, metrics focused on energy use, global climate change, non-renewable resource consumption, and water consumption are developed.

MSEC_ICMP2008-72456

SURFACE FINISH IN HARD MACHINING BY PVD-COATED END-MILLS USING SOLID LUBRICANT

Geeta Lathkar — *MGM's College of Engineering,Nanded*
Shantisagar Biradar — *MGM's JNEC*
S. K. Basu — *Emeritus, College of Engineering*

Abstract The paper deals with machining of High C- High Cr die steel with Ti N, TiAlN Coated end mill cutter, using solid lubricant and obtaining a generalised relationship of surface roughness dependent on input parameters, based on response surface methodology. The hardness ratio of the tool and the workpiece, as one of the important parameters, having significant influence under near-dry machining condition, was studied under minimum quantity of oil using solid-lubricant (MOS2) mixed with base oil SAE-20 in different proportion. Key words: Solid Lubricant, Coated End-mill, Minimum Quantity of Lubricant (MQOL).

Symp 2-7 MODEL-BASED MANUFACTURING CONTROL

MSEC_ICMP2008-72212

DYNAMIC OPTIMIZATION OF THE GRINDING PROCESS IN BATCH PRODUCTION

Cheol W. Lee — *University of Michigan - Dearborn*

This paper presents a novel dynamic optimization framework for the grinding process in batch production. The grinding process exhibits time-varying characteristics due to the progressive wear of the grinding wheel. Nevertheless, many existing frameworks for the grinding process can optimize only one cycle at a time, thereby generating suboptimal solutions. Moreover, a dynamic scheduling of dressing operations in response to process feedback would require significant human intervention with existing methods. We propose a unique dynamic programming – evolution strategy (DP–ES) framework to

optimize a series of grinding cycles depending on the wheel condition and batch size. In the proposed framework, a dynamic programming module dynamically determines the frequency and parameter of wheel dressing while the evolution strategy (ES) locates the optimal operating parameters of each cycle subject to the constraints on the operating ranges and part quality. Case studies based on experimental data are conducted to demonstrate the advantages of the proposed method over conventional approaches.

MSEC_ICMP2008-72218

QUALITY MONITORING AND FAULT DETECTION ON STAMPED PARTS USING DCA AND LDA IMAGE RECOGNITION TECHNIQUES

Qiangsheng Zhao — *Michigan Technological University*
Jaime Camelio — *Virginia Tech*

New vision technologies provide an opportunity for fast detection and diagnosis of quality problems compared with traditional dimensional measurement techniques. This paper proposes a new use of image processing to detect quality faults using images traditionally obtained to guide manufacturing processes. The proposed method utilizes face recognition tools to eliminate the need of specific feature detection on determining out-of-specification parts. The algorithm is trained with previously classified images. New images are then classified into two groups, healthy and unhealthy. This paper proposes a method that combines Discrete Cosine Transform (DCT) with either Principal Component Analysis (PCA) or Linear Discriminant Analysis (LDA) to detect faults, such as cracks, directly from sheet metal parts.

MSEC_ICMP2008-72219

DIMENSIONAL ERROR COMPENSATION IN COMPLIANT ASSEMBLY PROCESSES USING VIRTUAL ASSEMBLY TRAINING

Kang Xie — *Michigan Technological University*
Jaime Camelio — *Virginia Tech*
L. Eduardo Izquierdo — *University of Warwick*

Dimensional variation propagation and accumulation in multistage manufacturing processes are among the most important issues that affect quality. Although robust design and statistical process quality control help to reduce the effects of these problems, neither of these two methods can be used for instant variation reduction during assembly operations. This paper introduces a complete methodology for error compensation in compliant sheet metal assembly processes. The proposed methodology can be divided in two steps: (1) an off-line error control-learning module using virtual assembly models, and (2), an in-line control implementation using a feedforward control strategy. The off-line learning method focuses on determining the optimal control actions or corrections to a set of predefined deviations. Specifically, it utilizes a newly developed iterative sampling method based on Kriging fitting to efficiently determine an optimal control action. The in-line feedforward control uses measurements of incoming assembly components to select an appropriate pre-learned control action. Two case studies are presented; first, a mathematical case study is used as the empirical proof for the feasibility of the iterative sampling and fitting algorithm. Second, a simulation-based case study is used to illustrate the effectiveness of the proposed methodology to improve dimensional quality in assembly operations of compliant sheet metal parts.

MSEC_ICMP2008-72222

A NEW POSITION FEEDBACK METHOD FOR MANUFACTURING EQUIPMENT

Chan Wong — *Clemson University*
Carlos Montes — *Clemson University*
Laine Mears — *Clemson University*
John Ziegert — *Clemson University*

This paper presents an innovative real time position measuring method of an XY stage by using vision input from an actively-controlled pixel matrix. The test stage of this research consists of a digital and a Liquid Crystal Display (LCD) screen that serves as feedback input to the controller. The objective of this research is to measure the absolute position of the XY stage to sub-micron accuracy using visual feedback of the dynamically controlled image. In order to achieve sub-micron resolution using a pixel array as a target, a method to actively control pixel elements, arrayed in directions of interest and through depth of grayscale intensity to provide an "Intensity Centroid" for target positioning is developed. In addition, a trajectory predicting algorithm will be developed in order to interpolate between the absolute residual errors measured by the vision system to provide feedback data to the controller at intermediate time steps between vision update cycles at the lower camera refresh rate (~60 Hz) compared to the motion controller (>10 kHz).

MSEC_ICMP2008-72310

GRAPHICAL MPC FOR FAST DYNAMIC SYSTEMS

Ricardo Dunia — *National Instruments*
Javier Gutierrez — *National Instruments*

Software configuration and engineering costs have limited the application of model predictive control (MPC) for small but fast dynamic systems. This work illustrates the benefits

of using a graphical programming framework for the configuration and implementation of MPC controllers. Graphical programming facilitates the understanding and configuration of advanced applications so that engineers in industry can be responsible for the installation and maintenance of advanced controllers. Costs reduction and minimal specialized labor opens the possibilities of applying MPC to small systems with fast dynamics. Fast MPC execution is achieved by including the optimization constraints as penalty terms in the cost function. An air-heater pilot system is successfully used to demonstrate the advantages of a graphical framework for process modeling, design, and real-time implementation of MPC controllers in systems with fast dynamics

MSEC_ICMP2008-72468

ASSESSMENT OF THE PROCESS PARAMETERS AND THEIR EFFECT ON THE CHIP LENGTH WHEN USING CNC TOOLPATHS TO PROVIDE CHIP BREAKING IN TURNING OPERATIONS

Bethany Woody — *UNC Charlotte*
K. Scott Smith — *University of North Carolina at Charlotte*
David J. Adams — *University of North Carolina at Charlotte*
William E. Barkman — *Y-12 National Security Complex*

Past work at UNC Charlotte has demonstrated that the use of oscillating CNC toolpaths provides a reliable chip breaking alternative to conventional methods such as the use of cutting inserts with special geometries and/or adjusting machining parameters. The specific toolpath geometry and the selection of the oscillating parameters is an important step to reliably and constantly create broken chips using this new method. This paper builds on the past work and discusses the proper selection of oscillation amplitude and its effect on the ability to break chips and to achieve desired chip lengths.

MSEC_ICMP2008-72542

ERP SYSTEMS SUPPORTING LEAN MANUFACTURING: A LITERATURE REVIEW

Pritish Halgeri — *Kansas State University*
Zj Pei — *Kansas State University*
Karthik Iyer — *KSU*
Kendal Bishop — *KSU*
Ahmad Shehadeh — *KSU*

Lean manufacturing and ERP are two popular business improvement methodologies. This paper first presents the misconceptions about the co-existence of ERP and Lean and also discusses the differences in the two concepts. The paper also discusses about the Lean toolset that are offered by the vendors in current ERP systems. A sample list of ERP vendors offering Lean enabled software system is presented out of which three vendors are selected for this paper and are briefly described. The ERP vendors selected are Oracle, TTW and Pelion systems. The paper is intended to answer the much debated argument "Can ERP and Lean co-exist" and that the synergistic combination of ERP and Lean manufacturing can help companies achieve new level of operational excellence.

MSEC_ICMP2008-72548

ANALYTICAL MODELING OF METAL TRANSFER FOR GMAW IN THE GLOBULAR MODE

Ugur Ersoy — *University of Michigan*
S. Jack Hu — *University of Michigan*
Elijah Kannatey-Asibu Jr.

A lumped parameter dynamical model is developed to describe the metal transfer for gas metal arc welding (GMAW) in the globular mode. The oscillations of molten drop are modeled using a mass-spring-damper system with variable mass and spring coefficient. An analytical solution is developed for the variable coefficient system to better understand the effect of various model parameters on the drop oscillations. The effect of welding drop motion on the observed current and voltage signals is investigated and the model agrees well with the experimental results. Furthermore, the effect of wire feeding rate (or welding current) on the metal transfer cycle time is studied and the model successfully estimates the cycle times for different wire feeding rates.

Symp 2-8 SEMICONDUCTOR MATERIALS MANUFACTURING

MSEC_ICMP2008-72059

ULTRA-PRECISION MACHINING TECHNOLOGY OF THE SOFT AND BRITTLE FUNCTIONAL CRYSTAL

Chunpeng Lu — *Dalian University of Technology*
Hang Gao — *Dalian University of Technology*
Renke Kang — *Dalian University of Technology*
Xiaoji Teng — *Dalian University of Technology*
Qiangguo Wang — *Dalian University of Technology*

As an important branch of materials, soft and brittle functional crystals (SBFC) are widely used in the field of modern technology. However, the softness, brittleness, deliquescence, and strongly anisotropic natures of these materials present a challenge for their ultra-precision machining. The definition of SBFC is firstly given and their applications in many fields are also presented. For the ultra-precision machining technologies to satisfy the applied requirements, many methods such as single diamond turning, ultra-precision grinding, magnetorheological Finishing and so on, are successfully applied in SBFC materials, the challenges and difficulties occurred during machining these SBFC materials, such as KH2PO4, CdZnTe and CaF2, etc., are reviewed and the limits are also analyzed in detail. Moreover, many novel machining methods are suggested to achieve better surface quality and enhance machining efficiency.

MSEC_ICMP2008-72171

DRY POLISHING OF NON-CUBIC CRYSTAL WAFERS.

Scott Sullivan — *DISCO*

We have just begun investigated polishing non-cubic crystal wafers using a unique dry polishing process. The wafers tested were GaN and SiC. Wafers of both GaN and SiC have surfaces terminated by different materials. Each of these surfaces will react differently when polished. For GaN the Ga (000-1) surface has a higher degree of chemical inertness than the nitrogen terminated surface (0001). To compensate for this difference in chemical inertness complex slurries and long polish times are used in chemo-mechanical polishing (CMP). Dry polishing equaled the surface finish and removal of subsurface damage of CMP in significantly reduced polishing times.

MSEC_ICMP2008-72253

COMPARISON OF FREE ABRASIVE MACHINING PROCESSES IN WAFER MANUFACTURING

Chunhui Chung — *Stony Brook University*
Imin Kao — *Stony Brook University*

Free abrasive machining (FAM) processes, such as slicing using slurry wiresaws, lapping, and polishing, are very important manufacturing processes in wafer production for micro-electronics fabrication. Since the materials in semiconductor industry are usually brittle, such as silicon, gallium arsenide, ... etc., the FAM processed can provide more gentle machining than the bonded abrasive machining process. Various machining theories and models have been developed to understand those processes. In this paper, the free abrasive machining processes in wafer manufacturing will be discussed in conjunction with the brittle material cracking theory. The modern slurry wiresaw slicing process and lapping process in wafer production will be presented with comparison to abrasive grits, manufacturing process models, characterization of manufacturing mechanisms, and properties of processes.

MSEC_ICMP2008-72445

A MULTI-SCALE MODEL FOR WAFER SURFACE EVOLUTION IN CHEMICAL MECHANICAL PLANARIZATION

Pavan Karra — *Iowa STate University*
Abhijit Chandra — *Iowa State University*
David Asplund — *Iowa State University*

A new multi-scale model is presented to simulate the wafer profile evolution accounting for the different pattern densities encountered at the die scale during chemical mechanical planarization (CMP). Based on the work of Greenwood and Williamson (1966), the model evaluates the pressure distribution between a rough pad and a patterned wafer first. Approaches are then proposed to re-distribute the pressure to consider the surrounding topography effects due to the pad bending. The modified pressure is then utilized in Archard's law (1953) to predict the local material removal rate and associated wafer surface evolution. The model predictions are first verified against the experimental observations of Ouma et al. (2002). A parametric study, based on this model, is then conducted to study the effects of pad roughness, bending ability, and the influence length, over which the surrounding features affect the material removal rate at a given location. Insights gathered regarding CMP pad designs for effective planarization are finally discussed.

Symp 2-9 INNOVATIVE CUTTING TOOL TECHNOLOGIES FOR MODERN MACHINING CHALLENGES

MSEC_ICMP2008-72082

MODELING MACHINING AT HIGH SPEEDS AS A FLUID MECHANICS PROBLEM

Roman V. Kazban — *Southwest Research Institute*
James J. Mason — *Zimmer Inc*

Even though many models for machining exist, most of them are for low-speed machining, where momentum is negligible and material behavior is well approximated by quasi-static plastic constitutive laws. In machining at high speeds, momentum can be important and the strain rate can be exceedingly high. For these reasons, a fluid mechanics approach to understanding high-speed, very high-speed, and ultra-high-speed machining is attempted here. Namely, a potential flow solution is used to model the behavior of the material around a sharp tool tip during machining at high speeds. It is carefully argued that the potential flow solution is relevant and can be used as a first approximation to model the behavior of a metal during high-speed, very high-speed, or ultra-high-speed machining events; and at a minimum, the potential flow solution is qualitatively useful in understanding mechanics of machining at high speeds and above. Interestingly, the flow solution predicts that there is a stagnation point on the rake face, not at the tool tip as is usually assumed. Because the stagnation point is not at the tool tip, the flow solution predicts a significant amount of deformation in the workpiece resulting in large residual strains that may lead to a temperature rise on the finished surface.

MSEC_ICMP2008-72131

SOME DISCUSSIONS OF VIRTUAL TESTING OF CUTTING TOOLS

Christian Fischer — *Scientific Forming Technologies Corporation*

The drive for ever increasing productivity puts continuously increasing demands on cutting tool performance. With the cost of a single prototype tool design near $10,000, the benefits of virtual development are clear. Computer simulation can provide accurate information on chip form, cutting force, temperature, workpiece surface integrity and other vital performance information. Recent advances in simulation technology, combined with ever increasing available of computational power at low cost, have vastly expanded the range of machining applications which can be studied in practical times. This paper examines finite element solver technology, recent research and test results enabling virtual development and prototyping of cutting tools.

MSEC_ICMP2008-72156

DEFORMATION ANALYSIS ON WORKSHEET WITH FLEXIBLE UNDERLAY DURING WEDGE CUTTING PROCESS

Seksan Chaijit — *Nagaoka University of Technology*
Shigeru Nagasawa — *Nagaoka University of Technology*
Yasushi Fukuzawa — *Nagaoka University of Technology*
Akira Hine — *Katayama Steel Rule Die Inc.*

This paper reports on the deformation characteristics of a polycarbonate (PC) worksheet mounted on a flexible underlay subjected to a wedge indentation. The effect of underlay stiffness in thickness direction ku as defined as the underlay Young's modulus by underlay thickness ku=Eu/tu is introduced. Indentation of 42 degree center bevel blade into a 0.5mm thickness of PC sheet that mounted on flexible underlays was carried out experimentally and numerically. On the experimental works, we empirically know that the underlay mechanical properties affect the cutting load response and deformation features of the PC sheet. To discussing the underlay stiffness effect on the deformation profile of the PC sheet, the finite element analysis (FEA) with elasto-plastic model is conducted. The following were obtained: (i) the deformation profile of PC sheet depends on the stiffness ratio of the underlay with the PC sheet, when the stiffness ratio is less than a certain value. (ii) the separation of PC sheet was available when the stiffness is larger than a certain critical value. (iii) the flexible underlay contributes to enlarge the equivalent wedge angle due to sinking and bending of wedged PC sheet.

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DEFINITION OF CUTTING CONDITIONS FOR THIN-TO-THIN MILLING OF AEROSPACE LOW RIGIDITY PARTS

Francisco J. Campa — *University of the Basque Country*
Luis N. Lopez De Lacalle — *University of the Basque Country*
Gorka Urbikain — *University of the Basque Country*
Daniel Ruiz — *University of the Basque Country*

The main drawback of the high speed milling of monolithic parts for the aerospace industry is the high buy-to-fly ratio that leads to a huge material waste. This problem is caused by the need to stiffen the part during the machining in order to avoid chatter, excessive vibration and residual stresses. The present work proposes a methodology for the milling of compliant parts based on the selection of cutting conditions free of chatter. First, the modal parameters of the part in the most problematic stages of the machining are calculated by means of the finite elements method. Secondly, a three-dimensional stability model is used in each stage to calculate a three-dimensional stability lobes diagram dependent on the tool position along the whole tool path. Given the fact that the depth of cut is defined by the bulk of material, the three-dimensional stability diagram can be reduced to a two-dimensional one, which relates tool position during the machining and spindle speed, and indicates how to change the spindle speed in order to avoid the unstable areas. What is more, the proposed methodology can also be used to dimension the bulk of material, select the proper tool or improve the fixturing of the part. Finally, the methodology is validated experimentally on a test part.

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NUMERICAL SIMULATIONS OF 3D TOOL GEOMETRY EFFECTS ON DEPOSITION STRESSES IN DIAMOND COATED CUTTING TOOLS

Anderson Renaud — *The University of Alabama*
Jianwen Hu — *The University of Alabama*
Feng Qin — *The University of Alabama*
Kevin Chou — *The University of Alabama*

Diamond-coated cutting tools are attractive alternatives to polycrystalline diamond tools for machining lightweight, high-strength components made of advanced materials such as composites. However, residual stresses induced by the diamond deposition process, due to thermal mismatch between diamond and the substrate, significantly impact the coating-substrate adhesion, and thus, the tool performance in machining. Moreover, the tool geometry, particularly at the very tip, complicates the stress fields because of the sharp geometry changes. The objective of this research is to investigate the effects of critical tool geometry parameters on the residual stress augmentations in diamond coated cutting tools. In this study, computer-aided design (CAD) software was used to create the solid model of various tool geometries. It was used to create an accurate model of the tool, which emulates each aspect of the tool geometry, e.g., as small as 5-micron edge radius on a 12.7-mm tool. The solid model was then exported to finite element analysis (FEA) software for 3D simulations of residual stresses generated in the tool with given deposition conditions. The obtained stress data was transformed to evaluate the interface stress profiles around the tool edges. To systematically investigate the tool geometry effects, a test matrix, determined using the design of experiments approach, includes 4 factors (edge radius, relief angle, corner radius, and corner angle) and 2 levels with a full factorial design. Analysis of variance was performed to quantitatively reveal the significant factors and interactions between the factors that dominate the stress concentrations. Results are summarized as follows. (1) The cutting edge radius is the most significant factor to the interface stresses. (2) For a 5 Âμm edge radius, the radial normal stress (?r) increases from 0 at the top uniform surface to about 1.5 GPa in tension, and the circumferential normal stress (??) increases from around 3.0 GPa in compression to over 3.7 GPa. (3) The corner radius is of secondary importance to ?r, and the relief angle is of secondary importance to ??.

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MODELING AND ANALYSIS OF THE THREAD MILLING OPERATION IN THE COMBINED DRILLING/THREAD MILLING PROCESS

Martin Jun — *University of Victoria*
Anna Araujo — *Centros Federais de EducaÃ§Ã£o TecnolÃ³gica*

This paper investigates a thread making process called thrilling, which performs both drilling and thread milling with one tool. A chip thickness and mechanistic cutting force model has been developed for a thread milling operation with a thrilling tool. The model considers the complex geometry of a thrilling tool and the unique tool paths associated with the thread milling operation. Calibration experiments have been conducted to estimate the cutting coefficients associated with specific cutting energies. Experiments have been conducted to validate the developed model. Comparison of the average torque and forces between experiment and simulation results shows that the model predicts the experimental results within 12% error. The model has also been used to analyze the effects of helix angle and number of engaged threads on the cutting forces.

MSEC_ICMP2008-72230

CHARACTERISTICS OF RESIDUAL STRESS PROFILES IN HARD TURNED VERSUS GROUND SURFACES WITH AND WITHOUT A WHITE LAYER

Andrew W. Warren — *The University of Alabama*
Y.B. Guo — *The Univ. of Alabama*

Hard turning and grinding are competitive processes in many cases for manufacturing various mechanical products. Product performance is highly dependent on the process induced residual stresses. However, there exist some inconsistence regarding the true residual stress profiles generated by hard turning and grinding with and without the presence of a white layer. This study aims to clarify the pressing issues via an extensive residual stress measurement for five surface types: hard turned fresh (HTF), hard turned with a white layer (HTWL), ground fresh (GF), ground with a white layer (GWL), and as heat treated. The x-ray diffraction data revealed distinct differences in the residual stress profiles between the turned and ground surfaces. Specifically, the key findings are: (i) HTF surfaces generate a "hook" shaped residual stress profile characterized by surface compressive residual stress and maximum compressive residual stress in the subsurface, while GF surfaces only generate maximum compressive residual stress at the surface; (ii) HTWL surfaces generate a high tensile stress in the white layer, but has highly compressive residual stress in the deeper subsurface than the HTF surface; (iii) GWL surfaces only shift the residual stress to more tensile but does not affect the basic shape of the profile; (iv) Tensile residual stress in the HTWL surface is higher than that for the GWL one. However, the residual stress for the ground white layer does not become compressive and remains tensile in the subsurface; (v) Elliptical curve fitting is necessary for measuring residual stress for the HTWL surface due to the presence of shear stress induced severe splitting; (vi) Residual stresses by grinding show more scattering than those by hard turning; and (vii) Machining is the deterministic factor for the resulting residual stress magnitudes and profiles compared with the minor influence of initial residual stress by heat treatment.

MSEC_ICMP2008-72307

IMPLEMENTATION OF MULTIRATE ESTIMATION FOR THE CYLINDRICAL GRINDING PROCESS

Cheol W. Lee — *University of Michigan - Dearborn*

This paper presents implementation results of the multirate estimation scheme, proposed by Lee (Lee, C.W., 2007, "Multirate Estimation for the Machining Process under Multirate Noise," Proceedings of the 2007 ASME IMECE, November 11-15, 2007, Seattle, WA), on the cylindrical plunge grinding process. The multirate scheme is an efficient tool for integrating real-time sensor signals with postprocess inspection data for estimating the immeasurable variables. In order to accomplish this goal, process models for grinding power, surface roughness and wheel wear are developed using experimental data. Case studies are performed on simultaneous state-parameter estimation for actual grinding batches after the multirate observers are built based on the process models. Results from case studies validate the applicability of the proposed scheme to challenging estimation tasks in the manufacturing industry that cannot be undertaken by traditional approaches.

MSEC_ICMP2008-72366

MICROSTRUCTURE AND MATERIAL ANALYSIS OF WORN WC-CO BALL-END MILLS

Hsin-Yu Kuo — *University of Michigan*
Kevin Meyer — *GE aviation*
Roger Lindle — *GE aviation*
Howard Weaver — *GE aviation*
Jun Ni — *University of Michigan*

The objective of this study is to examine the relationship between microstructure and material content at critical locations of used WC-Co ball-end mills. In this study, three similar tools displaying visually different performance after experiencing the exact same cutting conditions were observed. For each tool, three sample slices were cut from different positions on the WC-Co ball-end mills corresponding to different stages of each tool's lifecycle. Scanning Electron Microscopy (SEM) was used for observation of the microstructure of material. Chemical compositions of each tool were first examined using EDS techniques. However, higher accuracy chemical analysis using microprobe techniques and slice-averaged wet chemistry results were then completed to verify trends and chemical contents. The results of this study showed that the microstructure is closely related to the cobalt content. Moreover, cobalt losses resulting from the machining process as well as phenomena resulting in microstructure defects in the manufacturing stage of the carbide were evident in worse performing tools. Furthermore, differing grain inhibitor contents of each tool might have led to additional performance differences.

MSEC_ICMP2008-72369

ALTERNATIVE BINDER CARBIDE TOOLS FOR MACHINING SUPERALLOYS

Daniel Waldorf — *California Polytechnic State University*
Scott Liu — *Genius Metal Inc.*
Michael Stender — *California Polytechnic State University*
Daniel Norgan — *California POlytechnic State University*

This study examines the performance of a new class of wear-resistant but economical cutting tools produced by varying the binder composition of standard cemented carbide composites. By replacing some or all of the cobalt binder with rhenium and nickel-based superalloy, a stronger composite tool results, potentially capable of machining heat-resistant superalloys at significantly higher cutting speeds. Sample tools with alternative binder were produced and compared to standard tools bound with cobalt only. Turning experiments on Inconel 718 were run to evaluate wear resistance and tool life for several grades. The experimentation also examined the effects of varying the relative proportions of each binder constituent as well as the overall binder percentage in the composite. Results show a clear advantage of the alternative binder tools as evidenced by a 150% increase in tool life or the equivalent of an 18% increase in cutting speed. Although increasing amounts of rhenium in the binder show a positive effect on performance, the effects of superalloy and overall binder % are inconclusive.

MSEC_ICMP2008-72388

METHODS FOR IMPROVING CHUCKING ACCURACY

Jeongmin Byun — *St. Cloud State University*
Richard Liu — *Purdue University*

Since recent studies have demonstrated the benefits of hard turning over other abrasive machining processes as a finishing process in terms of surface integrity, a strong need has existed to improve the performance of chucking. It is because the poor repeatability and accuracy in the positioning of chucked workpieces became the major bottleneck in the implementation of finish hard turning for precision mechanical components. However, the understanding of chucking has not been adequate, nor has any systematic method been reported for improving chucking accuracy. In this paper, all the major factors that affect the positioning accuracy and repeatability of a chucked workpiece have been identified by error budgeting and systematic measurements. In addition, the characteristics of these factors, as well as their effect on chucking accuracy, were investigated. From the results, a chucking error map that summarizes the relations between these factors and the positioning error of a chucked workpiece was developed. Then, a series of experiments were carried out, based on the results of the earlier works to test the effectiveness of the error budget. The results demonstrated that the knowledge on these factors was accurate and it could be effectively used to improve the positioning accuracy and repeatability of a range of cylindrical workpieces chucked for machining. It was also shown that hard turning alone, without any extra machining process, could satisfy the same level of concentricity which is currently achieved by finish grinding in the machining of different types of cylindrical workpieces. Even if this study was originally intended for the implementation of finish hard turning that can replace finish grinding, the methods developed can be used to improve the final form accuracy of cylindrical workpieces in other finishing processes including grinding if any workholding devices similar to chucks are used to hold the workpieces. The methodology and the procedures for improving chucking accuracy are covered in a pending patent by the authors.

MSEC_ICMP2008-72402

CRATER WEAR PATTERNS AND EVOLUTION ON MULTI-LAYER COATED CARBIDES USING THE WAVELET TRANSFORM

Jorge Olortegui-Yume — *Michigan State University*
Moon Chul Yoon — *Pukyong National University*
Patrick Kwon — *Michigan State University*

The crater topography of wear patterns on a series of multi-layer coated tools after machining has been measured using Confocal Laser Scanning Microscopy and Stylus Profilometry in order to study the crater wear patterns and their evolution. The crater profile and raw patterns were processed using multi-resolution 1D and 2D wavelet analysis to eliminate noise and spike/pits and then to decouple the large- and short-scale wear features in order to examine the crater wear accurately. The wavelet method proved to be very powerful to extract the meso-scale crater wear pattern free of noise/artifacts without losing the general crater pattern. Micro-scale details were successfully identified which indicates a great potential for the local analysis of wear mechanism.

MSEC_ICMP2008-72469

DRY MACHINING USING VORTEX-TUBE GENERATED COLD AIR AS COOLANT: A LITERATURE REVIEW

Ben Cong — *Kansas State University*
Zj Pei — *Kansas State University*

This paper reviews the literature on dry machining with VT cooling (using vortex-tube generated cold air as coolant). It presents reported experimental results on effects of VT cooling on cutting force, cutting temperature, tool wear, surface roughness, and residual stress. It also points out areas where VT cooling applications have not been reported and potential directions for future research.

MSEC_ICMP2008-72489

EXPERIMENTAL INVESTIGATION ON DIAMOND DRILLING OF POTASSIUM DI-HYDROGEN PHOSPHATE (KDP) CRYSTAL

Qiangguo Wang — *Kansas State University*
Zj Pei — *Kansas State University*
Hang Gao — *Dalian University of Technology*
Nikhil Churi — *Kansasa State Univ*
Renke Kang — *Dalian University of Technology*

KDP (potassium di-hydrogen phosphate) crystal is used to fabricate important electro-optic parts. It is a typical hard-to-machine material because it is soft, brittle, and anisotropic. Parts made of KDP usually have extremely high requirements for machining quality. Reported machining methods so far for KDP crystal include single point diamond turning, grinding, Magnetorheological finishing, and polishing. This paper presents an experimental investigation on diamond drilling of KDP. Data of several output parameters (including grinding force and torque, surface roughness, and edge chipping) were collected and analyzed. Ultrasonic vibration was superimposed to the rotation of the tool to study its effects.

MSEC_ICMP2008-72492

A LOW COST WIRELESS TOOL TIP VIBRATION SENSOR FOR MILLING

Christopher Suprock — *University of New Hampshire*
Robert B Jerard — *University of New Hampshire*
Barry K Fussell — *University of New Hampshire*
Raed Hassan — *University of New Hampshire*

A low cost, wireless vibration sensor system has been developed for noninvasive integration into commercial end milling tool holders. Electret based accelerometers are used as the sensors and a Bluetooth compatible digital transmitter is used as the sensor interface. The use of mass market consumer electronic components is low cost and plug and play with modern PC hardware. Two prototypes were built and, in both cases, were able to collect good quality data at high sampling rates. The objective of the research is to enable accurate observation of NC metal cutting system dynamics. Initial results indicate the system can be used to estimate tool runout and detect the onset of regenerative chatter, prior to workpiece damage.

MSEC_ICMP2008-72513

A COMPARABILITY STUDY OF A WIRELESS ELECTRET ACCELEROMETER TO A TRADITIONAL PIEZOELECTRIC ACCELEROMETER

Joshua J. Jones — *Penn State Erie, The Behrend College*
Timothy A. Mcneal — *Penn State Erie, The Behrend College*
Wesley A. Salandro — *Penn State Erie, The Behrend College*
John T. Roth — *Penn State Erie, The Behrend College*
Christopher A. Suprock — *University of New Hampshire*
Barry K Fussell — *University of New Hampshire*

Traditional piezoelectric accelerometers used for machine condition monitoring are expensive and represent a capital risk when placed in the harsh environment of a cutting process. Additionally, these components require signal conditioning hardware and are sampled on a PC via an independent data acquisition interface (DAQ card). The goal of the research discussed herein is to test an industrial-friendly electret-based accelerometer that can perform tasks similar to a traditional piezoelectric accelerometer. The sensor will be adapted to utilize Bluetooth wireless data capabilities, further enhancing the sensors industrial practicality. The output of this electret-based sensor will be compared to the output of a traditional piezoelectric accelerometer and accompanying DAQ. More specifically, the study will focus on the effects of elevated temperature on the sensor. To achieve this, a comparison of both the electret and piezoelectric accelerometer response spectra will be observed over a range of 21°C to 77°C. To further validate the sensor, turning data is collected wirelessly from the sensor and compared to the output of the traditional piezoelectric sensor. Finally, the performance of the sensor for monitoring a tool's condition during turning is evaluated and presented. The generated trend is contrasted to the comparable trend developed from the piezoelectric-based accelerometer.

Symp 2-12 EMERGING AND NON-TRADITIONAL MANUFACTURING

MSEC_ICMP2008-72078

EFFECT OF TOOL WEAR ON ROLLING CONTACT FATIGUE PERFORMANCE OF SUPERFINISH HARD MACHINED SURFACES

Youngsik Choi — *Florida Institute of Technology*
C. Richard Liu — *Purdue University*

This study investigates the effect of tool wear on the rolling contact fatigue performance of superfinish hard machined surfaces. Specimens were machined at two different cutting tool conditions: new and worn tools. The condition of a new tool is defined as the state of an unused tool, while that of a worn tool is defined as the state of a tool after being used for machining 150 identical specimens at the same machining conditions. It is noted that tool wear induces less compressive residual stresses for the specimens machined by square tools, while tool wear induces more compressive residual stresses in a deeper region for the specimens machined by round tools, which have a relatively large tool nose radius. In the micro-hardness distribution, the specimen machined by a worn tool typically shows a more softened layer than the specimen machined by a new tool. The rolling contact fatigue test results indicate that the rolling contact fatigue life of the specimen machined by a new tool is generally longer than that of the specimen machined by a worn tool.

MSEC_ICMP2008-72083

MACHINABILITY OF COMPACTED GRAPHITE IRON IN HONING

Yhu-Tin Lin — *General Motors Corporation*

Compacted graphite iron (CGI) has been viewed as the next generation casting material for diesel engines to further the automotive energy efficiency because of its better mechanical strength for lighter engine designs as compared to conventional cast iron. The machinability of CGI is analyzed and tested in honing, a standard engine manufacturing process for cylinder bores. Its comparable stock removal rate and tool life to cast iron honing lessen the concern of the machinability problems normally seen in other machining operations on CGI parts.

MSEC_ICMP2008-72111

EXPERIMENTAL STUDY ON SUBMERSED GAS-JETTING EDM

Xiaoming Kang — *Shanghai Jiao Tong University*
Wansheng Zhao — *Shanghai Jiao Tong University*
C. J. Tang — *Shanghai Jiao Tong University*
L. S. Ding — *Shanghai Jiao Tong University*

A new method called submersed gas-jetting EDM was proposed, in which the high-pressure gas working as the dielectric medium, is blown throughout the inner hole of a tubular electrode, and dielectric liquid around the gas plays significant roles of helping cooling and debris evacuation but doesn't involve in the discharge directly. The comparison of the submersed gas-jetting EDM with dry EDM has been made in terms of material removal rate and surface quality. The preliminary study indicates that submersed gas-jetting EDM demonstrates higher material removal rate (MRR) and better surface quality compared with dry EDM. Numerical simulation of the gap condition partially verified the experimental results.

MSEC_ICMP2008-72252

STUDY OF MAGNETIC FIELD ASSISTED FINISHING OF QUARTZ WAFERS

Hitomi Yamaguchi — *University of Florida*
Takeo Shinmura — *Utsunomiya University*
Kazuki Yumoto — *Nikon Corporation*
Takahiko Okazaki — *Bando Chemical Industries, Ltd.*

The aim of this paper is to propose a new finishing process for thin quartz wafers used for high-frequency devices. The process requires simultaneous improvement of surface roughness and flatness while maintaining minimal material removal. Consequently, the process must allow for the control of both superfine finishing and localized material removal. The magnetic field-assisted finishing process enables localized material removal through control of the magnetic field distribution at the finishing area, and mirror finishing is achieved using magneto-rheological fluid based slurry. This paper proposes the application of magnetic field-assisted finishing to the finishing of thin quartz wafers. It describes the processing principle and the development of the finishing equipment used to realize the principle. The finishing experiments demonstrate the feasibility of the proposed process for superfine finishing of thin quartz wafers with localized material removal to improve the flatness.

MSEC_ICMP2008-72258

LASER POLISHING PARAMETER OPTIMISATION FOR DIE AND MOULDS SURFACE FINISHING

E. Ukar — *University of the Basque Country UPV/EHU*
A. Lamikiz — *University of the Basque Country UPV/EHU*
L.N. Lopez De Lacalle — *University of the Basque Country UPV/EHU*
F. Liebana — *ROBOTIKER-Tecnalia*
J.M. Etayo — *Robotiker*

Final polishing operation for die and mould manufacturing represents up to 30% of the total manufacturing cost and it is a high added value operation carried out manually by qualified personnel. The work presented in this paper proposes an automated solution for this task by the process known as Laser Polishing. This process is based on the application of a laser beam melting a microscopic layer of material, which lately solidifies filling the gaps, and smoothing the overall topography. Several Laser Polishing tests have been done with CO2 and High Power Diode Lasers (HPDL) on two different materials commonly used in die and mould industry: a DIN 1,2379 Tool Steel tempered up to 62HRC, used for injection moulds inserts, and a spheroidal graphite Cast Iron DIN GGG70L used typically on large stamping dies manufacturing. By means of the tests and Design of Experiments (DoE) technique, the operation parameters for the Laser Polishing process as well as its degree of influence in the melted surface have been defined. Starting off from an initial surface obtained by means of High Speed Milling operation, it has been possible to obtain satisfactory results with final roughness reductions higher than 80% with respect to the initial values, and mean roughness values below 0.8?m Ra.

MSEC_ICMP2008-72274

SHIFTING SECONDARY DISCHARGE AS THE EXPULSION MECHANISM IN EDM

Yuefeng Luo — *Federal-Mogul*
Jia Tao — *University of Michigan*

A new understanding of the expulsion mechanism in electrical discharge machining (EDM) is discussed in this study. The shifting secondary discharge inside the cathodic root is discovered as the major driving force for material removal. The investigation is conducted using the typical electrode couple of steel for cathode and copper for anode. Micro-graphs of discharge craters are taken from the complex surface directly after EDM with both normal and reversed polarities. The apparent difference in crater morphologies on anode and cathode indicates the unique expulsion mechanism, secondary discharges, that only take place inside the cathodic root. The compliance of secondary discharges with long-disputed phenomena, such as the discrepancy between energy distribution and metal removal, is demonstrated through the applications of the mechanism to the phenomena. The applied approaches and results are more direct and realistic. The better understanding of EDM can lead to significant process advancements in the future developments.

MSEC_ICMP2008-72501

A NEW COMPUTATIONALLY EFFICIENT METHOD IN LASER HARDENING MODELING

Leonardo Orazi — *University of Modena and Reggio Emilia*
Alessandro Fortunato — *University of Bologna*
Giovanni Tani — *University of Bologna*
Giampaolo Campana — *DIEM/University of Bologna*
Alessandro Ascari — *University of Bologna*
Gabriele Cuccolini — *DISMI/University of Modena-Reggio Emilia*

Laser hardening is a laser assisted process devoted to the surface hardening of the mechanical components. This process is highly suitable for medium carbon steels with carbon content comprised between 0.2 - 0.6% or for low alloy steels which are usually surface hardened during their manufacturing process. Laser hardening technology is gaining a great industrial interest in the last years in fact, the possibility of integrating the heating source directly on the production line, together with the absence of the quenching medium, meets the production needs of modern industries. Laser hardening optimization could be complex especially when tempering due to multiple passes effects must be considered. Many research studies have been proposed in the last years aimed at predicting the optimal laser process parameters such as beam power density, beam velocity and scanning strategies. Many Authors agree with the assumption that the whole austenite resulting from the heating is transformed into martensite during the quenching. This is a valid approximation for single pass but could be a rough hypothesis in multiple-passes when the cooling rate could be not so high. Moreover hysteresis phenomena, due to the severe heat cycle occurring in laser hardening, should be taken into account for pearlite to austenite and martensite to austenite transformations during heating and for martensite tempering during multiple passes. In this paper the crucial problems to be faced regarding laser surface hardening modeling are discussed with respect to current literature. In particular, partial austenitization of the pearlite is suggested as a solution of the hardness prediction of the profile depth. Then three transformation parameters are proposed in order to take into account the hysteresis phenomena in martensite and pearlite transformations into austenite and in martensite tempering. Finally several experimental examples are proposed in order to validate the mentioned assumptions

MSEC_ICMP2008-72604

EXPERIMENTAL INVESTIGATION OF SURFACE ROUGHNESS IN CYLINDRICAL WIRE ELECTRO DISCHARGE MACHINING (CWEDM)

Hossein Mohammadi — *Isfahan University of Technology*
Alireza Fadaei Tehrani — *Isfahan University of Technology*
Ali Zeinal Hamadani — *Isfahan University of Technology*
Aminollah Mohammadi — *Isfahan University of Technology*

In this paper the effects of machining parameters on the surface roughness (Ra) in cylindrical wire electro discharge machining (CWEDM) are investigated. CWEDM is a new technology in which a rotary axis is added to a usual Wire EDM machine. In this process, a new machining parameter, such as rotational speed, is introduced, which changes the normal machining conditions in conventional wire electrical discharge machining (WEDM). Current paper investigates the effects of main parameters of CWEDM including power, voltage, pulse-off time, rotation speed of rotary axis and form factor (cone angle) on the surface roughness in CWEDM. This has been done by means of the technique of design of experiments (DOE); the three levels fractional factorial method was used for studying the selected factors which allows us to carry out the above-mentioned analysis performing a relatively small number of experiments. Analysis of Variance (ANOVA) has been used to determine significant factors; also an equation based on data regression has been presented. Results from ANOVA show that power is a significant variable to surface roughness of cylindrical wire-EDMed AISI D3 cold worked steel parts. The surface roughness of test specimen increased as power and voltage increased and pulse off time and rotation speed decreased. Surfaces of the cylindrical WEDM parts were examined using Scanning Electron Microscopy (SEM) to identify the macro-ridges and craters on the surface. Cross-sections of the EDM parts are examined using the SEM to quantify the sub-surface recast layers and heat-affected zones under various process parameters and to determine their relation with surface roughness of parts.

Symp 2-13 ENERGY FIELD MANUFACTURING

MSEC_ICMP2008-72210

STRUCTURAL MODIFICATION OF AMORPHOUS FUSED SILICA UNDER FEMTOSECOND LASER IRRADIATION

Sinisa Vukelic — *Columbia University*
B. Robert Gao — *Columbia University*
Sunmin Ryu — *Columbia University*
Y. Lawrence Yao — *Columbia University*

Non-linear absorption of femtosecond laser pulses enables the induction of structural changes in the interior of bulk transparent materials without affecting their surface. This property can be exploited for the transmission welding of transparent dielectrics, three dimensional optical data storages and waveguides. In the present study, femtosecond laser pulses were tightly focused within the interior of bulk fused silica specimen. Localized plasma was formed, initiating rearrangement of the network structure. The change in material properties were studied through employment of spatially resolved Raman spectroscopy, atomic force microscopy and optical microscopy. The nature of the physical mechanisms responsible for the alteration of material properties as a function of process parameters is discussed.

MSEC_ICMP2008-72231

FABRICATION AND FINITE ELEMENT ANALYSIS OF MICRO DENTS USING U-LASER SHOCK PEENING

Michael Sealy — *The University of Alabama*
Y.B. Guo — *The Univ. of Alabama*
M.F. Horstemeyer — *Mississippi State University*

Laser shock peening (LSP) is an innovative surface treatment developed to improve surface integrity. This study explores the feasibility using LSP to direct-write surface micro dents for lubricant retention. Since LSP is a highly transient process with a pulse duration of 10 â□“ 100 ns, a real time in-situ measurement of laser/material interaction such as transient stresses/strains is challenging. Therefore, a 3D finite element simulation of micro-scale laser shock peening was developed to determine the effect of laser pulse duration and peak pressure on the transient material behaviors of titanium Ti-6Al-4V. The simulated dent geometry is similar to the measured dent geometry in terms of morphology. The results suggested there is an optimal peening time that produces the deepest dent. The maximum transient stress in peening direction occurred at a

certain laser pulse time. However, the stress along the depth and radius were drastically affected by the peak pressures.

MSEC_ICMP2008-72259

A PARAMETRIC STUDY ON OVERLAPPING LASER SHOCK PEENING ON 4140 STEEL VIA MODELING AND EXPERIMENTS

Yunfeng Cao — *Purdue University*
Yung Shin — *Purdue University*
Benxin Wu

Laser shock peening (LSP) under water confinement regime (WCR) involves several complicated physical phenomena. Among these phenomena, the interaction between laser and coating material during LSP is very important to the laser induced residual stress, which has an important effect on the fatigue and corrosion properties of the substrate material. To gain a better understanding of this interaction, a series of experiments, including single shot, single track overlapping, and multi-track overlapping LSP, have been carried out on 4140 steel with black paint coating. A 3-D finite element model has also been developed to simulate the LSP process. Combining this with a previously developed confined plasma model, which has been verified by the experimental data from literature, the 3-D finite element model is used to predict the residual stresses induced in the substrate material as well as the indentation profile on the substrate surface. The model prediction of indentation profiles are compared with the experimental data and good agreements are obtained. The effect of process parameters on the residual stress has also been investigated both experimentally and theoretically.

MSEC_ICMP2008-72293

MANIPULATING SHAPE AND SIZE OF NANOPARTICLES WITH PLASMA FIELD

Tao Deng — *GE*
James Cournoyer — *GE*
James Schermerhorn — *GE*
Joleyn Balch — *GE*
Margaret Blohm — *GE*

Tuning the plasma field in reactive ion etching generates different etching profile of nanoparticles. For nanoparticles in an isotropic plasma field, there will be uniform shrinkage of the particle sizes due to the isotropic etching, with the curvature of the particles unchanged after the etching. An anisotropic etching, on the other hand, provides rich opportunities in modifying the shape of the particles with reduced dimensions. For a monolayer of silica nanoparticles on a flat substrate in a unidirectional plasma field, the reactive ion etching changed the shape of silica nanoparticles from spherical to spheroid-like geometry. The mathematical description of the final spheroid-like geometry was discussed and matched well with the experimental results. The surface curvature of the particles after etching remained the same for both the top and the bottom surfaces, while the overall shape transformed to spheroid-like geometry. Varying the etching time resulted in particles with different height to width ratios. The unique geometry of these non-spherical particles will impact fundament properties of such particles, such as packing and assembly. In the case of spheroid-like particles, packing of such particles into ordered structures will involve an orientational order, which is different from spherical nanoparticles that have no orientational order.

MSEC_ICMP2008-72426

NUMERICAL INVESTIGATION OF TEMPERATURE FIELD DURING SINTERING OF BIOCERAMIC NANOPARTICLES BY PULSE LASERS

Chang Ye — *Purdue University*
Gary Cheng — *Purdue University*

As one of the leading commercial process for rapid fabrication, laser sintering has the advantage of high efficiency, high precision, good controllability, etc. Laser sintering of nanoparticles has been a field of great interest due to its possible application in directed three-dimensional nanoparticle assembly, the low melting temperature of metallic nanoparticles. HAp bioceramics has attracted much attention recently due to its good biocompatibility and mechanical strength used in biomaterials. One major issue in this process is the difference in the thermal expansion coefficient (TEC) between HAp and Titanium, which will result in low interfacial strength of the coating. One way to resolve this is to coat the mixture of HAp and Ti instead of pure HAp. In this way, the difference in thermal property between the powder and substrate is gradient, and therefore the interfacial strength will be improved. In this paper, the electromagnetic model and the heat transfer model are coupled numerically in a multiphysics model to investigate the temperature field during laser sintering of Hap/Ti nanoparticles. The resistive heating calculated from Maxwell's equation is used as the heat source term in the heat transfer equation, and the temperature field is simulated accordingly. The influence of laser power, laser wavelength, particle composition and sintering time is investigated. The presented work can be applied to many other works involving laser sintering of nanomaterials.

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INVESTIGATION ON OPERATING TEMPERATURE IN LASER ASSISTED MILLING OF SILICON NITRIDE CERAMICS

Xinwei Shen — *Kansas State University*
Shuting Lei — *Kansas State University*

This paper discusses the operating temperature in laser assisted milling (LAMill) of silicon nitride ceramics. Experimental investigation shows that the laser parameters including laser power, laser beam diameter, laser translating speed and preheat time affect the temperatures at the cutting zone. Especially, laser intensity plays an important role in the heat absorption of silicon nitride ceramics. In LAM, high laser intensity is desired. In addition, laser interaction mechanism with silicon nitride shows that high operating temperature may cause the material at the thin top layer of the workpiece to oxidize and thereby forming silica bubbles. With high operating temperature the machined surface of the workpiece has good finish and less edge chipping. Keywords: laser assisted milling, silicon nitride ceramics, heat absorption, laser intensity, operating temperature

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EFFECT OF ELECTRICAL PULSING ON VARIOUS HEAT TREATMENTS OF 5XXX SERIES ALUMINUM ALLOYS

Wesley A. Salandro — *Penn State Erie, The Behrend College*
Joshua J. Jones — *Penn State Erie, The Behrend College*
Timothy A. Mcneal — *Penn State Erie, The Behrend College*
John T. Roth — *Penn State Erie, The Behrend College*
Sung-Tae Hong — *University of Ulsan :School of Mechanical and Automotive Engineering*
Mark T. Smith — *Pacific Northwest National Laboratory*

Previous studies have shown that the presence of a pulsed electrical current, applied during the deformation process of an aluminum specimen, can significantly improve the formability of the aluminum without heating the metal above its maximum operating temperature range. The research herein extends these findings by examining the effect of electrical pulsing on 5052 and 5083 Aluminum Alloys. Two different parameter sets were used while pulsing three different heat treatments (As Is, 398°C, and 510°C) for each of the two aluminum alloys. For this research, the electrical pulsing is applied to the aluminum while the specimens are deformed, without halting the deformation process. The analysis focuses on establishing the effect the electrical pulsing has on the aluminum alloy's various heat treatments by examining the displacement of the material throughout the testing region of dogbone shaped specimens. The results from this research show that pulsing significantly increases the maximum achievable elongation of the aluminum (when compared to baseline tests conducted without electrical pulsing). Significantly reducing the engineering flow stress within the material is another beneficial effect produced by electric pulsing. The electrical pulses also cause the aluminum to deform non-uniformly, such that the material exhibits a diffuse neck where the minimum deformation occurs near the ends of the specimen (near the clamps) and the maximum deformation occurs near the center of the specimen (where fracture ultimately occurs). This diffuse necking effect is similar to what can be experienced during superplastic deformation. However, when comparing the presence of a diffuse neck in this research, electrical pulsing does not create as significant of a diffuse neck as superplastic deformation. Electrical pulsing has the potential to be more efficient than traditional methods of incremental forming since the deformation process is never interrupted. Overall, with the greater elongation and lower stress, the aluminum can be deformed quicker, easier, and to a greater extent than is currently possible.

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SPATIALLY RESOLVED CHARACTERIZATION OF GEOMETRICALLY NECESSARY DISLOCATION DEPENDENT DEFORMATION IN MICRO-SCALE LASER SHOCK PEENING

Youneng Wang — *Columbia University*
Sinisa Vukelic — *Columbia University*
Jeffrey W. Kysar — *Columbia University*
Y. Lawrence Yao — *Columbia University*

As the laser spot size in micro-scale laser shock peening is in the order of magnitude of several microns, the anisotropic response of grains will have a dominant influence on its mechanical behavior of the target material. Furthermore, conventional plasticity theory employed in previous studies needs to be reexamined due to the length scale effect. In the present work, the length scale effects in microscale laser shock peening have been investigated. The crystal lattice rotation underneath the shocked surface was determined via Electron Backscatter Diffraction (EBSD). From this measurements, the geometrical necessary dislocations (GND) density that the material contains has been evaluated. The yield strength increment was then calculated from the GND distribution by using Taylor model and integrated into each material point of the FEM simulation. Finite element simulations, based on single crystal plasticity, were performed of the process for both with and without considering the GND hardening and the comparison has been conducted.

MSEC_ICMP2008-72541

REVIEW OF INTELLIGENT ENERGY FIELD MANUFACTURING (EFM)

Wenwu Zhang — *GE GRC*

The long cycles of modern economy is driven by technology innovations. New methodologies are needed to increase the efficiency of technology innovations. Intelligent Energy Field Manufacturing is one of such methodologies. The evolution and the fundamentals of Intelligent Energy Field Manufacturing (EFM) are reviewed in this paper. One issue in technology innovation is that the importance of manufacturing process innovations is underestimated. The other issue is how and why shall manufacturing Go Green to increase long-term sustainability. These should be the important topics in the research of Intelligent EFM.

Track 3 Properties and Applications

Symp 3-1 MECHANICAL CHARACTERIZATION AND MEASUREMENT TECHNIQUES

MSEC_ICMP2008-72013

EFFECT OF CHEMICAL COMPOSITION ON ELEVATED TEMPERATURE BRITTLENESS OF DUCTILE CAST IRON

Yoshitaka Iwabuchi — *Kushiro National College of Technology*

Elevated temperature brittleness (ETB) of ductile cast iron (DCI) has been referred to as reduced ductility within an elevated temperature range and has been related to grain boundary brittleness. The phenomenon of ETB has not been yet clearly understood. In this study, the mechanism of ETB was studied in terms of strain rate and chemical composition. Yield strength was related to solid solution hardening of silicon. The reduced tensile ductility was the direct result of intergranular embrittlement and the temperature, at which ductility was minimum, was strain-dependent and was about 700K. Heats containing high phosphorous exceeding 0.032 mass% were found to be immune to ETB, while molybdenum and nickel had little effect on ETB. It is found that ETB could be suppressed by the ratio of magnesium and phosphorous to less than 1.5.

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MATERIAL CHARACTERIZATION OF UNCOATED BORON STEEL FOR AUTOMOTIVE BODY STRUCTURE APPLICATIONS

Ramakrishna Koganti — *Ford Motor Company*
Sergio Angotti — *Ford Motor Company*
Ronald Cooper — *Ford Motor Company*
Dan Houston — *Ford Motor Company*
Asif Waheed — *AECL*
Timothy Topper — *University of Waterloo*

Use of Advanced High Strength Steels in automotive applications is increasing. One of these materials is boron steel, which is commercially available in coated and uncoated sheets. Parts manufactured with uncoated boron typically undergo a de-scaling step after a hot-stamping process to improve the part's weldability. This procedure is accomplished by either a "pickling" or "shot-peening" process, the latter being more common. Automotive manufacturers are using boron steel in body structure applications to produce light weight parts and to address safety requirements. Boron steel is also available in a non heat-treated condition (also referred to as "green state") which has a typical yield strength around 350 MPa. The yield strength for a fully temperature hardened boron steel increases to above 1000 MPa, depending on heat treatment temperature and quenching methods used. In this report, the static and fatigue properties of uncoated boron steel was evaluated. One objective was to understand whether these properties varied with respect to the material rolling direction (longitudinal, transverse and diagonal). Three different gages were evaluated; 1.0 mm, 1.5 mm and 2.0 mm. For fatigue evaluation, samples were cut from three unique gage thicknesses. Static tensile tests on 1.5 mm samples revealed that no difference was observed for UTS, Yield and Uniform Elongation between longitudinal, transverse and diagonal sample groups. Based on statistical testing, the properties are uniform in all three directions. Based on comparison of the monotonic and cyclic stress strain curves that the boron steel is strain-softening material

MSEC_ICMP2008-72318

DIFFERENCE IN TENSILE AND COMPRESSIVE STRESSES OF PURE TITANIUM AND ALUMINUM ALLOY SHEETS AND ITS EFFECT ON BENDING CHARACTERISTICS

Toshihiko Kuwabara — *Tokyo University of Agriculture & Technology*
Y. Ichinose — *University of Agriculture and Technology*

In-plane tension and compression experiments on pure titanium sheets and aluminum alloy sheets have been carried out using a specially designed testing apparatus. The testing apparatus is equipped with comb-shaped dies so that we can measure the stress-strain curves of sheet materials subjected to tension followed by compression, and vice versa, without buckling of the specimen, as well as those for monotonic tension and compression of the as-received material. A difference in the flow stresses between tension and compression was observed for the as-received test materials. Moreover, stress reversal tests, such as tension followed by compression and compression followed by tension, were carried out to quantitatively evaluate the Bauschinger effect of the test materials. As the second part of the experiment, bending moment-curvature diagrams were determined for the as-received and pre-stretched specimens. The observed bending moment-curvature diagrams were compared with those calculated using the stress-strain curves obtained from the tension-compression tests. The observed moment-curvature diagrams were found to be in good agreement with the calculated ones when the strength differential between tension and compression (strength-differential effect) was

correctly reproduced in calculating the bending moment for the as-received materials and when the reverse loading properties (Bauschinger effect) were correctly reproduced in calculating the bending moment for the pre-stretched materials.

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TWO STAGE S-N CURVE IN CORROSION FATIGUE OF EXTRUDED MAGNESIUM ALLOY AZ31

Md.Shahnewaz Bhuiyan — *Nagaoka University of Technology*
Yoshiharu Mutoh — *Nagaoka University of Technology*
Thutomu Murai
S. Iwakami — *Sankyo Aluminum Industry Co., Ltd.*

Tension-compression fatigue tests of extruded AZ31 magnesium alloys were carried out under corrosive environments: (a) high humidity environment (80 %RH) and (b) 5 wt. %NaCl environment. It was found that the reduction rate of fatigue strength due to corrosive environment was 0.12 under high humidity and 0.53 under NaCl environment. It was also observed that under 5% NaCl environment, the S-N curve was not a single curve but two stage curve. Above the fatigue limit under low humidity, the crack nucleation mechanism was due to localized slip band formation mechanism. Below the fatigue limit under low humidity, the reduction in fatigue limit was attributed to the corrosion pit formation under the combined effect of cyclic load and the corrosive environment. In this stage, reduction in fatigue strength resulted from pit formation and its growth to the critical size for fatigue crack nucleation. The critical size was attained when the stress intensity factor range reached the threshold value for crack growth. Key words: fatigue, corrosion fatigue,two stage S-N curve corrosion pit, humidity, NaCl, magnesium alloy

MSEC_ICMP2008-72436

FATIGUE CRACK GROWTH BEHAVIOR OF STEELS WITH PEARLITE PARTICLES DISPERSED IN FERRITE MATRIX

Mohammad Sukri Mustapa — *Nagaoka University of Technol*ogy
Jayaprakash Murugesan — *Nagaoka university of Technology*
Yoshiharu Mutoh — *Nagaoka University of Technology*
T. Sadasue — *Steel Research Lab., JFE Steel Corporation*

It is known that microstructure has an influence significantly on stage I and IIa crack growth behavior but less on stage IIb (Paris regime) crack growth behavior. However, complex microstructure with two phases of hard and soft may influence fatigue crack growth behavior even in Paris regime, because two phase microstructure will be possible to change crack growth mechanism and then crack growth resistance. In the present study, structural steels with pearlite particles dispersed in ferrite matrix were prepared and fatigue crack growth tests of the steels were carried out under in situ observation to investigate effect of pealite particle size and spacing in microstructure controlled steels with pearlite particles dispersed in ferrite matrix on fatigue crack growth behavior in Paris regime. The steel with large spacing and size of pearlite particles indicated higher threshold value and better FCG resistance compared to the steel with small spacing and size of pearlite particles. To understand effect of microstructure on FCG behavior in detail, -constant FCG tests in Paris regime were carried out under a scanning electron microscope (SEM) equipped with a servo-hydraulic testing machine. During the test, crack closure was monitored and crack path was observed in detail. From the crack closure measurements, the crack growth curves arranged by didn't come on one line and still showed effect of microstructure on fatigue crack growth behavior. Based on in situ crack path observations, interlocking between crack surfaces and branching, which induce crack tip stress shielding, were observed more in the steel with larger spacing and size of pearlite particles. Keywords: In-situ SEM observation, crack tip stress shielding, fatigue crack growth, interlocking, pearlite particle, ferrite-pearlite steel.

MSEC_ICMP2008-72582

EFFECT OF THE SPHERICAL INDENTER TIP ASSUMPTION ON NANOINDENTATION

Li Ma — *National Institute of Standards and Technology*
Dylan Morris — *National Institute of Standards and Technology*
Lyle Levine — *National Institute of Standards and Technology*
Stefhanni Jennerjohn — *Washington State University*
David Bahr — *Washington State University*

One of the interesting applications of nanoindentation of crystalline materials is measurement of the maximum shear stress at the onset of plastic yielding, which often corresponds to dislocation nucleation. The maximum shear stress is estimated by assuming that the contact is Hertzian up to the first "pop-in" event, which is a sudden displacement burst during nanoindentation. However, it is known that indenter tips may have irregular shapes, especially at the nanometer-scale indentations corresponding to the first pop-in events. The irregular

shape will significantly change the stress distribution, and therefore the maximum shear stress, at the contact. In a recent work, atomic force microscopy (AFM) was used to measure the real shape of a nanoindenter tip. The finite element method was then used to simulate nanoindentation of -oriented single crystal Al using both the measured tip shape and an effective spherical shape that was determined by fitting the simulated load-displacement data. The irregular tip shape increased the local maximum shear stress by as much as 17 % over the fitted spherical indenter. In this work, a real Berkovich tip-shape is measured by AFM and input into a finite element model for nanoindentation experiments on -oriented single crystal tungsten (W) samples in the elastic regime. The radius of an effective spherical indenter was extracted by fitting the resulting load-displacement data and corresponding indentation simulations were carried out using this spherical indenter. Although the load-displacement curves for the realistic and spherical indenters are in good agreement, the resulting stress distributions within the tungsten are different. The maximum shear stresses for the AFM-measured indenter are larger than those with the spherical indenter for the first pop-in nanoindentation depth on single crystal W, which means estimates of the dislocation nucleation stress from experimental data would therefore be lower if a spherical-tip assumption were made for the measured indenter. The finite element simulations are also compared with real W nanoindentation measurements using this same indenter.

Symp 3-2 ADVANCES IN SENSORS, CONTROLLER, INTELLIGENT SYSYTEMS AND ROBOTICS FOR MATERIAL PROCESSING AND INSPECTION

MSEC_ICMP2008-72103

WELDING PENETRATION CONTROL OF FIXED PIPE IN TIG WELDING USING FUZZY INFERENCE SYSTEM

Ario Sunar Baskoro — *Graduate School of Science and Technology, Keio University*
Masashi Kabutomori — *Graduate School of Science and Technology, Keio University*
Yasuo Suga

This paper presents a study on welding penetration control of fixed pipe in Tungsten Inert Gas (TIG) welding using fuzzy inference system. The welding penetration control is essential to the production quality welds with a specified geometry. For pipe welding using constant arc current and welding speed, the bead width becomes wider as the circumferential welding of small diameter pipes progresses. Having welded pipe in fixed position, obviously, the excessive arc current yields burn through of metals; in contrary, insufficient arc current produces imperfect welding. In order to avoid these errors and to obtain the uniform weld bead over the entire circumference of the pipe, the welding conditions should be controlled as the welding proceeds. This research studies the intelligent welding process of aluminum alloy pipe 6063S-T5 in fixed position using the AC welding machine. The monitoring system used a charge-coupled device (CCD) camera to monitor backside image of molten pool. The captured image was processed to recognize the edge of molten pool by image processing algorithm. Simulation of welding control using fuzzy inference system was constructed to simulate the control model. The simulation result shows that fuzzy controller was suitable for controlling the welding speed and appropriate to be implemented into the welding system. A series of experiments was conducted to evaluate the performance of the fuzzy controller. From the experimental results it shows the effectiveness of the control system that is confirmed by sound weld of experimental result. Key words: Welding Penetration Control, Fixed Pipe, Backside Image of Molten Pool, Fuzzy Inference System

MSEC_ICMP2008-72299

ESTIMATION AND CONTROL OF PENETRATION USING VISION SENSOR IN TIG WELDING OF THIN STEEL PLATES

Yasuo Suga

An intelligent welding robot system with visual sensors is developed in order to realize full automatic welding of thin mild steel plates including automatic seam tracking and automatic control of welding conditions. In particular, control of a back bead width is crucial in thin plate welding, which requires the information on the back bead. However, it is difficult to observe the back bead directly, since sensors, such as a CCD camera, cannot be placed beneath the work in practical applications. Conventionally, the back bead width for a given geometry of a molten pool is estimated according to a database obtained from experiments, which was time and cost consuming. In this work, a welding simulation based on the heat conduction equation was performed to estimate the back bead width. Then a penetration control system using the simulation and visual monitoring of molten pool is constructed, and the effectiveness is confirmed by welding control experiments.

MSEC_ICMP2008-72315

CALIBRATION OF A MILLING FORCE MODEL USING FEED AND SPINDLE POWER SENSORS

Bryan Javorek — *University of New Hampshire*
Barry K Fussell — *University of New Hampshire*
Robert B Jerard — *University of New Hampshire*

Changes in cutting forces during a milling operation can be associated with tool wear and breakage. Accurate monitoring of these cutting forces is an important step towards the automation of the machining process. However, direct force sensors, such as dynamometers, are not practical for industry application due to high costs, unwanted compliance, and workspace limitations. This paper describes a method in which power sensors on the feed and spindle motors are used to generate coefficients for a cutting force model. The resulting model accurately predicts the X and Y cutting forces observed in several simple end-milling tests, and should be capable of estimating both the peak and average force for a given cut geometry. In this work, a dynamometer is used to calibrate the feed drive power sensor and to measure experimental cutting forces for verification of the cutting force model. Measurement of the average x-axis cutting forces is currently presented as an off-line procedure performed on a sacrificial block of material. The potential development of a continuous, real-time force monitoring system is discussed.

MSEC_ICMP2008-72374

FORCE/VELOCITY CONTROL OF A PNEUMATIC GANTRY ROBOT FOR CONTOUR TRACKING WITH NEURAL NETWORK COMPENSATION

Mohammed Abu-Mallouh — *Queen's University*
Brian Surgenor — *Queen's University*

In this paper, the application of a pneumatic gantry robot to contour tracking is examined. A hybrid controller is structured to control the contact force and the tangential velocity, simultaneously. A previous study provided controller tuning and model validation results for a fixed gain PI-based force/velocity controller. Performance was limited by system lag and Coulomb friction. New results demonstrate that even with perfect friction compensation, the limiting factor is the system lag. A neural network (NN) compensator was subsequently developed to counter both effects. Results for straight and curved edged workpieces are presented to demonstrate the effectiveness of the NN compensator and the capabilities of a pneumatic gantry robot.

MSEC_ICMP2008-72484

VISUAL SIMULATION OF ARISTO ROBOT WITH WORKSPACE ANALYSIS

Upendra Parghi — *Sardar Vallabhbhai National Institute of Technology*
Dr. Harit K. Raval — *S. V. National Institute of Technology*

Robotics is a technology that is utilized tremendously in Industrial and commercial applications. Different types of robotic arms are used to fulfill the industrial needs. The aim of the work presented in this paper is to give a visual simulation of the robotic arm (Aristo Robot â□“ 6 DOF) which can be used with offline robotic programming thereby introducing the language to the user and creating a training package for the user. This software also reduces the time as programming can be done offline. The pick and place robotic arm comprises of 6 links, which each of them has one degree of freedom (DOF) with a payload capacity of 3 kg is used for visual simulation. The main objective is to design a three dimensional graphic of a robotic arm and its movement animation that imitates the movement of actual robotic arm. The graphic design is then used as a foundation to find its limits of reach in the surrounding. Also the analysis of workspace is done to understand its workspace volume properly.

MSEC_ICMP2008-72493

INFERRING HARDNESS FROM HIGH-SPEED VIDEO OF THE MACHINING PROCESS

Don R. Hush — *Los Alamos National Laboratory*
Matthew T. Bement — *Los Alamos National Laboratory*
Tim K. Wong — *Los Alamos National Laboratory*

This paper presents the results of a study to assess the feasibility of inferring workpiece material hardness from high-speed video data of chip formation obtained during a turning operation. The motivation for assessing hardness in situ comes from the fabrication of shaped charges, where spatial variation in hardness is known to affect the performance of the shaped charge. While other in-process data could be used for this purpose, video data are analyzed here because of the stand-off, non-contact advantages afforded. This is especially relevant for highly qualified machining processes for small-lot, high value parts where any interference with the process (e.g., introduction of cables near the machine tool) is undesirable. A multistep image processing procedure is presented which is used to extract several features from the video data. These features are then used to develop a classifier which can be used to predict workpiece hardness. Multiple classifier designs (Knn and Ratchet) are considered.

MSEC_ICMP2008-72503

CHARACTERIZATION OF A NANO-COMPOSITE SENSOR IN MULTIPLE ENVIRONMENTAL DOMAINS

Swathi Chimalapati — *Clemson University*
Laine Mears — *Clemson University*
Andrew C., Clark — *Sensor Tech, Inc.*

A sensor composed of a composite material formed of a polymer and nano-carbon conductive filler is characterized for measurement of pressure through the relationship to contact resistance. The sensor has the physical attributes of polymer, but is electrically conductive and can therefore be used on a conductive substrate to gauge pressure and subsequently load. Benefits over traditional force sensing include reduced cost, full control of geometry, reduced form factor, resistance to impact and resistance to corrosion. A test circuit was developed to study the behavior of the sensor at different loads and surface conditions, and behavior over time. Prospective applications on manufacturing and automotive fields are proposed.

MSEC_ICMP2008-72507

CHARACTERISTICS OF ACOUSTIC EMISSION SIGNALS IN MACHINING USING DIAMOND COATED TOOLS

Jianwen Hu — *UA*
Feng Qin — *UA*
Kevin Chou — *The University of Alabama*
Raymond Thompson — *Vistae Engineering*

Diamond coated cutting tools have been pursued as a cost-effective substitute to brazed polycrystalline diamond (PCD) tools in applications such as machining high-strength and lightweight materials. However, coating delamination has been known as the major failure mode of diamond coated tools, which terminates tool life prematurely. Once delamination failure occurs, the tool substrate often subjects to severe abrasive wear leading to catastrophic tool failures that imparts the part quality and interrupts machining operations. Hence, accurate detections and forecasts of coating delamination events can prevent production loss and assist process planning. In this study, the characteristics of acoustic emission (AE) signals when machining a high-strength aluminum alloy and a composite using diamond coated cutting tools were investigated. The AE signals were analyzed in both time and frequency domains at various machining conditions and different cutting times. It was found that AE root-mean-square values decrease considerably once coating delamination occurs. The results also indicate a correlation between the tool condition and fast Fourier transformation (FFT) spectra of AE raw data. In addition, the machining experiments implied that it may be feasible to use AE signals to monitor the condition of diamond coated tools during machining.

Symp 3-3 CONTACT SURFACE MECHANICS, FRACTURE AND FRACTURE RELIABILITY

MSEC_ICMP2008-72038

ULTRASONIC DETECTION OF INVISIBLE FATIGUE CRACK INITIATED AT BOLTED JOINTS OF ALUMINUM ALLOY PLATES

Sanat Wagle — *Saitama university*
Hiroshi Kato — *Saitama University*

Bolted specimens of the aluminum alloy plate (A2024-T3) were subjected to fatigue testing to evaluate effects of the tightening torque and the fatigue life on the failure mode at different levels of the stress amplitude. Regardless the stress amplitude, in a range of smaller torques, the fatigue life of the bolted specimen increased with increasing tightening torque, and the mechanical fatigue crack initiated and propagated from the bolt hole edge. At a range of higher torques, the fracture occurred near the bolt hole due to the fretting fatigue, and the fatigue life decreased with increasing torque. These results were illustrated in a tightening torque and a fatigue life diagram. Then the in-process ultrasonic measurement was carried out with the surface acoustic wave for the bolted specimen during the fatigue testing to detect a fine fretting crack. During the fatigue process, the intensity of the scattering wave gradually increased with the number of fatigue cycles at the fretted region ahead of a bolt hole. When the change in the intensity reached a critical value, a fine fretting crack appeared at the edge of the fretted area.

MSEC_ICMP2008-72112

MECHANISM OF REDUCTION OF FRETTING FATIGUE LIMIT IN HYDROGEN GAS ENVIRONMENT

Masanobu Kubota — *Kyushu University*
Yoshiyuki Kondo — *Kyushu University*
Kyohei Kuwada — *Graduate school of Kyushu University*
Yasuhiro Tanaka — *Graduate school oh Kyushu University*

In the fretting fatigue test performed in hydrogen gas environment, fretting fatigue life was longer than that in air at the stress amplitude above fretting fatigue limit in air, but the failure of specimen steadily occurred at stress amplitude below the fretting fatigue limit in air. The objective of this study is to discuss the causes of these characteristics observed in fretting fatigue in hydrogen gas environment. The material was work-hardened austenitic stainless steel SUS304. Discussions were done through detailed observation of micro fretting fatigue cracks and fretting wear process and continuous measurement of propagation of fretting fatigue crack. In hydrogen gas environment, the initiation life of microcrack was nearly the same in both hydrogen gas and air environment. The start of propagation of microcrack to major crack was at the last stage of fatigue life in hydrogen gas. The microcrack observed in air was steadily propagated after the initiation. The most of fatigue life in hydrogen gas was spent for the formation of many microcracks. This is the reason for the extension of fretting fatigue life. Adhesion was dominant in the fretting wear process in hydrogen gas environment. It is considered that the adhesion have close relation to the crack initiation at the stress level below the fretting fatigue limit in air in hydrogen gas environment. Tangential force coefficient in hydrogen gas was higher than that in air due to the adhesion and no production of oxidized fretting wear products. The decrease of fretting fatigue strength in hydrogen gas environment was caused by the nucleation of microcrack and the increase of tangential force resulting from the change of dominant process of fretting wear from oxidation to adhesion.

MSEC_ICMP2008-72154

EFFECT OF AN INTERLAYER ON THE FREE-EDGE SINGULAR STRESS FIELD OF BONDED DISSIMILAR MATERIALS

Seiji Ioka — *Osaka University*
Shiro Kubo — *Osaka University*

The free-edge stress singularity usually prevails near the intersection of the free-surface and the interface for the bonded dissimilar materials. When two materials are bonded by using an adhesive, an adhesive layer is sandwiched by the two materials. To defuse the residual stress which develops when two materials are bonded directly, an interlayer may be inserted between two materials. Stress field near the edge of the interface in the presence of the interlayer is very important for evaluating the strength of bonded dissimilar materials. In this study, stress distributions on the interface of bonded dissimilar materials with an interlayer are calculated by using the boundary element method, and the effect of the interlayer on the stress distribution is investigated. It is found that the stress near the edge of the interface of bonded dissimilar materials with an interlayer is controlled by the free-edge stress singularity of bonded dissimilar materials without an interlayer. Effect of the interlayer on the stress distribution is limited within the region where the distance from the edge of the interface is smaller than the height of the interlayer.

MSEC_ICMP2008-72229

THE BASIC RELATIONSHIP BETWEEN MACHINING INDUCED RESIDUAL STRESS PROFILES AND FATIGUE LIFE

Y.B. Guo — *The Univ. of Alabama*
Andrew W. Warren — *The University of Alabama*

The characteristics of residual stress (RS) profiles and their effects on rolling contact fatigue life for precision turned and ground surfaces with a white layer (WL) are very controversial. The key findings of this study are: (a) The basic RS profiles by a sharp tool can be fundamentally changed by a turned WL but not a ground WL; (b) The hook shaped RS profile of a turned surface may have about 40% more fatigue life than a ground one; (c) The white layer may reduce fatigue life as much as 7-8 times despite the deep compressive RS in the subsurface.

MSEC_ICMP2008-72239

STUDY OF THE DYNAMIC CRACK GROWTH OF A PLANAR CRACK FRONT IN THREE-DIMENSIONAL BODY SUBJECTED TO MODE I LOADING

Felicia STAN — *Dunarea de Jos University of Galati*

In this paper, a methodology is presented for predicting crack growth rate along three-dimensional crack fronts under mode I dynamic loading conditions. Within the present methodology, for every point along the crack front the stress intensity factor matches the dynamic fracture toughness at the onset of propagation. In order to accurately evaluate the dynamic stress intensity factor the component separation method of the dynamic J integral is used. To overcome the difficulties in three-dimensional dynamic fracture simulations, the three-dimensional dynamic moving finite element method based on three-dimensional moving 20-noded isoparametric elements is used. In the absence of experimental measurements for dynamic fracture toughness, a new methodology to estimate the dynamic fracture toughness is proposed, i.e., a hybrid experimental-numerical approach, which makes use of numerically determined histories of the dynamic stress intensity factor. The values of the dynamic stress intensity factor are converted into dynamic fracture toughness. The predictive ability of the developed methodology is demonstrated through the prediction of the dynamic crack growth in Double Cantilever Beam (DCB) specimen of PMMA with different thickness.

MSEC_ICMP2008-72320

EFFECT OF CONTACT PAD FOOT HEIGHT AND WIDTH ON FRETTING FATIGUE BEHAVIOR OF TURBINE STEEL

Jayaprakash Murugesan — *Nagaoka university of Technology*
Yoshiharu Mutoh — *Nagaoka University of Technology*
Kunio Asai — *Materials Research Laboratory, Hitachi, Ltd.*
Kunihiro Ichikawa — *Hitachi Ltd.*

Fretting fatigue is a serious problem in engineering applications, where two components are in contact and one of them is subjected to cyclic loading. The initiation of fatigue cracks in fretting fatigue depends mainly on the state of stress at the contact edge. Important variables influence fretting fatigue behavior, includes contact pressure, relative slip amplitude and coefficient of friction. Despite these important variables there were also number of other variables that influence fretting fatigue life, but they received only little attention. Recently there were reports mentioned that the rigidity of contact pad have an influence on fretting fatigue life, as both the stress at the contact edge and the relative slip changes with contact pad rigidity. But there is no detailed investigation so far. In the present work the effect of contact pad rigidity, i.e., pad foot height and width, on fretting fatigue behavior of turbine steel was studied. Fretting fatigue tests were carried out on Ni-Cr-Mo-V steel (which is commonly used for steam turbine rotors) with contact pads made of 12-Cr steels (which is commonly used for steam turbines blades), with four different pad foot heights (0mm, 1mm, 2mm and 3mm). During the test the friction force between the pad and the specimen were also monitored. FEM analysis was also performed to estimate the stress distribution at the contact edge and the relative slip amplitude. From the experimental results it was observed that in case of specimens tested with pads of 1mm, 2mm and 3mm foot height the fretting fatigue life deceased with decrease in pad foot height. But for pad with no foot (0mm foot height), the fretting fatigue life was in-between the specimens tested with pads of 2mm and 3mm foot height. From the FEM analysis it was identified that for the specimens tested with contact pads of 1mm, 2mm and 3mm foot height, with decrease in pad foot height the stress at the contact edge increased. But in the case of specimens tested with contact pad of no foot, showed the lowest stress at the contact edge among the specimens tested in present study. To understand the behavior of pad with no foot clearly, FEM analysis were performed with contact pads of different contact widths (4mm, 10mm, 15mm and 20mm). The results indicated the reasonable explanation for both effects of pad foot height and width. Keywords: Fretting fatigue, pad foot height, pad foot width, FEM.

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STUDY ON ADHESIVE STRENGTH CRITERION UNDER COMPLEX STRESSES

Kenji Kaneko — *Tokyo university of science*

In this report?adhesive strength criteria are investigated experimentally and analytically? Both the cylindrical butt joint specimen subjected to various combined tensile and torsion loadings and the round bar butt joint specimen with various angles of interface edge are used for the experiments? Temperature dependency is also investigated? Principal stress, principal strain and von Mises stress distributions at the adhesive interface of these specimens under the critical load are obtained by the elastic-plastic finite element analysis using MARC? As a result, the mean value of von Mises stress distribution at the singularity area is found to be the most dominant factor of adhesive strength? This fact is confirmed also for the strength evaluation of the double lap joint subjected to tension through the additional examination and the corresponding three dimensional elastic-plastic FEM analysis? The critical von Mises stress can be obtained directly by a usual experimental method using a cylindrical butt joint specimen under torsion without any numerical analysis?

MSEC_ICMP2008-72480

MECHANICAL CONSIDERATIONS OF FRETTING FATIGUE STRENGTH & LIFE

Toshio Hattori — *Gifu University*
Minoru Yamashita — *Gifu-University*
Naoya Nishimura — *Meijo University*
Vu Kien — *Gifu University*

Fretting fatigue process have many features such as early stage crack initiation at contact edge, very slow crack propagation and fatigue failure after very long life operation. In previous paper we present new fretting fatigue model which can explain these fretting fatigue features reasonably[1,2]. In this paper we try to explain other many fretting features such as fretting fatigue strength and life dependence on contact pressure, contact edge shapes. Firstly we try to discuss the dependence of fretting fatigue strength/life on contact pressure. In accordance with the increase of the contact pressure the stress concentration at contact edge increase and crack initiation stress level decreased. But to open this small cracks initiated at contact edges more wear or more load cycles are needed. So fretting fatigue strength limit decrease in accordance with the increase of contact pressure and fretting fatigue life increase in accordance with the increase of contact pressure. Then we discuss the fretting fatigue strength dependence on contact edge shape, such as stress release projection or interference of contact edge with stress concentration fillet. And experimental results of fretting fatigue strength improvement with stress release projection can be explained analytically. The two-stage S-N curve can be shown in joint structures, in which contact edge is set near the stress concentration fillet. These feature also can be explained analytically in this paper.

MSEC_ICMP2008-72525

MOLTEN-SHAPE PREDICTION AND FRACTURE-LIFE EVALUATION OF MICRO-SOLDER JOINT IN SEMICONDUCTOR STRUCTURE

Hisashi Tanie — *Hitachi, Ltd.*

The reliability of a micro-solder joint in a semiconductor structure depends on its solder shape. Therefore, many methods of predicting the molten-solder shape have been proposed. However, conventional methods cannot be used to accurately predict the shape of a miniaturized solder. In a miniaturized solder joint, molten solder greatly changes its shape during the reflow process, and even topology changes (e.g., merging with another solder in a neighboring joint or splitting into several pieces) might occur. Conventional methods cannot be used for expressing these phenomena. To predict a miniaturized solder shape, we developed a new shape-prediction method based on the moving-particle semi-implicit (MPS) method. In the MPS method, a continuum is expressed as an assembly of particles. In contrast to finite element analysis (FEA), our new method can easily express large deformation and topology changes because the continuum does not need to be divided into elements. Moreover, we evaluated the fracture life of a solder joint with the predicted solder shape by coupling our shape-prediction method with a crack-propagation analysis method that we also developed. The crack-propagation is used for automatically calculating a crack-initiation point and crack-propagation paths, and the fracture life is evaluated quantitatively. We applied this coupling method to evaluate fracture lives of various solder joints and found that a difference in solder shape caused a difference in crack-initiation points, crack-propagation paths, and fracture lives.

Symp 3-4 SURFACE MODIFICATION TECHNIQUES, WEAR AND TRIBOLOGY

MSEC_ICMP2008-72009

IN SITU OBSERVATION OF DYNAMIC CHEMICAL CHANGES OF ZNDTP ON METAL FRICTION SURFACES.

Keiji Sasaki — *DENSO*
Naruhiko Inayoshi — *DENSO*
Kohji Tashiro — *Toyota Technological Institute*

A new in situ technique to observe the behavior of lubricant molecules on a metal surface during friction has been developed by combining a two-dimensional fast imaging ATR-FTIR (attenuated total reflectionâ□"Fourier transform infrared) spectrometer with temperature-controlled friction apparatus containing a lubricating agent. Using this new system, the chemical and/or physical changes of lubricant molecules have been successfully detected. In this paper, the chemical reaction of ZnDTP during friction is reported with detailed information on time-dependent 2D images of the spatial distribution on a sliding metal surface.

MSEC_ICMP2008-72021

WEAR-PROTECTIVE TRIBOFILMS PRODUCED BY SUPPLYING OXIDE NANOPARTICLES ON RUBBING STEEL SURFACES

Hirotaka Kato — *Fukui National College of Technology*

This study is the first to demonstrate wear-protective tribofilms produced by supplying nanometer-sized oxide particles on rubbing steel surfaces. Particularly, the influence of the type of supplied oxide, atmosphere and applied load in the tribofilm production process, on the behavior of tribofilm formation and the wear of the tribofilms have been investigated in detail. Tribofilms were produced by supplying CuO (mean particle diameter: 48 nm), Fe2O3 (30 nm) or Bi2O3 (51 nm) oxide particles in a normal laboratory atmosphere of air or in a vacuum (8Ã— 10-4 Pa) by using a pin-on-disc friction method. The material used for the pin and disc specimens was normalized 0.45 mass% carbon steel. The produced tribofilms were examined by a CCD microscope and a SEM equipped with an EDX. The wear properties of the tribofilms were tested by using the same pin-on-disc machine in air. It has been found that the tribofilms produced by supplying Bi2O3 particles were thicker and wider compared with those produced by supplying CuO or Fe2O3 particles. The tribofilms produced by supplying CuO, Fe2O3 or Bi2O3 oxide particles reduced the wear considerably. Particularly, the tribofilms produced by supplying Bi2O3 particles on a disc surface showed mild wear throughout the wear test, resulting in a very small wear volume. Moreover, the tribofilms produced in a vacuum showed longer sliding distance of the transition from mild to severe wear than those produced in air, owing to the dense structure and the wide area of the produced tribofilms. The tribofilms produced by supplying Bi2O3 particles at a middle load of 20 N in a vacuum presented the best performance in the wear tests, suggesting that the tribofilms should be produced at a suitable load, which is not too low or not too high.

MSEC_ICMP2008-72027

EXPERIMENTAL INVESTIGATIONS ON WEAR RESISTANCE CHARACTERISTICS OF ALTERNATIVE DIE MATERIALS FOR STAMPING OF ADVANCED HIGH STRENGTH STEELS (AHSS)

Omer Necati Cora — *Virginia Commonwealth University*
Muammer KOC — *Virginia Commonwealth University*

This study is mainly focused on the anti-wear performance evaluation of alternative die materials used in forming of advanced high strength steel sheet blanks especially in auto body structures.

MSEC_ICMP2008-72055

MICRO-FEATURES FORMATION IN INJECTION COMPRESSION MOLDING

Hiroshi Ito — *Yamagata University*
Hajime Suzuki — *Yamagata University*

Thin-wall injection molded products with micro-feature surface were produced by using precision injection compression molding (ICM) process to analyze the effect of molding conditions on the replication of surface pattern and higher-order structure development of products. Compression delay time in ICM, which was defined as to start time after molten resin injection, was the most important for improving flow length. Residual stress was influenced by the compression conditions, and it was increased with increasing the compression delay time. The optical retardation also was influenced by the compression condition. In particular the retardation was decreased at longer delay time. Replication ratio showed higher in comparison with injection molding process. The ratio was also influenced by the compression condition, and the ratio decreased drastically at longer delay time.

MSEC_ICMP2008-72226

WEAR RESISTANCE OF AISI316L STEEL MODIFIED BY PRE-FPP TREATED DLC COATING.

Hiroshi Nanbu — *KEIO University*
Shoichi Kikuchi — *KEIO university*
Yutaka Kameyama — *RIKEN Material Fabrication Laboratory*
Jun Komotori — *KEIO university*

Diamond-Like Carbon (DLC) films are used increasingly for coating of tribological moving components. This is because DLC films have good tribological properties. However, the adhesion of DLC films, especially on steel, is usually poor. In order to improve the adhesion strength of DLC films, fine particle peening (FPP) with SiC shot particles was carried out on AISI316L steel before DLC coating. The surfaces were characterized by scanning electron microscopy (SEM) and energy dispersive X-ray spectroscopy (EDS). To discuss tribological properties of treated surfaces, reciprocating sliding wear tests were also carried out. The FPP treatment increased surface roughness of the substrate and formed Si-rich layer near treated surface. In the case of DLC coated substrate without pre-FPP treatment, the value of friction coefficient suddenly increased after relatively short period of sliding cycles. The increase in friction coefficient was due to the delamination of DLC films by sliding action. In the case of pre-FPP treated and DLC coated substrate, however, lower values of friction coefficient were maintained during whole period of wear tests. Consequently, the higher adhesion strength of DLC films was achieved by increase of surface roughness and the presence of Si-rich layer by pre-FPP treatment.

MSEC_ICMP2008-72232

A COMPARATIVE STUDY ON THE EFFECT OF SURFACE TOPOGRAPHY BY HARD TURNING VERSUS GRINDING ON FRICTIONAL PERFORMANCE AT DRY AND LUBRICATED SLIDING CONTACT

Rahul Waikar — *The University of Alabama*
Y.B. Guo — *The Univ. of Alabama*

Machining-induced surface topography has a significant effect on tribological performance of machined components in sliding contact. However, the effect of different surface topography by turning versus grinding on tribological performance has received very little attention. In this study four types of surface topography by turning and grinding AISI 52100 bearing steel (62 HRc) were prepared and characterized to study its effect on friction and wear in sliding contact. Dry and lubricated reciprocating sliding wear tests with an on-line acoustic emission (AE) sensor were carried out using a ball-on-disk tribometer. The experimental results have shown that: (i) the turned surfaces, regardless of the presence of a white layer, yield smaller friction of coefficients in sliding along feed marks than across sliding at both dry and lubricated conditions. However, the opposite hold true for the ground surfaces; (ii) friction of coefficients (0.6~0.8) at dry conditions is higher for both turned and ground fresh surfaces than their white layer counterparts regardless of sliding direction. At lubricated conditions, Friction of coefficients (0.1~0.12) are smaller for the both turned and ground fresh surfaces than the white layer surfaces in along sliding, while it is equivalent in across sliding; (iii) the trends of acoustic amplitude amplitude are consistent with those of frictional coefficients for the turned or ground surfaces at dry conditions. Similar trends are also true for the turned surfaces at lubricated conditions, but not for the ground surfaces; and (iv) the wear debris on the track may act as solid lubricants to reduce the sliding frictional coefficient. Machining induced white layers leads to a better wear resistance than the fresh surfaces in either along or across sliding.

MSEC_ICMP2008-72240

A METALLIC FOIL THINNING PROCESS USING AN INDIRECT SHOT BLASTING TECHNIQUE

Ken Yamashita — *Nagaoka University of Technology*
Ryo Katsube — *Nagaoka University of Technology*
Masayoshi Ogata — *MACOHO Co.,Ltd.*
Tohru Matsubara — *MACOHO Co.,Ltd.*
Shigeru Nagasawa — *Nagaoka University of Technology*
Yasushi Fukuzawa — *Nagaoka University of Technology*

Shot blasting method is well known as a surface modification and treatment technique without deforming objectives. Generally these abrasive shots are sufficiently small against the objectives, their deformability are usually ignored. However, in case of comparably sized objectives as films, shots are capable of deforming these objectives due to their own grinding and peening effects. Thus shot impacts have a potential to provide effective measures for micro fabrications, in so far as their several effects are exploited intensively and selectively. In this study, we proposed the technique to thinning foils through using a peening effect on shot impact selectively, in such a way that several metallic foils were covered by aramid films and were beaten by shot blasting indirectly. Some metallic foils were successfully thinned to sub-micro meters without damage on the surface. Relative results were compared in terms of hardness and Young's modulus of the materials. Further it was revealed that the additional external tension facilitates the smooth thinning of these films. The thinning rates of blasting under the tensile stress were much faster

than the total rates of the isolated thinning rates of blasting and tensile stress respectively. As a result, it was concluded that the combination of tensile stress and shot impacts led to effective thinning mechanism.

MSEC_ICMP2008-72317

MECHANICAL PROPERTIES AND ATOMIC STRUCTURE OF DIAMOND-LIKE-CARBON FILMS FABRICATED BY UNBALANCED MAGNETRON SPUTTERING

Shinji FUJIMOTO — *Matsushita Electric Works, Ltd.*
Naoto OHTAKE — *Nagoya University*

Relationship between mechanical properties of DLC film prepared by UBM method and bonding structure of carbon atoms in film has been revealed by Raman spectrum analysis. For friction coefficient, which has no stronger relationship with bonding structure than does hardness, changes in sp2 and sp3 bonding components are analyzed using AES-EEFLS spectra measured before and after applying sliding friction. Decrease in amount of sp2 bonding component or disordering of sp2 bond has been confirmed. Content of sp2 bond component in film decreases mainly through migration of graphite component to counter material, so that graphite contents in DLC film and counter material reach equilibrium. This is considered to be one of factors of appearance of low frictional coefficient.

MSEC_ICMP2008-72435

TRIBOLOGICAL PROPERTIES OF SEGMENT-STRUCTURED DLC FILMS COATED ON STAINLESS STEEL SUBSTRATE

Tsuyoshi Kuroda — *Nagoya university*
Mai TAKASHIMA — *Nagoya University*
Naoto OHTAKE — *Nagoya University*
Osamu Takai — *Nagoya University*

Diamond-like carbon (DLC) films have low coefficient of friction against variety of materials and high wear resistance; however, DLCs are often damaged when the DLC film is distorted with deformation of the substrate. 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 the small segments. The purpose of this study is to fabricate S-DLC film on stainless steel substrate and functionalize DLC films on the substrate based on S-DLC film. In this study, fluorocarbon polymer embedded segment-structured DLC (FC-S-DLC) film was fabricated by spraying fluorocarbon polymer into the grooves between the DLC segments. The DLC films were deposited by a RF plasma chemical vapor deposition (CVD) method. Evaluations of tribological properties of these high-functional DLC films were performed under plane contact condition by pin-on-disk (PoD) test. As a result, the S-DLC film exhibited better tribological properties than that of continuous DLC film. Furthermore, the FC-S-DLC coating exhibited the most excellent tribological property among all samples and gave high wear resistance and steady coefficient of friction to stainless steel substrates at a plane contact pressure of 0.16~0.24MPa.

MSEC_ICMP2008-72442

DEVELOPMENT OF ANTIWEAR SHIM INSERTS UTILIZING SEGMENT-STRUCTURED DLC COATINGS

Mai TAKASHIMA — *Nagoya University*
Tsuyoshi Kuroda — *Nagoya university*
Masanori SAITO — *Tokyo Institute of Technology*
Naoto OHTAKE — *Nagoya University*
Makoto MATSUO — *iMott Inc.*
Yoshinao IWAMOTO — *iMott Inc*
Masao KUMAGAI — *Kanagawa Industrial Technology Center*
Makoto Kano — *Kanagawa Industrial Technology Center*
Hiroshi KIMOTO — *Kobe Material Testing Laboratory*
Masaru SHINOHARA — *KURITA SEISAKUSYO Co., Ltd.*

Wear and fretting fatigue are important technological problems in automotive, railway and aerospace fields. The purpose of this study is to find a method of reducing the wear of cast-iron (FCD)/aluminum components, which are usually applied to automotives, and thus extend their lifetime. First, we designed a stainless-steel (SUS) shim that can be inserted between an FCD plate and an aluminum plate. Secondly, we applied diamond-like carbon (DLC) coatings to the shim inserts to prevent the FCD and aluminum plates from wear. We then evaluated the tribological and fatigue characteristics of the shim by a ball-on-disk (BoD) test and a bending fatigue test of up to 1Ã—106 cycles. Each substrate was coated with DLC by Plasma-Based Ion Implantation and Deposition (PBII&D). A unique feature of our shim is that we employed a segment-structured DLC film (S-DLC) as well as a continuous DLC (C-DLC) film. The effect of the DLC coating on reducing the damage to the Al plate was apparent, because the surface roughness of the Al plate abraded with the DLC-coated shim was significantly smaller than that abraded directly with the FCD plate. Moreover, the average damage fraction to the C-DLC coating is approximately twentyfold larger than that to the S-DLC coating. The DLC film suffers severe damage near the bolt hole in the case of a C-DLC coating, whereas the

S-DLC film suffered almost no damage even after 106 bending cycles. From these results we conclude that an S-DLC-coated SUS shim has a marked effect on reducing the wear of Al/FCD components and improving their lifetime.

MSEC_ICMP2008-72524

FRICTIONAL POPERTEIS OF TITANIUM-BORON-NITERIDE COATINGS WITH PREFERRED GRAIN ORIENTATION DEPOSITED BY AIP UNDER DRY CONDITION

Yasuo Tanno — *Sumitmo Heavy Industries Ltd.*
Akira Azushima — *Yokohama Natinal University*

In order to reduce coefficients of friction of TiN coatings, the frictional properties of TiN coatings with the preferred grain orientation deposited by arc ion plating (AIP) have been investigated. It is possible to control the preferred grain orientation of TiN coatings by changing a substrate bias voltage. In a ball-on-disc friction test, the coefficients of friction for TiN coatings with (111) preferred grain orientation are lower (about 0.2) than those (0.5 to 0.8) for TiN coatings with (200) preferred grain orientation. Furthermore, in order to improve the frictional properties of TiN coatings with (111) preferred grain orientation, the frictional properties of Ti-B-N coatings with (111) preferred grain orientation deposited by AIP process have been examined. The coefficients of friction for Ti-B-N coatings with (111) preferred grain orientation is measured by the ball-on-disc friction test. It is found that Ti-B-N coatings with (111) preferred grain orientation are able to maintain low coefficients of friction (about 0.2) under various sliding conditions in comparison with TiN coatings with (111) preferred grain orientation.

MSEC_ICMP2008-72531

NEW MEASUREMENT METHOD FOR ADHESION OF HARD COATING FILM

Kaoru Ikenaga — *Yokohama National University*
Akira Yanagida — *yokohama National University*
Akira Azushima — *Yokohama Natinal University*

Various surface coating technologies have been applied to improve tribological and mechanical properties. For using the surface modified tools and parts under more severe conditions, a thin film with higher adhesion strength are inevitable. In order to measure adhesion of coating films on substrate quantitatively, a new measurement method for adhesion of hard coating film is developed which consist of indentation and AE (Acoustic Emission) system. TiN coatings are deposited using the arc ion plating PVD on substrate of WC-Co are used for specimens. Indentation test is conducted at different film thickness between 3 to 7?m. Two specific loads one is “Cirital load”, the other is “fracture load” are defined. The critical load and fracture load are correlated to initiation of delamination and film fracture, respectively, form results of finite element calculation and SEM observation.

MSEC_ICMP2008-72535

SEGMENT-STRUCTURED DIAMOND-LIKE CARBON COATINGS ON POLYMER CATHETER

Taku Nakagawa — *Nagoya University*
Ryusuke Ohishi — *Nagoya University*
Naoto OHTAKE — *Nagoya University*
Osamu Takai — *Nagoya University*
Nobumasa Tsutsui — *Tokai Medical Products, Inc.*
Yasuhiro Tsutsui — *Tokai Medical Products, Inc.*
Yasuhiro Muraki — *Tokai Medical Products, Inc.*
Jyunpei Ogura — *Tokai Medical Products, Inc.*

Diamond-like carbon (DLC) has remarkable mechanical and tribological properties. Besides those mechanical properties, it is clarified that DLC shows high biocompatibility in recent years. DLC coating can give high strength, abrasion resistance, and biocompatibility for surface of substrates. Hence DLC is a candidate for the coating material for medical devices such as artificial organ, joint, catheter, etc. In the field of intravascular surgery, balloon catheter is used for some surgical techniques i.e. IABP and PTA. In these techniques, abrasion and puncture accidents of balloon catheters occur because there are often hard and sharp tissues of calcified lesion in blood vessel. So it is important to improve tribological property and strength of polymer materials. The objective of this study is to develop safety protection films that enable long term use in human body for implantable medical devices utilizing DLC coatings. In this study, 1) continuous structured DLC (C-DLC), 2) segment-structured DLC (S-DLC), and 3) S-DLC with C-DLC inter layer (Double-Layered DLC) were deposited on polyurethane and nylon sheets that have been used for catheters by a plasma CVD methods. S-DLC is separated like grid by depositing with covering of metallic mesh. Segment size of Small S-DLC is 0.2Ã—0.2mm, and groove width is 0.03mm. And that of Large S-DLC is 1Ã—1mm, and groove width is 0.2mm. The grid-like shape can reduce internal stress in the films and also prevent from deformation of DLCs. The performances of these DLC films are evaluated through three items as follows: 1) tribological property, 2) abrasion-resistance, and 3) puncture-resistance. In addition, Anti-thrombogenicity was

tested by Quartz Crystal Microbalance. As a result, friction coefficient of DLC coated polyurethane sheet is about one-sixth of that of pristine polyurethane sheet, and S-DLC and double-layered DLC showed very low friction coefficient of ?=0.1-0.2. The puncture-resistance of nylon sheets increased 0.2MPa on average by DLC coatings regardless of the film structure. Moreover, S-DLC shows highest performance. And it was clear that DLC can inhibit adsorption of fibrinogen, one of the blood coagulation factors. In conclusion, we succeed to verify that these DLC films can improve tribological property, abrasion-resistance, puncture-resistance, and anti-thrombogenicity of polymer catheters. It can be concluded that DLC itself has an excellent properties as catheter coatings. Moreover, segment-structured DLC films exhibits high performance for protection of polymer material for polymer catheters.

Symp 3-5 DYNAMIC BEHAVIOR OF MATERIALS AND STRUCTURES (in honor of Prof. Shioya and Dr. Ogawa)

MSEC_ICMP2008-72052

CHIP STICK AND SLIP MOTIONS OF A MACHINE TOOL IN THE CUTTING PROCESS

Brandon Gegg — *Texas A&M University*
Steve Suh — *Texas A&M University*
Albert Luo — *Southern Illinois University At Edwardsville*

The two-degree of freedom oscillator is presented to model the dynamics of a machine tool system in the cutting process. The chip dynamics are presented through a discontinuous system with a velocity boundary (frictional force). The closed form solutions are presented for the normalized linear set of ordinary differential equations. The basic mappings are introduced to investigate the stick-slip motion in such a mechanical model. The mapping structures for the periodic motions will be developed. The numerical prediction of the phase trajectory, over a range of the excitation frequency is presented through the discontinuity. The predictions are verified by numerical illustrations of the phase trajectory, velocity and forces time histories. The main contributions are the forces and force product distribution at the switching points for this machine-tool.

MSEC_ICMP2008-72058

VISUALIZATION OF HYDROGEN ACCUMULATION DURING IMPACT DEFORMATION AND FRACTURE OF ALUMINUM ALLOYS

Keitaro Horikawa — *Osaka University*
Hiyoyuki Yamada — *Osaka University*
Kenichi Tanigaki — *Osaka University*
Hidetoshi Kobayashi — *Osaka University*
Masashi Daimaruya — *Muroran Institute of Technology*

Aluminum alloys have been regarded as one of the candidate materials for a high-pressure hydrogen gas container for the fuel cell vehicle. Thus, it becomes important to study the impact properties of the alloys affected by hydrogen. In order to understand the effect of hydrogen on impact properties, application of the hydrogen visualization method would be also useful. In the present study, hydrogen accumulation during the impact test of aluminum alloys was investigated by means of hydrogen microprint technique (HMT), together with sprit Hopkinson pressure (SHPB) method. Prior to the impact test, hydrogen was charged into the plate type test pieces from the air atmosphere with a relative humidity of 90% (RH90) in the course of slow strain rate testing (SSRT) at room temperature. Then, the test pieces were covered with a liquid nuclear emulsion containing AgBr crystals and gelatin using a wire loop method. After the impact tests, test pieces were dipped into formalin and immersed in a fixing solution. Distribution of silver particles, which represent points of hydrogen emission, was observed with the scanning electron microscopy (SEM) equipped with an energy dispersive X-ray spectrometer (EDXS). When the 7075-T6 aluminum alloys were pre-strained (~5.5%) by SSRT in RH90, marked decrease of ductility was observed in the impact test. Hydrogen accumulation during the impact test was identified particularly around intermetallic phases.

MSEC_ICMP2008-72095

IMPACT LATERAL COMPRESSION TESTS OF THIN-WALLED CIRCULAR TUBE FILLED WITH ALUMINUM FOAM

Hidetoshi Kobayashi — *Osaka University*
Keitaro Horikawa — *Osaka University*
Masahiro Hori — *Osaka University*
Kinya Ogawa — *Space Dynamics Laboratory*
Masashi Daimaruya — *Muroran Institute of Technology*

Lightweight structures such as thin-walled tube, reinforced thin plates, honeycomb sandwiched plates etc. are strongly required not only in aerospace engineering but also in railway and/or automotive engineering to reduce running

cost and CO2 emission. In order to absorb impact energy, the plastic deformation and buckling of thin-walled tubes are often used. In the axial crush of thin-walled tubes, however, the high initial peak load and the relatively wide change of the load are usually observed, which are inconvenient to design the members for energy absorption because they has to crush to protect other important structures such as a cabin. The deformation of circular tubes in lateral compression is relatively smooth deformation without any characteristic changes in the load as seen in their axial compression, although the amount of energy absorption in lateral compression of tubes is not so large as the case of axial loading. In this study, the impact deformation of thin-walled circular tubes filled with aluminum foam in lateral compression were investigated using a special load cell and a high speed camera. Aluminum foam cylinder was inserted into a circular tube to increase the absorbed energy. It was found that the absorbed energy up to the deformation of 60% of the specimen diameter obtained from impact tests is greater than that obtained in static tests, because of strain rate sensitivity of aluminum foam. The load-displacement curve of a circular tube with an aluminum foam cylinder just inserted was consistent with the sum of the curves individually obtained. However, the load of the tube with the foam inserted and glued by adhesive resin observed in the lateral compression tests became larger than the sum of the individual loads, because of the interaction between the circular tube and the aluminum foam cylinder.

MSEC_ICMP2008-72148

MATERIAL DUCTILITY OF PP/SEBS/SIO2 NANOCOMPOSITES AT IMPACT LOADING

Hiroyuki Mae — *Honda R&D Co., Ltd.*
Masaki Omiya — *Keio University*
Kikuo Kishimoto — *Tokyo Institute of Technology*

This study investigates the effects of SiO2 nanoparticles on the mechanical properties of the thermoplastic polypropylene (PP) blended with two different styrene-ethylene-butadiene-styrene tri-block copolymer (SEBS) at the intermediate and high strain rates. Tensile tests are conducted at the nominal strain rates from 3 x 10^-1 to 10^2 s^-1. Phase morphology is investigated by transmission electron microscopy (TEM). The fracture surfaces are observed by scanning electron microscopy (SEM) to investigate the fracture mechanisms. In addition, the finite element (FE) analyses are carried out by applying the elastoviscoplastic constitutive law with craze nucleation and growth in the plane strain morphological model. The elastic modulus increases only when nanoparticles are blended in the small-diameter SEBS blended PP. Decreases in the rupture strain and the strain energy up to failure are prevented for the blend system where nanoparticles are blended in the large-diameter SEBS blended PP. These experimental observations and the numerical simulation result indicate that the nanoparticles located inside rubber particles should lead to the ductile fracture mechanism while the nanoparticles located outside rubber particles lead to the debonding sites between SiO2 particles and PP matrix because of the stress concentration around them. The synergistic effect of these nanoparticles gives importance to the location of nanoparticles in PP/ SEBS blend systems and the stiffness of SEBS particle.

MSEC_ICMP2008-72149

COMPARISON OF TENSILE AND DART IMPACT PROPERTIES IN POLYPROPYLENE SYNTACTIC FOAMS

Hiroyuki Mae — *Honda R&D Co., Ltd.*
Masaki Omiya — *Keio University*
Kikuo Kishimoto — *Tokyo Institute of Technology*

This study attempts to characterize the mechanical properties of the thermoplastic syntactic polypropylene (PP) foams at the intermediate and high strain rates. In addition, it is investigated how the mechanical properties are influenced by the micro porous shape under tensile and dart impact loadings. Tensile tests are conducted at the nominal strain rates from 3 x 10^-1 to 10^2 s^-1. Moreover, the dart impact tests are conducted at the impact velocities of 0.1, 1 and 10 m/s. Then, the microstructural finite element (FE) analysis is conducted to characterize the local stress states in the microstructure. The apparent elastic modulus is not influenced by the shape of the micro pores in the PP matrix at the wide range of strain rate while the shape of the micro pores have some effect on the macroscopic yield stress. The material ductility is strongly influenced by the shape of the micro pores in the PP matrix. This is because the magnitude of the localized stress in the ligaments between the elliptical-shape micro pores is much larger than that in the ligaments between the spherical micro pores. In the dart impact loading, the microstructure of pores has strong effect on the absorbed energy. This is because the elliptical micro pores are much more sensitive to the shear deformation than the spherical micro pores.

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EFFECTS OF STRAIN RATE AND TEMPERATURE ON COMPRESSIVE PROPERTIES OF STARCH-BASED BIODEGRADABLE PLASTICS

Masahiro Nishida — *Nagoya Institute of Technology*
Noriomi Ito — *Nagoya Institute of Technology*
Hiroyuki Kawase — *Nagoya Institute of Technology*
Koichi Tanaka — *Nagoya Institute of Technology*

The effect of strain rate on compressive properties of starch-based biodegradable plastics (Nihon Cornstarch Co., CPR-M2) was examined. Dynamic stress-strain curves of starch-based biodegradable plastics were measured over a wide range of strain rates from 10^-5 s^-1 to 10^4 s^-1, using a quasi-static compression testing machine and a split Hopkinson pressure bar (SHPB) method. The strain rate slightly affected Young's modulus and considerably increased 7% flow stress. Empirical equation for 7% flow stress was derived for the strain rates from 10^-5 s^-1 to 10^4 s^-1. In addition, the effect of temperature on Young's modulus and flow stress was also examined in a range from 277 K to 336 K. A master curve of 7% flow stress, reduced to 297 K, was made. The values of activation energies related to the alpha and beta relaxation processes were respectively estimated from the master curve of 7 % flow stress and from the best fit of equations based on Ree-Eyring theory and Bauwens' treatment. Temperature measurement of specimens was also made using thermocouples during dynamic compression.

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EXPERIMENTAL CHARACTERIZATION OF DYNAMIC MODE II FRACTURE BEHAVIOR OF ZANCHOR REINFORCED CF/EPOXY COMPOSITES USING SHPB TECHNIQUE

Takayuki Kusaka — *Ritsumeikan University*
Kinya Ogawa — *Space Dynamics Laboratory*
Keiko Watanabe — *Osaka University*
Masaki Hojo — *Kyoto University*
Toshiyasu Fukuoka — *Mitsubishi Heavy Industries*
Masayasu Ishibashi — *Shikibo*

Mode II interlaminar fracture behavior of Zanchor reinforced composites was evaluated using the ENF (End Notched Flexure) specimen and the SHPB (Split Hopkinson Pressure Bar) technique. Ramped incident stress wave was utilized for suppressing the high frequency fluctuation of the stress field in the vicinity of the artificial delamination tip of the specimen. The validity of the proposed method was studied on the basis of the experimental and numerical results. The results demonstrated that the mode II energy release rate could be precisely determined by the formula based on the static theory. Loading rate dependence of mode II fracture toughness was not so large for the Zanchor reinforced composites. This tendency was inferred to be a consequence of microscopic fracture behavior of Zanchor reinforced composites.

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THERMAL ACTIVATION THEORY AND HIGH STRAIN RATE DEFORMATION

Kinya Ogawa — *Space Dynamics Laboratory*

Thermal activation theory has been the most fundamental concept to understand the deformation of materials at relatively low strain rates, and it can be applied to interpret high strain rate behaviors of materials. Temperature dependence of strength in materials is greatly concerned from the practical point of view, but it is also relevantly needed to clarify the deformation mechanism based on the thermal activation theory. The present paper describes the basic idea of thermal activation theory and its application together with several experimental verifications. Temperature and strain rate change tests to identify activation parameters and deformation history effects are briefly described, and temperature measurements during high strain rate deformation to detect adiabatic heating effect is also explained. Deformation characteristics of aluminum alloys, titanium alloys and steels in wide range of temperature and strain rates are experimentally investigated and are explained in conjunction of thermal activation theory. In the case of titanium alloys temperature and strain rates history effect is not significant and so called deformation map is constructed solely based on the thermal activation theory. Adiabatic heating effect inevitably encountered in high strain rate deformation especially at low temperature is also confirmed in titanium alloys and high strength steels, but heat conversion ratio of plastic deformation depends on the materials and the amount of plastic strain. Effect of heat treatment on the strength of materials is also studied from metallurgical point of view, and deformation behaviors are clarified in connection with individual characteristics of their microstructures. Transition from thermal activation process to viscous drag-controlling process is discussed and is predicted.

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DAMPED VIBRATION RESPONSE AT DIFFERENT SPEEDS OF WIRE IN SLURRY WIRESAW MANUFACTURING OPERATIONS

Chunhui Chung — *Stony Brook University*
Imin Kao — *Stony Brook University*

Wiresaw has become a standard slicing tool especially for large ingots in the wafer preparation industry since late 1990s. To meet the requirements of the surface finish and topology, it is critical to control the process parameters to render good surface finish and to minimize kerf loss. The vibration of moving wire in the wiresaw manufacturing operation affects the wafer surface finish and kerf loss; therefore, the study and analysis of vibration of moving wire become very important and relevant to this manufacturing process. Built on the previous research, the free vibration response of axially moving wire with damping is a combination of infinite sets of response solutions, with trigonometric functions due to end constraints. The apparent damping due to the increase of speed on the first several components of responses will be presented and discussed in this paper. The results also show that the increase in speed will excite components of response except the dominating one. Since the free vibration response is a combination of infinite sets of solutions, it is not possible for the system to be completely critically-damped or over-damped because of the existence of under-damped modes at higher order. Therefore, a damped index is introduced to help in understanding the behavior of such system. When the physical damping is increased (for example, by using a more viscous carrier fluid in slurry), all components are more damped accordingly. However, in addition to the physical damping, the apparent damping caused by the increase of wire speed will also damp out the response. These two parameters, physical damping and apparent damping, control the behavior of an axially moving wire. This is a new finding in vibration analysis of moving wire that, to our best knowledge, has not been reported in the previous literature.

MSEC_ICMP2008-72313

A GEOMETRICALLY COMPREHENSIVE APPROACH TO MODELING DYNAMIC CUTTING FORCES IN TURNING: APPLICATION TO REGENERATIVE CHATTER

Adam Cardi — *Georgia Institute of Technology*
Matthew Bement — *Los Alamos National Laboratory*
Steven Liang — *Manufacturing Research Center (MaRC), Georgia Institute of Technology*

Present chatter models in turning lack physical insight because they do not model the process in a geometrically rigorous manner. Many of the models are linear and produce unrealistic, unbounded vibration amplitude growth after the onset of chatter. Those that are nonlinear are typically reverse engineered in order to predict bounded vibration. The current approach models the forces in machining due to chip formation, plowing, and interference between the flank of the cutting tool and the machined workpiece surface in a geometrically comprehensive fashion. Additionally the effects of strain, strain rate and temperature on the chip formation process are captured. In doing so, accurate predictions can be made for both the occurrence of chatter and its vibration amplitude growth over time. The proposed model is validated with machining experiments on a compliant workpiece to explore the effect of tool nose radius on chatter.

MSEC_ICMP2008-72337

EFFECT OF OUTPUT BAR SUPPORTING METHODS ON HIGH VELOCITY TENSILE BEHAVIOR FOR STEEL PLATE

Masaaki Itabashi — *Tokyo University of Science, Suwa*

In order to obtain precise and correct dynamic stress-strain behavior for steel plate, the split Hopkinson (Kolsky) bar method or the one bar method has been adopted as a testing method. In these two methods, a dynamic load transducer is thin steel bar(s). On the input and output bars, typically two or four strain gages are adhered at the same distance from the end of them to detect strains of the bars as dynamic load signal. The bars are usually mounted on simple supports, allowing a little axial elongation of the bars. Then, ball bearings or polytetrafluoroethelene parts are frequently installed between the bars and supports. Because, the friction between them will affects on quality of the dynamic load signal. On the other hand, only for the one bar method, it is reported that a relatively tight support, neighboring the loading end of the output bar, is effective to reduce an initial stress peak on dynamic stress-strain curve. In this paper, some trials have been carried out to find the optimum supporting condition for the output bar loading end of the one bar method. An impact block is connected to a plate specimen assembly. The other end of the assembly is an extension of the output bar. Usually, from the end of gage length of the specimen plate, there is no output bar support within approximately 650 mm. This situation is designated as “no support”. At a location of 60 mm from the end of the gage length, an additional simple output bar support is introduced. This situation is called as “simple support”, because the output bar is left on the V-shaped top of the support. Two additional upper supporting parts can be installed to the simple support condition. After the installation, a square hole is formed on the top of the additional support. The output bar is touched by four sides of the hole. This situation is called as “surrounding support”. In addition, specimen assembly types are also included in experimental conditions. Shapes of obtained stress-strain curves in each experimental condition are compared each other, and also compared with that by the split Hopkison bar method. Two experimental conditions are recommended to detect acceptable stress-strain relationships for steel plate.

MSEC_ICMP2008-72401

HIGH STRAIN-RATE COMPRESSIVE STRESS-STRAIN LOOPS OF SEVERAL PLASTICS

Kenji NAKAI — *Okayama University of Science*
Takashi YOKOYAMA — *Okayama University of Science*

Polymeric materials have extensively been used as car components in automotive industry. To date, their mechanical properties have been evaluated primarily under quasi-static loading conditions. A precise knowledge of their mechanical behavior under impact loading is essential for the safety design of car components. However, their dynamic properties have been much less understood, because of the experimental difficulties in impact test methods. In the present work, compressive stress-strain loops of several plastics at strain rates up to 800/s are determined in the standard split Hopkinson pressure bar. Four different commonly used plastics or typical thermoplastics: ABS, HDPE, PP and PVC are tested at room temperature. Cylindrical specimens with a slenderness ratio (= length l /diameter d) of 0.5 are used in the Hopkinson bar tests, and those with l /d = 2.0 as specified in the ASTM Designation E9-89a are used in the static tests. The stress-strain loops in compression at low and intermediate strain rates are measured on an Instron testing machine. The effects of strain rate on the Young's modulus, flow stress at 5% strain and dissipation energy are investigated. It is shown that the area included within the stress-strain loop (or dissipation energy) increases with increasing strain rate as well as given strain, that is, all plastics tested exhibit intrinsic strain-rate dependent viscoelastic behavior and a high elastic aftereffect following complete unloading.

MSEC_ICMP2008-72428

HIGH STRAIN-RATE COMPRESSIVE RESPONSE OF FRICTION STIR WELDED AA2024-T3 JOINTS

Takashi YOKOYAMA — *Okayama University of Science*
Kenji NAKAI — *Okayama University of Science*

Friction stir welding (FSW) is a relatively new technique for joining Al alloys. Unlike traditional fusion welding, FSW is a solid-state joining process that does not melt the base metals, and has the potential to avoid significant change in their microstructure and mechanical properties. The FSW process provides a suitable method for joining some Al alloys such as 2000 and 7000 series Al alloys that are normally un-weldable. In many applications, the welded structures may be subjected to dynamic loading such as impact or explosive as well as static or repeated loading. It is, therefore, important to understand the mechanical properties of FS welded joints at high rates of strain to which the FS welded structures may be subjected during their service life. The objective of the current study is to determine the high strain-rate compressive response of FS welded AA2024-T3 joints using the conventional split Hopkinson pressure bar (SHPB). AA2024-T3 plates of 3.85 mm in thickness were friction stir welded in the butt joint configuration. A fixed set of the FSW parameters is selected from a wide range of the appropriate welding conditions to reduce the number of the tests. After the FSW process, micro-vickers hardness profiles were measured on the cross section perpendicular to the welding direction to identity the microstructural change or the weld nugget (WN), the thermo-mechanically-affected zone (TMAZ) and the heat-affected zone (HAZ). Cylindrical specimens were cut from the weld nugget of the FS welded AA2024-T3 joints and the base material in the through-thickness direction. The compressive stress-strain responses up to strain rates of nearly 1000/s were determined with the SHPB, and those below strain rates of 0.001/s were obtained on an Instron testing machine. The effect of strain rate on the flow stress and strain hardening behavior of both the weld nugget and the base material was examined. It was shown that the FSW process reduces the flow stress of the base material by nearly 7 to 10 % due to the localized heating generated during welding. It was also shown that the flow stress of the weld nugget increases very slightly with strain rate, while its strain hardening rate does not vary with strain rate. The possible reasons for the reduction in the flow stress of the weld nugget were discussed from a microstructural point of view.

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VISCOELASTIC ANALYSIS OF DYNAMIC BEHAVIOR OF MATERIALS

Toshifumi Kakiuchi — *The University of Elctro-Communications*
Tadashi Shioya — *Nihon University*
Koji Fujimoto — *The University of Tokyo*
Masanao Sekine — *The University of Tokyo*

The internal friction of engineering materials at elevated temperature and under impact loading is investigated analytically and experimentally. A composite sphere model in the microstructure is established to describe the viscoelastic behaviors of materials. From this model, a two-parallel-Maxwell-body mechanical model is deduced and used to explain the test results of internal friction. The viscoelatic behaviors is studied by the method of split Hopkinson pressure bar at elevated temperature. A method to determining the internal friction is suggested and the internal friction of materials are evaluated.

Symp 3-6 ADVANCES IN NONDESTRUCTIVE EVALUATION AND MONITORING TECHNIQUES

MSEC_ICMP2008-72421

DAMAGE DEGREE EVALUATION OF IRON AND NICKEL THIN FATIGUE SPECIMENS USING EMAT FOR AN S0-LAMB WAVE AND AN SH0-PLATE WAVE

Riichi Murayama — *Japan/Fukuoka Institute of Technology*
Yusuke Okawa — *Fukuoka Institute of Technology*
Yuta Ito — *Fukuoka Institute of Technology*
Tomoaki Nagai — *Fukuoka Institute of Technology*

When an ultrasonic wave is injected into a crack, if the width of the crack opening is of almost the same order of magnitude as the displacement of the ultrasonic wave, the crack may be closed or opened. When the crack closes, a portion of the ultrasonic beam can through the crack. On the other hand, the ultrasonic beam will be reflected. As a result, the waveform of the received ultrasonic wave is slightly deformed from that of the incident ultrasonic wave. This interaction between a minute crack and an ultrasonic beam is called the nonlinearity of an ultrasonic wave. The deformation of the wave form of the received ultrasonic wave is detected by evaluating the power spectrum. Especially, it is proposed that the harmonic frequency component changes be evaluated as it penetrates the crack. However, its variation is very small and the nonlinearity between a liquid material and an ultrasonic wave was greater than that of a solid material, a liquid material needs to be used as a coupling medium when we use a piezoelectric-type ultrasonic transducer. We then attempted to evaluate its nonlinearity by applying an electromagnetic acoustic transducer (EMAT), which does not require a coupling medium. We made the trial EMAT that could alternately drive an S0-Lamb wave and an SH0-plate wave and developed a method to detect the harmonic components in the received ultrasonic wave. We then evaluated if the EMAT could detect the harmonic components using the fatigue specimens we fabricated. As a result, we observed that the harmonic components increased when we used a specimen with a specific loading condition and confirmed that there were correlations between the amplitude of the harmonic components and the damage rates of the test piece. This indicated that the harmonic component detection using the EMAT could also provide useful information about the degree of damage of any structure or any material.

MSEC_ICMP2008-72455

ULTRASONIC IN-SITU MONITORING OF TEMPERATURE GRADIENT INSIDE MATERIALS DURING HEATING AND COOLING

Manabu Takahashi — *Nagaoka University of Technology*
Ikuo Ihara — *Nagaoka University of Technology*

A new ultrasonic method for monitoring the temperature gradient inside a material being heated and cooled is presented. The principle of the method is based on the temperature dependence of ultrasonic velocity in a material. An effective inverse analysis coupled with a finite difference calculation has been developed to determine the one-dimensional temperature gradient inside a thick plate. To verify the validity of the developed method, experiments have been performed: a single side of a steel plate of 30 mm thickness is heated by contacting with a heater of 200 ÂºC and subsequently cooled down by water. Ultrasonic pulse-echo measurements are then performed for the steel during the heating and cooling. A change in the transit time of longitudinal ultrasonic waves across the steel is continuously acquired and used to determine the temperature gradient inside the steel. The temperature gradient and its transient variation determined by the developed ultrasonic method almost agree with those obtained using thermocouples installed in the steel.

MSEC_ICMP2008-72465

VISUALIZATION OF GUIDED WAVE PROPAGATION FROM DEFECTS IN A PIPE

Nor Salim Muhammad — *Nagoya Institute of Technology*

Guided wave inspection has become commonplace in screening plates and pipes. However, guided wave reflections from defects are not clarified due to complicated mode conversions. This paper describes the visualization technique for guided wave propagation in pipes with a defect. Waveforms in the vicinity of a defect in a pipe were collected on whole circumferential positions using a laser vibrometer equipped with a robot arm, and the guided wave propagation is visualized using the collected signals. Since the reflected waves from defects are not clearly shown due to interferences with incident guided wave, a signal processing technique was carried out to emphasize only reflected waves. As a result, it was found that reflected guided waves from an oblique defect propagate in the spiral direction on a pipe

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EFFICIENT GENERATION AND DETECTION OF A GUIDED WAVE IN A PIPE USING GUIDED WAVE REFLECTORS

Hideo Nishino — *The University of Tokushima*
Yasuhisa Kato — *The University of Tokushima*
Yasuhiro Tanaka — *The University of Tokushima*
Kenichi Yoshida — *The University of Tokushima*

A simple and effective method for generation and detection of a guided wave in a pipe was proposed using an iron hose-fixing belt as a reflector of the guided wave. The reflector is located n?/2 (n = 1,2,3,,,) apart from a guided wave sensor in axial direction for the effective generation or detection. In above reflector setting, large amplitude is obtained because multiple-reflection between the reflector and the sensor occurs under phase matching conditions. In this paper, the principle of the method was first described. Experiments were carried out with the non-dispersive T(0,1) mode to verify the principle in comparison to a simple theory.

MSEC_ICMP2008-72486

QUANTITATIVE EVALUATION OF THE BLOCKING RATIO OF A BLOCKAGE INSIDE A PIPE UTILIZING FILM-TYPE PZT ELEMENTS

Hideo Cho — *Aoyama Gakuin university*
Takahiro Abe — *Aoyama Gakuin University*
Takuma Matsuo — *Aoyama gakuin university*

We quantitatively estimated the location and area fraction of a model blockage inside a pipe utilizing guided waves propagating in a liquid inside a pipe. The guided wave was excited and detected by film-type PZT elements wounded around an external pipe surface. Location of the blockage can be estimated from an arrival time of the wave reflected by the blockage and measured propagation velocity. The blocking ratio can be also estimated by comparing the measured amplitude to the predicted one when the profile of the blockage was roughly evaluated prior to the measurement. We also discussed the effect of the flow rate on the amplitude of the reflected wave.

MSEC_ICMP2008-72487

EVALUATION OF BOND STENGTH OF NI-P-SIC ELECTRONIC PLATING BY LASER SPALLATION TECHNIQUE

Tomonari Uchiyama — *Jaoan, Aoyama Gakuin univ.*
Hideo Cho — *Aoyama Gakuin university*
Takeshi Ogawa — *Aoyama Gakuin Univ.*

We used the laser spallation technique to estimate a distribution of the bond strength of the Ni-P-SiC plating on an aluminum alloy plate. Strong tensile wave produced by laser ablation of black ink was utilized for exfoliating a surface layer. The critical tensile wave causing the delamination of the surface layer was determined by the surface displacement of the sample excited by laser ablation when the dalmination occurred. For detecting the initiation of the delamination without observing cross-section of the sample, we utilized non-linearity of ultrasonic at the interface between a surface layer and substrate with defects. As a result, the bond strength of Ni-P-SiC plating used in this study was estimated as from 95 MPa to more then 110 MPa. This modified technique enables us to estimate a distribution of the bond strength with high spatial resolution.

MSEC_ICMP2008-72526

TOOL WEAR MONITORING USING TIME SERIES ANALYSIS

Dongyeul Song — *Gunma Industrial Technology Center*
Yasuhiro Ohara — *Kuramae Industries Co. Ltd*
Haruo Tamaki — *Mathematical Assistance Design Laboratory*
Masanobu Suga — *Mathematical Assistance Design Laboratory*

The monitoring of machining abnormal and the surface state estimation of the machined products during cutting operation are indispensible to the stability and the automation of manufacturing process as well as the high machining accuracy. However, this abnormal monitoring technique is greatly influenced by machining environment such as cutting tool, work material and cutting conditions, and consequently is not yet sufficiently available in the actual machining field. Recently, we examined from the viewpoint of time series analysis the correlation among the mechanical model of cutting process, its corresponding time series model and the surface roughness of the machined workpiece, and showed that the change in the cutting resistance and the surface state of workpiece during cutting can be estimated by the time series parameter obtained from the measured vibration signal. However, the

nonlinear behavior of the cutting mechanism become remarkable due to severe wear, chip friction, and/or localized chipping at the edge of cutting tool, and accordingly the measured signal wave exhibits the increasing of its random irregular component. Thus, the machining abnormal during cutting may not be monitored accurately by the change in the linear time series parameter. In this study, the tool wear monitoring approach considering this nonlinear behavior caused by tool wear and/or localized tool failure during cutting is newly proposed, and its effectiveness is verified through the cutting experiment. Consequently, it is found that the early tool wear state, i.e. flank wear under 40 micrometer, can be monitored, and also the variation of surface roughness Pz in the range of 3 to 8 micrometer can be estimated.

Symp 3-7 CONDITION-BASED AND PREDICTIVE MAINTENANCE FOR MANUFACTURING EQUIPMENT AND SYSTEM

MSEC_ICMP2008-72030

IDENTIFYING CORRELATIONS BETWEEN INDEPENDENT SETS OF MAINTENANCE AND MANUFACTURING QUALITY DATA

Hany El-Gheriani — *Queen's University*
Guillaume Graton — *Ecole Centrale de Marseille*
Martin Guay — *Queen's University*
Jorge Arinez — *General Motors R&D Center*

Effective equipment maintenance is essential for a manufacturing plant seeking to produce high quality products. The impact of equipment reliability and quality on throughput have been well established, however, the relationship between maintenance and quality is not always clear or direct. This paper describes a statistical modeling method that makes use of a Kalman filter to identify correlations between independent sets of maintenance and quality data. With such a method, maintenance efforts can be better prioritized to satisfy both production and quality requirements. In addition, this method is used to compare results from the theoretical maintenance-quality model to data from an actual manufacturing system. Results of the analysis indicate the potential for this method to be applied to preventive as well as reactive maintenance decisions since ageing aspects of equipment are also considered in the model.

MSEC_ICMP2008-72297

FEATURE-BASED TOOL CONDITION MONITORING IN A GEAR SHAVING APPLICATION

Adam Brzezinski — *University of Michigan, Ann Arbor*
Yong Wang — *Huazhong University of Science and Technology*
D. K. Choi — *Kangnung National University*
George Qiao — *University of Michigan, Ann Arbor*
Jun Ni — *University of Michigan*

Condition monitoring (CM) is an effective way to improve the tool life of a cutting tool. However, CM techniques have not been applied to monitor tool wear in an industrial gear shaving application. Therefore, this paper introduces a novel, sensor-based, data-driven, tool wear estimation method for monitoring gear shaver tool condition. The method is applied on an industrial gear shaving machine and used to differentiate between four different tool wear conditions (new, slightly worn, significantly worn, and broken). This research focuses on combining, expanding, and implementing CM techniques in an application where no previous work has been done. In order to realize CM, this paper discusses each aspect of CM, beginning with data collection and pre-processing. Feature extraction (in the time, frequency, and time-frequency domains) is then explained. Furthermore, feature dimension reduction using principal component analysis (PCA) is described. Finally, feature fusion using a multi-layer perceptron (MLP) type of artificial neural network (ANN) is presented.

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SMART MACHINE HEALTH AND MAINTENANCE: TOOL ASSEMBLY PROGNOSTICS

Edzel Lapira — *University of Cincinnati*
Amit Deshpande — *TechSolve, Inc.*
Jay Lee — *University of Cincinnati*
John Snyder — *TechSolve, Inc.*

It is well established that unbalance in the tool assembly causes excessive loads on spindle bearings, tool wear and increased vibration levels. However in the days where High-Speed Machining (HSM) has become a common practice in the manufacturing industry, methodologies to measure tool assembly unbalance are not developed. In HSM the situation is worse as the unbalance force is directly proportional to square of the spindle speed. The common practice in industry is to balance the tool assembly either with in-house balancing machines or use third-party

balancing services after every batch cycle. This paper describes a data driven methodology developed to detect the presence of unbalance in a tool assembly relative to the tools with known balance levels. The unbalance detection prognostic application developed as part of the Smart Machine Platform Initiative (SMPI) checks for the threshold unbalance level in the tool assembly for the given machining requirements before the start of any run. This approach uses statistical tools and a supervised learning algorithm based on the Watchdog AgentÂ® toolbox developed by the Center for Intelligent Maintenance Systems. The proposed research finds high applicability in high precision manufacturing operations involving high-volume production.

MSEC_ICMP2008-72511

REAL-TIME DIAGNOSTICS, PROGNOSTICS & HEALTH MANAGEMENT FOR LARGE-SCALE MANUFACTURING MAINTENANCE SYSTEMS

Leandro G. Barajas — *General Motors R&D*
Dr. Narayan Srinivasa — *HRL Laboratories, LLC*

Traditional technologies emphasize either experience or model-based approaches to the Diagnostics, Prognostics & Health Management (DPHM) problem. However, most of these methodologies often apply only to the narrow type of machines that they were developed for, and only support strategic level assessments as opposed to real-time tactical decisions. By enabling widespread integration of diagnostics and prognostics into our manufacturing business processes, we have reduced spacio-temporal uncertainties associated with future states and system performance and therefore enabled more informed and effective decisions on manufacturing activities. For large-scale systems, the usual approach is to aggregate multidimensional data into a single-dimensional stream. These methods are generally adequate to extract key performance indicators. However, they only point to observable effects of a failure and not to their root causes. An integrated framework for DPHM requires the availability of bidirectional cause-effect relationships that enable system-wide health management rather than just predicting what its future state would be. This paper summarizes best practices, benchmarks, and lessons learned from the design, development, deployment, and execution of DPHM systems into real-life applications in the automotive industry.

MSEC_ICMP2008-72529

MODEL AND INFORMATION THEORY BASED DIAGNOSTICS FOR MACHINERY AND GEARS

Michael Bryant — *University of Texas at Austin*
Ji-Hoon Choi — *Samsung Electronics Co., LTD*

Machines focus power. We view a machine as a "machine communications channel," wherein components along the channel organize power and information flow. Errors from broken or degraded components disrupt this organization and the implicit information processing. Our model based diagnostics approach constructs detailed physics models of the machine having direct physical correspondence to components and faults, measures states off the real in-service machine, simulates states and sensor outputs of the machine under same service loads, compares simulated sensor outputs to real sensor outputs, and adjusts (tunes) the model's parameters until simulated outputs closely mimic real outputs. The tuned model now contains information on the real system's health condition. By comparing the numerical values of parameters to those of an ideal modelâ□"â□"an exemplar of perfect healthâ□"â□"faults are detected and located. To assess machine functional condition, Shannon's theorems of information theory are applied as a health metric to the machine communications channel. For prognosis of future health, plots of the model's parameter values extrapolated forward in time predicts future parameter values. Simulation of the machine channel model predicts "future" machine behavior, and future machine functional condition, using the aforementioned methods. This article applies these methods to a gearbox with tooth root cracking.

Symp 3-8 QUALITY CONTROL IN MULTISTAGE MANUFACTURING SYSTEMS

MSEC_ICMP2008-72147

IMPROVING CHUCKING ACCURACY AND REPEATABILITY BY REDUCING KINEMATIC REDUNDANCY

Jeongmin Byun — *St. Cloud State University*
Richard Liu — *Purdue University*

In this paper, the effect of kinematic redundancy on chucking, especially, on the positioning accuracy of a

cylindrical workpiece was investigated. No previous research on the effect of kinematic redundancy on the positioning accuracy and the repeatability of a workpiece in chucking has been reported, even if kinematic principle has been known for a long time. Starting from the description of the issues, a series of systematic experiments were carried out. It was demonstrated that the non-repeatability and the chucking error proportionally increase as the kinematic redundancy increases. Also, it was shown that kinematic redundancy had a significant effect on the positioning accuracy of chucked workpieces, especially the workpieces with a relatively higher length/diameter ratio. The contact area between the workpiece and the jaws was reduced to the extent which does not hurt the chucking rigidity and safety to reduce kinematic redundancy. It was shown that the concentricity of the workpieces was improved as much as 10 times by just minimizing the kinematic redundancy in the finish hard turning of the rings of a taper roller bearing.

MSEC_ICMP2008-72443

ALLOCATION OF FLEXIBLE TOOLING FOR OPTIMAL STOCHASTIC MULTISTATION MANUFACTURING PROCESS QUALITY CONTROL

Yibo Jiao — *University of Texas at Austin*
Dragan Djurdjanovic — *University of Texas at Austin*

Stream of Variance (SoV) modeling of multi-station manufacturing process has been studied for the past 15 years and was used for identification of root causes of manufacturing errors, characterization and optimal allocation of measurements in multi-station manufacturing processes, process-oriented tolerance allocation, and most recently, for optimal in-process adaptations of programmable, flexible tooling (flexible fixtures, CNC machines) for autonomous minimization of errors in dimensional product quality. However, due to the high expense of flexible tooling, it is plausible to strategically position such devices across a manufacturing system in a way that one's ability to mitigate quality problems is maximized. In this paper, a distributed stochastic feed-forward control method is devised which gives the optimal (in least square sense) reduction of the variance-covariance matrix of errors in dimensional workpiece quality in a multi-station manufacturing process with a limited number of flexible tooling components. A Genetic Algorithm is proposed to enable optimal allocation of flexible tooling devices. Theoretical results have been evaluated and demonstrated using the SoV model of a real industrial process.

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ENHANCING SAFETY IN MANUFACTURING SYSTEMS BY INTEGRATING DIAGNOSTIC INFORMATION

Kyle Schroeder — *University of Michigan*
Aftab Khan — *University of Michigan*
James Moyne — *University of Michigan*
Dawn Tilbury — *University of Michigan*

Integrating traditionally separate industrial control systems can derive factory-wide benefits by leveraging more information about the ongoing process. This paper shows that connecting a networked safety system and a process control system leads to an extension of the individual benefits provided by each system. A safety system gains the ability to protect not only the machines and workers but also the product that is being built. A diagnostic system can also raise safety alarms when a process variable is outside the expected range of safe operation. This connection is explored to determine the practical impact of different methods of integration on machining and system processes. Three integration methods are possible depending on which portions of the system can be classified as "safe". A case study integrating a diagnostics system as a non-safe sensor proves that this connection, when it is implemented on an industrial testbed, provides all of the benefits described and does not require significant changes to control software

MSEC_ICMP2008-72478

DESIGN OF A STAMPING TEST FOR INVESTIGATING SURFACE DISTORTION IN SHEET METAL PARTS

Zhengchun Fu — *Jilin University*
Ping Hu — *Dalian University of Technology*
Hui-Ping Wang — *General Motors*
Kunmin Zhao — *General Motors*

Surface distortions/deflections are frequently introduced into the Class "A" surfaces during sheet metal stamping processes. However, the origins of the draw die related surface distortion/deflection have not been well understood. This paper presents our design of a stamping test for the investigation of the distortion phenomenon. Five geometric parameters are first identified to represent basic geometry of typical automobile outer panel depression features around the surface distortions. Experimental stamping dies are then designed to reflect various combinations of these five geometric parameters with the assistance of numerical simulations to ensure that the designed dies are able to replicate the surface distortion phenomenon. Also, real-time dynamic measurement techniques are designed to collect historical data of strains and deflection on the stamping panels. Our preliminary tryouts show that the designed stamping test successfully replicates the distortion

phenomenon observed in production stamping processes. It provides a platform for the investigation of the root-cause of the draw die related surface distortions.

Track 4 Micro and Nano Technologies

Symp 4-1 MEMS AND NEMS APPLICATIONS

MSEC_ICMP2008-72349

DEVELOPMENT OF MICRO METALLIC VALVE FOR MTAS

Ming YANG — *Tokyo Metropolitan University*
Satoshi Ogata — *Tokyo Metropolitan University*
Arata KANEKO — *Tokyo Metropolitan University*
Keisuke YAMOTO — *Tokyo Metropolitan University*

Fabrication and Application of MEMS (Micro Mechanical Electro system) for biological and chemical analysis attract attention in this decade. The conventional process based on silicon process has its limitation for fabrication these devices. Development of MEMS based on micro metal forming was proposed by authors. In this study, a micro metallic valve was designed and fabricated. All of the parts are made of metals, and assembled in a unit. Sheet metal with thickness of 20 mm was used as valve plate. Sheet metal forming was applied to form the 3D structure, and Surface treatment with plating and SAM coating was carried out in order to compensate the surface roughness and to improve sealing property of valve. An equipment was developed for evaluating flow resistance of the valve. The influence of surface conditions on the valve properties including surface roughness, mechanical properties of surface coating was investigated experimentally. A model of micro flow between two walls with various surface roughness and surface tensions in a gap of several micron was proposed and simulated by a FEM code. Evaluation of the properties shows that the surface treatment is very effective to compensate the surface roughness and the valve is highly functional. Keywords: Micro Metallic Valve, Micro forming, surface treatment, Evaluation equipment References [1] M. YANG, “Fabrication of MEMS Using Micro Metal Forming Process”, Proc. ICNFT, (2004),pp.135-140. [2] Kinuko FUJIMOTO, Ming YANG etc., Fabrication of Dies in micro â□“scale for micro sheet metal forming, Journal of Material Processing Technology, Vol. 177, No. 1-3.

MSEC_ICMP2008-72351

NANOSTRUCTURED SURFACE BY SELF-ASSEMBLY OF CARBON NANOTUBES FOR BIO-ANALYSIS

Ryuuichi Kobayashi — *Tokyo Metropolitan University*
Ming YANG — *Tokyo Metropolitan University*

Nanomaterials have played a key rule in the development of electronic, biological, chemical, and medical application, and especially, Carbon nanotubes (CNTs) attract attention in these years. CNTs electrodes, reactor has been applied to electrode of fuel cell, reaction field of biosensor, and so on. On the other hand, the development of lab-on-a-chip (LOC) devices, a parallel term to “micro total analysis systems (?TAS),” for biochemical analysis has seen an explosive growth over the past decade. The LOC is now widely used in biology and biotechnology; applications include analysis (of DNA and proteins), high throughput screening, and chemical reactions. Various bio-substances are often analyzed by detecting the immune-reaction between antigens in sample solution and antibodies immobilized on microchannel surface using fluorescence detection, surface Plasmon resonance method. In these cases, the detection depends on the surface significantly. Design and creation of surface with larger reaction field could be one of most important issues in LOC or ?TAS. In this study, we attempted to design and create a surface with CNTs, which has high-aspect ratio in order to create a much wider reaction field on the surface for biological application. Multi-wall carbon nanotubes (MWNTs) were synthesized on Si/SiO2 substrate by ACCVD (Alcohol Catalytic Chemical Vapor Deposition). And trail CNTs well was carried out. The MWNTs were vertically aligned on the surface, and its structure and characteristics, such as wettability, were evaluated. The surface with MWNTs was also treated by Au coating and plasma irradiation to be hydrophilic. One of the important characteristics is deformation of reactor structure, which was contacted by pure water before and after. Experiment of dropping water on the MWNTs and drying was carried out, and the changes in structure and characteristics of MWNTs were evaluated by using scanning electron microscope (SEM). The results show that surface with MWNTs film behaved like super-hydrophobic surface before plasma treatment, but behaved super-hydrophilic after the treatment. Furthermore, MWNTs with plasma treatment bundled each other after dropping water and drying, and we found CNT moved after dropping water. These results have shown that high dense CNT could be realized for micro reactor and CNT interconnect.

MSEC_ICMP2008-72355

WELDING OF METALLIC FOIL WITH ELECTRON BEAM

Hiroki Ogawa — *Tokyo Metropolitan University*
Ming YANG — *Tokyo Metropolitan University*
Yukiko Matsumoto — *Tokyo Metropolitan University*
Wei Guo — *Tokyo Metropolitan University*

Fabrication of Micro Electrical Mechanical Systems (MEMS) and other micro devices by using metallic materials attracts attention in this decade. Metallic materials have the high strength, ductility, conductivity as well as good biocompatibility, such as Ti alloy and Stainless steel, in comparison to silicon and polymers. Furthermore, metallic materials are adaptive to mass production by using metal forming. Micro metal forming for production of small parts has been investigated, such as micro piercing, micro drawing, and micro forging. For fabrication of micro devices, jointing of small parts will be important. However, it is difficult to joint parts in the case of parts in micron size due to the size effect, and researches on micro joint are few. In this study, micro electron beam welding is applied to jointing of two metallic foils. Electron beam is adapted to micro welding due to its advantages on deep penetration and thin width. Material used is SUS, Ti with thickness of 20?m. Relationship between input energy of electron beam irradiation and size of welding spot was investigated. Furthermore, spot welding and overlap welding were carried out for same materials and difference materials. Surface and cross section of welded zone were observed by using scanning electron microscope (SEM) or confocal laser scanning microscope (CLSM). As the results, in the case of same materials, 20?m thickness of Ti/Ti was possible. On the other hand, in the case of difference materials, 20?m thickness of SUS/Ti was possible. The results show that micro welding could be a new technology for MEMS in addition to microfabrication.

MSEC_ICMP2008-72404

A CYLINDRICAL ULTRASONIC LINEAR MICROACTUATOR

Sheng Wang — *Tokyo Institute of Technology*
Doingming Sun — *Tokyo Institute of Technology*
Seiichi Hata — *Tokyo Institute of Technology*
Shimokohbe Akira — *Tokyo Institute of Technology*

A new kind of ultrasonic microactuator, called cylindrical ultrasonic linear microactuator (CULMA), is introduced, including the structure of the CULMA, the driving principle, the design, the manufacture process and the experiments of CULMA. CULMA is composed by a hollow cylindrical stator and a slider pipe is inserted outside of the stator. The total size of CULMA is about 2mm in diameter and 12 mm in length. The cylindrical stator is a double-pipe structure, which is consisted of a hollow cylindrical piezoelectric ceramic pipe (PZT pipe) and an elastic material-thin film metallic glass pipe (TFMG pipe) deposited on the outer surface of the PZT pipe. The vibration of the TFMG pipe generates an elliptical motion on the contact surface, which drives the slider to move linearly in axial direction. The driving principle of CULMA is simulated and confirmed using FEM software, getting the elliptical motion on the surface of the TFMG pipe in specific driving frequency. When fabricating the stator, the annealing problem and the etching hole influence the stiffness of the TFMG pipe, based on the experiment result, the actual equivalent Young's modulus is confirmed. Then the new prototype of the CULMA is redesigned based on the new data and property is improved. In the experiments, the linear motion of the slider pipe is observed, the motion of the slider pipe driven by the elliptical motion is identified, and the motion is measured.

MSEC_ICMP2008-72491

FABRICATION AND FLUID EJECTION PERFORMANCE OF HOLLOW MICRONEEDLE ARRAY FOR CELLULAR FUNCTION ANALYSIS

Takayuki Shibata — *Toyohashi University of Technology*
Norihisa Kato — *Toyohashi University of Technology*
Takahiro Sakai — *Toyohashi University of Technology*
Takahiro Kawashima — *Toyohashi University of Technology*
Mitsuyoshi Nomura — *Toyohashi University of Technology*
Takashi Mineta — *Hirosaki University*
Eiji Makino — *Hirosaki University*

In order to implement cellular function analysis on a chip-based system, we have been developing microneedle arrays capable of introducing desired biomolecules (nucleic acids, proteins, etc.) into living cells and extracting biomolecules expressed in the cells. An array of hollow silicon dioxide (SiO2) microneedles with a sharp tip radius of less than 0.5 Âμm was successfully fabricated by using microelectromechanical system (MEMS) technology. In order to examine the possibility of liquid delivery with fabricated SiO2 microneedles, water ejection tests were conducted. The preliminary tests showed ejection of water through microneedles with approximately 3.5 Âμm in inner diameter. Moreover, the flow rate increased in proportion to the fourth power of the inner diameter of the needles that is subject to the Hagen-Poiseuille's equation.

Symp 4-2 ADVANCES IN MECHANICAL MICROMACHINING

MSEC_ICMP2008-72028

EFFECT OF CARBON NANOTUBE (CNT) LOADING ON THE THERMO-MECHANICAL PROPERTIES AND THE MACHINABILITY OF CNT-REINFORCED POLYMER COMPOSITES

Johnson Samuel — *University of Illinois at Urbana Champaign*
Ashutosh Dikshit — *University of Illinois at Urbana Champaign*
Shiv Kapoor — *University of Illinois at Urbana-Chamapign*
Richard E. Devor — *University of Illinois at Urbana Champaign*
Jimmy K. Hsia — *University of Illinois at Urbana Champaign*

The machinability of carbon nanotube (CNT)-reinforced polymer composites is studied as a function of CNT loading, in light of the trends seen in their material properties. To this end, the thermo-mechanical properties of CNT composites with different loadings of CNTs are characterized. Micro endmilling experiments are also conducted on all the materials under investigation. Chip morphology, burr width, surface roughness and cutting forces are used as the machinability measures to compare the composites. For composites with lower loadings of CNTs (1.75% by weight), the visco-elastic/plastic deformation of the polymer phase plays a significant role during machining, whereas, at loadings > 5% by weight, the CNT distribution and interface effects dictate the machining response of the composite. The ductile-to-brittle transition and reduction in fracture strength that occurs with an increase in CNT loading, results in reduced minimum chip thickness values, burr dimensions and cutting forces in the CNT composite. The increase in thermal conductivity with the increase in CNT loading, results in reduced number of adiabatic shear bands being observed on the chips and reduced thermal softening effects at high cutting velocities. Thus, overall the increase in CNT loading improves the machinability of the composite.

MSEC_ICMP2008-72121

WEAR SIGNAL MEASUREMENT OF MICRO-END MILL USING WAVELET ANALYSIS

Jeong-Bin Park — *Seoul National University*
Yeong-Seon Hong — *Seoul National University*
Jin-Woong Kim — *Seoul National University*
Jun-Cheol Yeo — *Seoul National University*
Kyung-Tae Lee — *Seoul National University*
Jae-Seuk Park — *NEO Technical System CO., LTD.*
Young-Man Cho — *Seoul National University*
Sung-Hoon Ahn — *Seoul National University*

Tool breakage poses a major problem for mechanical micro-tools. Although the prediction of tool wear is important in the scheduling of tool change and maintaining productivity,the life of micro-tools is generally predicted statistically based on data from experimental machining trials. In this study, force signals were observed during machining using a micro-end mill. The relationship between these signals and the wear of the micro-end mill was investigated using wavelet analysis. Printed Circuit Board (PCB) substrate materials were used as a workpiece, and cutting forces were measured with a dynamometer. To determine the difference between worn and unused tool conditions, the continuous wavelet transform was applied to the force signals that were measured by the dynamometer. The signals from the worn and unused tools had a different dominant frequency or scale. As the machining cutting length increased, the variation in dominant frequency could be identified by wavelet analysis.

MSEC_ICMP2008-72138

MICRO ULTRASONIC MACHINING USING OIL BASED ABRASIVE SLURRY

Murali Sundaram — *University of Nebraska-Lincoln*
Sreenidhi Cherku — *University of Nebraska-Lincoln*
K.P. Rajurkar — *University of Nebraska-Lincoln*

Advanced engineering materials posses excellent properties such as high wear resistance, and inertness to corrosion and chemical reactions. Since these materials are usually hard, brittle, chemically inert, and electrically nonconductive, they pose serious machinability challenges. Micro ultrasonic machining (Micro USM) is an emerging method for the micromachining of hard and brittle materials without any thermal damage. This paper presents the results of micro ultrasonic machining using oil based abrasive slurry. Details of the in-house built experimental setup used to conduct the experiments are explained. The influence of process parameters such as slurry medium,

slurry concentration, and abrasive particle size on the performance of micro USM are reported. It was noticed that the evidence of three body material removal mechanism is predominant for micro USM using oil based slurry. In general, the material removal rate increases with the increase in the abrasive particle size for both aqueous abrasive slurry and oil based abrasive slurry. Further, material removal rate is consistently higher for experiments conducted with aqueous abrasive slurry medium. On the other hand, it is noticed that the oil based slurry medium provides better surface finish. It is also noticed that the smaller abrasive grains provide better surface finish for both aqueous, and oil based abrasive slurry mediums. Role of slurry concentration is ambiguous, as no clear trend of its effect of on process performance is evident in the available experimental results.

MSEC_ICMP2008-72262

INVESTIGATION OF OPTIMAL PARAMETER SPACE FOR HIGH-SPEED, HIGH-PRECISION MICROMILLING

J.Rhett Mayor — *Georgia Institute of Technology*
Angela Sodemann — *Georgia Institute of Technology*

In this paper, it is shown that due to scale effects in micromilling, tool size is a key parameter to consider in parameter optimization for productivity in a high-speed, high-precision micromilling operation. In this preliminary study, a method is proposed to determine the optimal tool sizes for roughing and finishing cuts in a micromilling operation, and corresponding feedrate and spindle speed profiles to maximize productivity. An objective function is developed for minimization, subject to a set of constraints. This paper will develop the framework of the optimization method and will consider constraints for sufficient reduction of geometric errors and achievability under spindle speed power limitations in particular. An algorithm is presented to solve the objective function assuming use of a roughing tool and a finishing tool. A numerical case study is presented to illustrate the implementation of the method.

MSEC_ICMP2008-72533

MOLECULAR DYNAMICS SIMULATION OF NANOMETRIC MACHINING UNDER REALISTIC CUTTING CONDITIONS

Rapeepan Promyoo — *IUPUI*
Hazim El-Mounayri — *IUPUI*
Xiaoping Yang — *Cummins Inc.*

Molecular Dynamics (MD) simulations of nanometric machining of single-crystal copper were conducted at a conventional cutting speed (5m/s) and different depths of cut (0.724 â“ 2.172 nm). The simulations were carried out to predict cutting forces and investigate the mechanism of chip formation at the nano level. The effect of tool rake angles and depths of cut on the mechanism of chip formation were also investigated. Tools with different rake angles, namely 0°, 5°, 10°, 15°, 30°, and 45°, were used. It was found that the cutting force, thrust force, and the ratio of the thrust force to cutting force decrease with increasing rake angle. However, the ratio of the thrust force to the cutting force is found to be independent of the depth of cut.

Symp 4-3 LASER MICROMACHINING TECHNOLOGY AND ITS APPLICATIONS

MSEC_ICMP2008-72195

ESTIMATION OF TEMPERATURE DISTRIBUTION IN SILICON DURING MICRO LASER ASSISTED MACHINING.

Kamlesh Suthar — *Western Michigan University*
John Patten — *Western Michigan University*
Lei Dong — *Condor USA, Inc.*
Hisham Abdel-Aal — *University of Wisconsin at Platt*eville

Silicon is machined using a diamond tool and the process is assisted with an IR Laser for the purpose of heating and thermal softening the work piece material. The laser beam passes through the tool and into the work piece, where the material is both thermally heated (by the laser) and mechanically deformed (by the tool). The laser is used to increase the work piece temperature (up to the softening temperature of silicon, about 500-800oC [10]), while the tool deforms and cuts the heated and softened silicon in the ductile regime, without producing cracks. This hybrid laser assisted machining process results in a smooth plastically deformed surface and extends the life of the diamond tool when cutting a hard and abrasive material, e.g. silicon.. Scratch tests were done using the micro laser assisted machining method with diamond tools, which demonstrated enhancement in the depth of cut from 60 nm to 120 nm with (a 2x increase in depth of cut, at a constant load) while the cutting speed varied from 0.305 mm/sec to 0.002 mm/s. An analytical and numerical method was used to estimate the temperature rise in the vicinity of the diamond tool due to laser irradiation and absorption by the

silicon work piece. It is assumed that the layer of silicon that absorbs the heat from the laser radiation is silicon II. Silicon II is a metallic phase of silicon, commonly referred to as the beta-tin structure, formed by a high pressure phase transformation (HPPT). In this context, the analytical and numerical models are solved using the heat conduction equation for semi-infinite solid over time with a Gaussian laser beam intensity distribution. The temperature rise for different cases (laser intensity, depth of cut, cutting speed, etc.) was modeled using point, and plane heat source method with Gaussian intensity distribution. These results are discussed in detail to estimate the temperature distribution while machining

MSEC_ICMP2008-72246

AN EXPERIMENTAL EVALUATION OF LASER ASSISTED MICRO-MILLING OF TWO DIFFICULT TO MACHINE ALLOYS

Jonathan Shelton — *Purdue University*
Yung Shin — *Purdue University*

due to a variety of scaling induced factors including: low cutting speeds, high relative tool deflections and runout, and increased material strength at smaller size scales. Additionally, edge burrs which can easily be removed after macro scale milling must be avoided in micro-milling due to the lack of available finishing operations. Laser assisted machining (LAM) involves localized heating of the work material prior to the cutting tool. This localized heating thermally weakens the workpiece resulting in lower cutting forces, improved surface finish, and longer tool life. Applying this concept to micro-milling offers the opportunity for process improvements, especially with materials which are considered difficult to machine. Laser assisted micro-milling (LAMM) was evaluated on Ti-6Al-4V and 316 stainless steel alloys using 100 Âµm diameter endmills in slotting operations. Micro-scale laser-material interactions were first studied with bulk material absorptivity being determined experimentally through a novel technique utilizing several calibrated melting mediums. A three-dimensional transient finite volume based thermal model was then used to analytically predict appropriate process parameters on the basis of material removal temperatures. A thorough investigation of acoustic emissions (AE) during LAMM was performed. In particular, the effects of depth of cut, tool wear, and material removal temperature on the RMS of AE were studied. Additionally, the effect of LAMM on the machined surface was evaluated quantitatively.

MSEC_ICMP2008-72247

MICROMACHINING OF METALS, ALLOYS AND CERAMICS BY PICOSECOND LASER ABLATION

Wenqian Hu — *Purdue University*
Yung Shin — *Purdue University*
Galen King — *Purdue University*

Microhole drilling and microstructure machining with a picosecond (ps) Nd:YVO4 laser (pulse duration of 10 ps) in metals, alloys and ceramics are reported. Blind and through microholes were drilled by percussion drilling as well as trepanning drilling. The diameters of the holes were in the range from 30 Âµm to 1000 Âµm. Microfeatures were machined and the flexibility of ps laser machining was demonstrated. The quality of drilled holes, e.g., recast layer, microcrack and conicity, and that of the microstructures, were investigated by optical microscope, surface profilometer, or scanning electron microscope (SEM). Ps laser ablation rate was investigated by experiments as well as a simplified laser ablation model.

MSEC_ICMP2008-72505

PULSED LASER MICRO POLISHING OF MICROFABRICATED NICKEL AND TI6AL4V SAMPLES

Tyler Perry — *University of Wisconsin-Madison*
Dirk Werschmoeller — *University of Wisconsin-Madison*
Xiaochun Li — *University of Wisconsin-Madison*
Frank Pfefferkorn — *University of Wisconsin-Madison*
Neil Duffie — *University of Wisconsin-Madison*

The objective of this work is to improve our understanding of pulsed laser micro polishing (PL?P) by studying the effects of laser pulse length, pulses per mm, and workpiece material on surface roughness. PL?P experiments are conducted with a multi-mode Nd:YAG laser (1064 nm wavelength) that is focused down to approximately 50 ?m diameter and scanned over the stationary workpiece surface. Simulation results presented here and previous work suggest that longer laser pulses are better for polishing. Results on microfabricated nickel samples using laser pulse lengths of 300 ns and 650 ns test this hypothesis. Additionally, a surface artifact introduced by the PL?P process will be investigated. Results on the microfabricated nickel sample prove that longer laser pulses yield a higher reduction in surface roughness; 300 ns and 650 ns pulses reduce the Ra of the sample by 30% and 50%, respectively. The artifact introduced by the PL?P is found to be directly related to the number of laser pulses per mm. Successful polishing is achieved on Ti6Al4V and the surface roughness (Ra) of the sample is reduced from 0.250 ?m to 0.058 ?m. It is also shown that the presence of

argon shielding gas is necessary to avoid surface cracks. The results presented here further validate the simplified thermal and fluid flow modeling of the PL?P process and demonstrate the effectiveness of PL?P on a broadly used titanium alloy, Ti6Al4V.

Symp 4-4 MINIATURIZATION OF MOLDING PROCESSES FOR MICROFABRICATION

MSEC_ICMP2008-72017

MECHANICAL PROPERTIES AND FRACTURE MECHANISM OF CF FLAT BRAIDED COMPOSITES WITH DISPERSED CARBON NANOFIBERS IN THE MATRIX

Yuka Kobayashi — *Kyoto Institute of Technology*
Mohamed S. Aly-Hassan — *Kyoto Institute of Technology*
Asami Nakai — *Kyoto Institute of Technology*
Hiroyuki Hamada — *Kyoto Institute of Technology*
Hiroshi Hatta — *Institute of Space and Astronautical Science (ISAS), Japan Aerospace Exploration Agency (JAXA)*

In laminated flat braided composites there are no fibers through the thickness direction except at the edges due to the fiber continuity of the braiding technique. A delamination along the interlaminar planes can be propagated because of the lack of fibers in the Z- or third-direction to the composite. The delamination initiates essentially as a result of arising the stresses concentrations around the transverse or matrix cracks that appear due to the mismatch of the thermal expansion coefficients of the fibers and matrix during the fabrication process. The delamination renders low interlaminar composite properties and represents a fundamental weakness of laminated flat braided composites especially with increasing the braiding angle, and thus minimizes the shear stress transfer. In this research, laminated flat braided carbon fabrics were performed via flattening tubular braided fabrics with braiding angle of Â±45o by applying carefully compressive loads laterally on the tubular fabrics. Then, carbon fiber reinforced composites were fabricated from the above-mentioned biaxial fabrics with and without uniformly dispersed carbon nanofibers throughout the matrix. Three loading percentages of carbon nanofibers (specifically, 0.5, 1, and 2 wt%) were dispersed in the matrix of the composites to enhance the matrix and interlaminar/inter-ply properties. The influence of matrix and interlaminar properties improvements on the in-plane tensile and shear response of the laminated flat braided composites was clarified via conducting of Â±45o laminates tensile tests. The experimental results of tensile tests revealed that the tensile and in-plane shear properties as well as the fracture behavior of the composites are substantially influenced by the incorporation of the dispersed carbon nanofibers in the matrix of the composites. A pulsed thermography technique was used to inspect the occurrence of the delamination after the fracture under tensile loadings. The thermal wave image and logarithmic temperature-time curves of the pulsed thermography inspection illustrated that the composites with dispersed carbon nanofibers rendered higher interlaminar properties than that of composites without nanofibers. The main conclusion of this research can be summarized that dispersion of carbon nanofibers through the epoxy matrix of laminated flat braided composites is not only enhanced the matrix properties but also improved the interphase morphology between the composite plies that maximized the stress transfer of the composites. In other words, the fabricated braided composites with braiding angle of Â±45o are predominantly by both of matrix and interlaminar properties.

MSEC_ICMP2008-72048

DISCRETE MICROPARTS PRODUCTION USING THROUGH-THICKNESS HOT EMBOSSING AND RUBBER-ASSISTED EJECTION

Ramasubramani Kuduva-Raman-Thanumoorthy — *Georgia Institute of Technology*
Donggang Yao — *Georgia Institute of Technology*

The hot embossing process has so far been mainly developed for replication of surface structures on thermoplastic substrates. Because of the lack of a through thickness action, fabrication of discrete microparts such as microgears is considered difficult. In this study, an embossing mold having 13 microcavities was used in a through-thickness embossing process with a rubber-assisted ejection mechanism. Microparts made of HDPE and ABS with each part weighing approximately 0.9 and 1.4 mg respectively were produced. When in the mold, embossed microparts were intermittently connected to each other through thin residual films of a thickness approximately 20-30 ?m on one surface. The residual films were detached from the microparts during ejection. Because no resin delivery path, e.g., runner and gate, is needed for microcavities on the mold, this micropart fabrication process could replace micro injection molding in numerous applications.

MSEC_ICMP2008-72056

PARTICLE DISTRIBUTION AND MECHANICAL PROPERTIES OF SILICA-FILLED PMMA MICRO-INJECTION MOLDINGS

Yew Wei Leong — *Kyoto Institute of Technology*
Supaporn Thumsorn — *Advanced Fibro Science, Kyoto Institute of Technology*
Asami Nakai — *Kyoto Institute of Technology*
Hiroyuki Hamada — *Kyoto Institute of Technology*
Hiroshi Ito — *Yamagata University*
Kohji Yoshinaga — *Kyushu Institute of Technology*

Micro-injection moldings of poly(methyl methacrylate) filled with silica of various particle sizes ranging from 5 to 50 mm were fabricated. The distribution of the silica particles throughout the moldings was found to be significantly different, i.e. a more homogeneous distribution of fillers was evident as particle size decreases. Fracture properties, fracture surface appearance and transparency were significantly affected by the state of filler distribution.

MSEC_ICMP2008-72092

SMALL SCALE MOLDING SYSTEM FOR THERMOPLASTIC MATERIALS USING STRONG ULTRASONIC VIBRATION

Takushi Saito — *Tokyo Institute of Technology*
Motoki Noko — *Tokyo Institute of Technology*
Tatsuya Kawaguchi — *Tokyo Institute of Technology*
Isao Satoh — *Tokyo Institute of Technology*

In this study, strong ultrasonic energy was experimentally used to directly heat the polymeric material to lower the energy consumption and to reduce the volume of waste material. To study the feasibility of the present technique, a test molding system was experimentally built. An oscillator and a horn of commercial ultrasonic welding device were used as the plasticizing unit. They were installed in the experimental system that equips the molds into where the molten polymer is filled. Rod shaped poly(methyl-methacrylate) having certain length was used as the processing material. Pushing force during the processing was controlled by a feedback system. By actually operating the system, the polymer melt flow in the mold cavity was observed and the micro-scale transcription was investigated. The temperature of the molten polymer reached higher than 200 deg. C, and it was high enough to flow the tested material. And the cavity having 10 mm length, 4.5 mm width and 0.2 mm thickness was successfully filled with the test material. It was also shown that microstructure of 60 microns patterns were almost completely replicated on the molded product surface, and the process time was only 0.5 s.

MSEC_ICMP2008-72093

EFFECT OF TOOLING SURFACE ROUGHNESS IN MICRO INJECTION MOLDING

SuNG-HWAN YOON — *University of Massachusetts Lowell*
Nam-Goo Cha — *Northeastern University*
Jisun Im — *University of Massachusetts Lowell*
Xugang Xiong — *Center for High-rate Nanomanufacturing*
Jun Lee — *University of Massachusetts Lowell*
Joey L. Mead — *Plastics Engineering*
Carol M. F. Barry — *Plastics Engineering*

Quality of tooling surface has been considered as one of the important factors defining the injection molded part quality. Therefore, surface polishing has been an important and relatively expensive step in conventional mold making process. Although the poor surface quality impacts the product quality when molding macroscale parts, it becomes more significant with sub-micrometer features. Previous micro injection molding research result has indicated that rough tooling surface may cause polymer adhesion on the tooling surface. To evaluate the effect of roughness, optical grade polycarbonate was molded using silicon inserts with artificially generated surface roughness (root-mean-square roughness: 3~143 nm) by dry etching. The silicon and molded parts surface were characterized using atomic force and scanning electron microscopy. Filling and ejection of the parts as well as residual polymer on the tooling correlated surface roughness of the tooling.

MSEC_ICMP2008-72128

VISCOELASTICITY EFFECTS OF POLYMERIC MATERIAL IN MICRO INJECTION MOLDING

Peiman Mosaddegh — *clemson university*
David C. Angstadt — *clemson university*

An experimental study has been carried out to determine the effect of viscoelasticity in comparison to viscosity on micro-injection molded parts. In this study, two different polymeric materials- Polystyrene (PS) as a viscous material and High Density Poly-Ethylene (HDPE) as a viscoelastic material- have been selected to observe the effect of melt elasticity on the filling phase of micro molding based on cavity pressure of molded part. All process parameters except temperature are the same for both polymers. Process temperatures have been selected in order to match the viscosity for both polymers used. Polymer viscosity was characterized at different shear rate and temperature. Viscoelasticity of both polymers were investigated using

rotational rheometry in the oscillation mode. The mold geometry with high aspect ratio has been used and the effect of viscoelasticity on cavity pressure has been discussed. It was observed that there is retardation on the response of pressure because of elastic response of material during filling. Despite the differences in slope, peak value, area, and cycle time between two curves, they share similar trends. The only difference is their response during solidifying because of material property.

MSEC_ICMP2008-72237

FABRICATION OF METALLIC STAMP WITH 30 NM HOLE ARRAY USING UV NANOIMPRINTING AND NANOELECTROFORMING

Jeongwon Han — *Yonsei University*
Jungmo Yang — *Yonsei University*
Byung Soo William Lee — *Yonsei University*
Shinill Kang — *Yonsei University*

With increasing demands for products with nano scale patterns manufactured by nanoreplication processes such as nanoinjection molding, nanoimprinting, and etc, fabrication of molds or stamps with nano patterns has become a priority for successful manufacturing of nano patterned products. In this study, a metallic stamp with nano hole array pattern was fabricated by ultra-violet (UV) nanoimprinting process and nanoelectroforming process. For the fabrication of the original silicon master, electron-beam (E-beam) lithography and inductively coupled plasma (ICP) etching process were used. Polymeric nano pillar array pattern, called polymeric master, was replicated from the original silicon master by UV nanoimprinting process. For the successful demolding during UV nanoimprinting process, self assembled monolayer (SAM) of fluoroctatrichlorosilane (CF3(CH2)8SiCl3) was deposited on the original silicon master. With this approach, the expensive silicon master could be reused many times as a master mold. Nickel seed layer as conductive layer was deposited onto the polymeric master using sputtering process. Nanoelectroforming process using nickel sulfamate solution (Ni(NH2SO3)2â□¢4H2O) was carried out to fabricate the metallic nano stamp. Metallic nano stamp which has hole array pattern with diameter of 30 nm and pitch of 50 nm was successfully fabricated by the proposed method. Nanoinjection molding of 30 nm pillar array pattern as a nano data storage media using the present metallic stamp is the subject of ongoing research.

MSEC_ICMP2008-72458

DYNAMIC MOLD TEMPERATURE CONTROL USING GAS-ASSISTED HEATING AND ITS EFFECT ON THE MOLDING REPLICATION QUALITIES OF MICRO CHANNELS

Shia-Chung Chen — *Chung Yuan Christian University*
Yaw-Jen Chang — *Chung Yuan Christian University*
Jen-An Chang — *Chung Yuan Christian University*
Hsin-Shu Peng — *Chung Yuan Christian University*
Ying-Chieh Wang — *Chung Yuan Christian University*

Dynamic mold surface temperature control (DMTC) has the advantage of improving molded part qualities without significant increases in cycle time. A gas-assisted heating system combined with water cooling was developed to achieve DMTC for injection molding. With gas-assisted heating, it takes 2s for the mold surface temperature to vary from 60 oC to 120 oC whereas it requires 186s using water heating. Further, it takes 21s and 84s for the mold surface to cool to 60 oC under gas heating and water heating, respectively. The gas-assisted heating system also shows excellent efficiency for micro injection molding of biochips to achieve high replication accuracy of the micro channels.

MSEC_ICMP2008-72459

THERMAL REFLOW PROCESS FOR GLASS MICROLENS MANUFACTURING

Yang Chen — *The Ohio State University*
Allen Yi — *The Ohio State University*
Donggang Yao — *Georgia Institute of Technology*
Fritz Klocke — *Fraunhofer Institute for Production Technology*
Guido Pongs — *Fraunhofer Institute for Production Technology*

This fabrication process includes three major steps, i.e., fabrication of glassy carbon molds with arrays of micro size holes, glass compression molding to create micro cylinders on glass substrate, and reheating to form microlens arrays. As compared to traditional polymer microlens arrays, glass microlens arrays are more reliable and therefore could be used in more critical applications. In this research, microlens arrays with different surface geometries were successfully fabricated on P-SK57 (Tg = 493 ÂºC) glass substrate using a combination of compression molding and thermal reflow process. The major parameters that influence the final lens shape, including reheating temperature and holding time, were

studied to establish a suitable fabrication process. A numerical simulation method was developed to evaluate the fabrication process.

Symp 4-5 MICRO/MESOSCALE MANUFACTURING CHALLENGES IN MATERIAL HANDLING

MSEC_ICMP2008-72225

ACTIVE FIXTURING FOR MESOSCALE MANUFACTURING SYSTEMS: FIXEL DESIGN ALTERNATIVES

Gloria Wiens — *University of Florida*
Koustubh Rao — *University of Florida*
Troy Rippere — *University of Florida*

This paper presents an investigation of fixel design alternatives for active (dynamic) fixturing to be incorporated into mesoscale manufacturing systems. Using simple compliant mechanisms and components (e.g., monolithic four-bar mechanisms and/or cantilever beams), fixels exhibiting mechanically adjustable stiffness characteristics are achievable. Manually or automating the stiffness adjustments, these fixels provide a functionality for enabling greater control of the dynamic response of the workpiece due to vibrations and variation in contact forces at the tool-workpiece-fixture interface. To quantify the fixel functionality and its dynamic range, this paper presents the theoretical models of the stiffness characteristics expressed as a function of each fixel design's mechanical variables. Upon establishing a common stiffness range for the different fixel designs, a metric is formed based on the sensitivity of stiffness expressed as a function of slenderness ratio and an operation range, bounded by a maximum possible stiffness value shared by all fixture models. Using this metric, results are generated to delineate the advantages and disadvantages of each design and their potential impact on fixturing and material handling in the creation of micron features on micro and macro parts.

MSEC_ICMP2008-72472

MODELING AND PREDICTION OF THE FLOW, PRESSURE AND HOLDING FORCE GENERATED BY A BERNOULLI HANDLING DEVICE

Xavier F. Brun — *Georgia Institute of Technology*
Shreyes N. Melkote — *Georgia Institute of Technology*

This paper presents the modeling and prediction of the air flow, pressure and holding force produced by a non-contact Bernoulli gripper, which is essentially a radial air flow nozzle, used to handle small and large, rigid and non-rigid materials. Previous studies have demonstrated the turbulent behavior of the flow and the presence of a flow separation region at the nozzle of the gripper. Here, a Reynolds stress model has been implemented in a finite volume based segregated Reynolds-Averaged Navier-Stokes solver. Compressible air is modeled to capture the effect of the high flow velocities generated by the nozzle. In addition an experimental set up is designed to validate the model. Experimental results of air pressure and force agree favorably with those predicted by the model. This model could be used to understand the influence of handling variables such as the stand-off distance and air flow rate on the suction pressure distribution and lifting force acting on the handled object.

MSEC_ICMP2008-72485

AN INNOVATIVE POLYMERIC MATERIAL FOR MICROHANDLING

Claudia Pagano — *ITIA-CNR*
Irene Fassi — *ITIA-CNR*

The rationales for the use of microsystems are numerous, including the reduction of consumables (less chemicals in Lab-on-a- Chip), a faster response time (airbag sensors), the enhanced portability (RF-MEMS), the higher resolution (Inkjet printer head), and the higher efficiency (micro-chemical reactor); moreover their application sectors are numerous. For this reason, during the past decades many improvements have been done concerning the design and manufacturing of microsystems and several products have been fabricated for a great variety of applications in the traditional fields, including the medical and biomedical sectors (e.g.: pacemakers, analysis equipments, microtweezers for minimally invasive surgery, micro drug delivery systems), automotive (sensors for safety in cars e.g. electrostatic field sensors for controlling airbags), aeronautics and aerospace (lightweight distributed sensors for micro crack detection), IT (ink jet printers, reading caps for hard disk, micropumps for microprocessor cooling) and telecommunication (e.g. micro optical switches) as well as in more innovative areas, such as household appliances,

entertainment and sport equipment (noise canceller ear plugs, variable stiffness tennis racket, skis equipped with piezoelectric active dampers). Nevertheless microproducts have still great difficulty in penetrating the market, mainly due to the limits of the fabrication processes. Indeed, the two main approaches, monolithic and hybrid, show both many issues to overcome. On one side, the monolithic approach has the consolidate expertise of lithographic processes for the manufacturing of electronic devices on one hand, but on the other hand it has the difficulty in producing three dimensional microdevices with good mechanical properties. On the other side, the hybrid approach is suitable for the fabrication of three dimensional microscopic structures but often fails in assembling processes. In order to overcome these issues, new materials have often been studied at microscale to extend the manipulation principles of macroproducts to microsystems (e.g. SMA microgripper), but the techniques imported from the assembly of macro components are, usually, not adaptable for microcomponents, which are subject to very strong superficial forces. Therefore new techniques for the manipulation of microcomponents, based on innovative principles, have been conceived and have to be further developed. In this paper the use of new materials in combination with a new handling principle has been proposed and the characterization of a smart material, which is promising for the assembly of microcomponents, has been presented.

MSEC_ICMP2008-72610

AN MICRO/MESOSCALE MACHINE TOOL BUILDER'S PERSPECTIVE IN FIXTURING

Jim Hall — *Atometric, Inc.*

Industry - Jim Hall, Applications Engineer Ret., Atometric

MSEC_ICMP2008-72611

MICRO-NANO SENSING FOR MICRO/MESOSCALE MATERIAL HANDLING AND FIXTURING

Xiaochun Li — *University of Wisconsin-Madison*

Distributed micro/nano-systems embedded at critical locations but without interfering with normal operation of the structures and their potential impact on micro/mesoscale material handling and fixturing needs.

MSEC_ICMP2008-72621

TECHNICAL CHALLENGES IN MICRO/MESO SCALE PART FIXTURING AND HANDLING

S. Melkote — *Georgia Institute of Technology University*

Providing research perspective of the technical challenges foreseen for micro/meso scale part fixturing and handling.

Symp 4-6 DEVELOPMENT AND APPLICATIONS OF MICRO MANUFACTURING EQUIPMENT

MSEC_ICMP2008-72067

PROTOTYPING OF ELECTRIC TWEEZER-TYPE SOLDERING IRON DEVICE WITH FLEXIBLE FINGERS FOR SMD

Hiroki Ando — *Nagoya Uvinersity*
Takahiko Murakami — *Mitsubishi Electric Corporation*
Naoki Muramatsu — *Nagoya University*

Recently, as typified by mobile phones and personal computers, downsizing of electric components for high density circuit boards supported by surface mount technology (SMT) is remarkable. In the production process of high density circuit boards, defects often occur in surface mount. To defective circuit boards detected in the check process, rework operations are conducted. Rework is an operation to remove a defective surface mount device (SMD) on the circuit board and mount a normal SMD again. As SMDs are downsized, mounting density on circuit boards is increasing, and the distance between SMDs becomes to be narrower. So the difficulty level of rework becomes to be higher. In rework, tweezer-type soldering irons have been used. This type of soldering iron has two heated metal tips. This metal tip is integrated with a heating element. Such a conventional tweezer-type soldering iron for rework has some technical issues as follows: 1) size of tip is not small enough for small SMDs, 2) manual operation of the tweezers is difficult to grip small SMDs, 3) gripping is unstable because of the stiff metal tip, 4) change parts are costly because the metal tip and the heating element are unitized, 5) alignment of the two metal tips is difficult at the time of changing them because they are uncombined. To resolve these technical issues, this paper proposes a new tweezer-type soldering iron device for rework to satisfy the following features: 1) size of tip is small enough for small SMDs, 2) tweezers are motorized, 3) the metal tips are flexible, 4) the metal tip

and heating element are separate parts, and 5) two metal tips are unitized. The proposed device consists of a gripping mechanism and a heat transfer mechanism. A flexible gripping mechanism proposed by one of us is employed as the gripping mechanism. The flexible gripping mechanism consists of unitized flexible fingers and a drive member. This mechanism is very simple and small. Moreover, to heat the tip of the finger, a heat transfer mechanism is proposed. The proposed heat transfer mechanism is designed on the basis of a thermal analysis by using the finite element method, and the proposed electric tweezer-type soldering iron device with flexible fingers is prototyped. Experimental results show the effectiveness of the proposed device.

MSEC_ICMP2008-72177

APPLICATION OF AN ACCURACY ENHANCEMENT MODULE FOR PRECISION MACHINE TOOLS BY SPATIAL ERROR COMPENSATION

Fu-Chuan Hsu — *Metal Industries Research & Development Centre (MIRDC)*
Cheng-Chang Chiu — *Metal Industries Research and Development Centre (MIRDC)*
Wen-Long Chang — *Metal Industries Research & Development Centre (MIRDC)*
Yu-Ting Lyu — *Metal Industries Research & Development Centre (MIRDC)*
Y. Y. Liao — *National Cheng Kung University*
J. J. Wang — *National Cheng Kong University*
Steven Liang — *Manufacturing Research Center (MaRC), Georgia Institute of Technology*

A PC-based precision promotion module named "Precimatics" is presented in this study, which uses a spatial error compensation algorithm to modify the G/M code of coordinates of a CNC machine tool. The spatial errors of three axes machine tools were measured by two kinds of laser interferometers (Renishaw Inc. & Optodyne Inc.) According to the American standard (ASME B 5.54) and the laser vector method with sequential step diagonal path (LDDMTM), the spatial errors of machine tools, such as linear position error, horizontal straightness error, vertical straightness error, and squareness error, were obtained without time consuming. A spatial error map of machine tools was created and embedded into the "Precimatics" for error compensation. The compensated results were simulated and verified by the coordinates of numerical control (NC) code. Integrating a CAD/CAM system with the "Precimatics", the position accuracy of micro/meso machine tools (mMTs) can be improved by spatial error compensation without changing the configuration of CNC controller.

MSEC_ICMP2008-72181

EXPERIMENTAL STUDY OF SOUND SIGNAL FOR TOOL CONDITION MONITORING IN MICRO MILLING PROCESSES

Chia-Liang Yen — *National Chung Hsing University*
Ming-Chyuan Lu — *National Chung Hsing University*
Ching-Yuan Lin — *Mechanical and Systems Research Laboratories, Industrial Technology Research Instititue*
Tin-Hong Chen — *National Chung Hsing University*

The audible sound signals obtained in micro-milling processes are analyzed in the time and frequency domain for the tool wear and breakage monitoring. Micro end-mills of ?700 ?m are implemented in the tool wear test, along with a high speed spindle with speed up to 60000 rpm. The audible sound signals and vibration signals for different tool conditions were collected simultaneously in the cutting. After transferring data from time domain to the frequency domain, as well as the Wavelet coefficients, the capability of audible sound signals in detecting the tool condition for the micro milling process was evaluated..

MSEC_ICMP2008-72311

DEVELOPMENT OF A PC-BASED MILLIMETER SCALE CNC TURNING CENTRE WITH GEAR HOBBING CAPABILITY

Shiqing Liu — *Institute of Precision Engineering, The Chinese University of Hong Kong*
Sunny Chan — *Institute of Precision Engineering, The Chinese University of Hong Kong*
Ho Ching — *Institute of Precision Engineering, The Chinese University of Hong Kong*
Tom Ching Kong — *Institute of Precision Engineering, The Chinese University of Hong Kong*
Ruxu Du — *Institute of Precision Engineering, The Chinese University of Hong Kong*

Currently, a trend of extreme product miniaturization is particularly evident in sectors such as portable multimedia devices, communications, aerospace and biomedical devices. With increasing product compactness, the demand for precision miniature components is driven higher and higher and the ability to manufacture these components accurately, swiftly and cost effectively is critical for manufacturers to maintain market competitiveness. However, traditional machine tools become ineffective for cutting miniature components. This paper presents our efforts in developing a PC-based millimeter scale turning

centre (referred to as MMT hereafter) with gear hobbing capability to machine miniature gears. The system architecture of our 2nd-gerneration MMT is given. In order to fine-tune the micro gear hobbing process to maximize the gear profile accuracy, the mechanics of the process must be thoroughly understood. In order to do so, a computer simulation tool is developed. The simulation procedure and simulation with different process defects are discussed in detail. Experiment results show that the machine is able to machine high quality components with diameter as small as 0.075 mm and hob gears with module as small as 0.3mm.

MSEC_ICMP2008-72380

A MESOSCALE MICRO-TURNING MACHINE WITH MODULAR LINEAR AIR-BEARING STAGES

Seung-Kook Ro — *Korea Institute of Machinery & Materials*
Sung-Kweon Jang — *Korea Institute of Machinery & Materials*
Jong-Kweon Park

In this paper, we describe the design, fabrication, and evaluation of a compact-sized diamond turning machine built with two air-bearing stages and a spindle. The two stages were developed to achieve the precise positioning required for submicron-level machining and miniaturization by introducing air bearings and a linear motor sufficient for mesoscale precision machine tools. The linear motor contained two permanent magnets and was designed to generate a preload force for the vertical air bearings and a thrust force for the stage movement. The size of the single-axis miniature stage was 120 x 120 x 50 mm^3, and the footprint of the turning machine was 200 x 350 mm^2, which is small enough for a tabletop. The positioning repeatability of the each linear axis was measured to be 0.05 um, and the machining error and was evaluated by cutting various depths of an aluminum alloy mirror with a single-crystal diamond. The estimated workpiece-tool stiffness was lower than that with conventional ultraprecision machine, but a form error of less than 0.16 um and a surface roughness (Rz) of 0.08 um were achieved by the finishing cut using a small depth of cut. This reveals that miniaturized machines can be used successfully for precision machining of small precision parts.

MSEC_ICMP2008-72475

ELECTROSPUN NANOCOMPOSITES AS FLEXIBLE SENSORS

Manish K. Tiwari — *University of Illinois at Chicago*
Alexander L. Yarin — *University of Illinois at Chicago*
Constantine M. Megaridis — *University of Illinois at Chicago*

Electrospun polymer/nanoparticle composite-fiber strips (nanocomposites) are introduced as permeable, flexible strain sensors. In the experiments with uniaxial elongation, the nanocomposite strips showed a reproducible increase in electrical resistance indicating the strain level. The resistance increase was interpreted with a novel percolation model that accommodated changing strips geometry. A theoretical framework for nanocomposites as possible detectors of local clogging in large-scale filters is also proposed.

MSEC_ICMP2008-72504

EMBEDDING OF MICRO THIN FILM SENSORS INTO POLYCRYSTALINE CUBIC BORON NITRIDE (PCBN) FOR POTENTIAL TOOLING APPLICATIONS VIA DIFFUSION BONDING

Dirk Werschmoeller — *University of Wisconsin-Madison*
Xiaochun Li — *University of Wisconsin-Madison*

Polycrystalline cubic boron nitride (PCBN) is increasingly being used in manufacturing processes to increase tool life and processing speed. Existing sensors in PCBN tools are unable to provide accurate time- and space-resolved measurements of the thermo-mechanical phenomena at and near the tool-work interface. Using microfabrication techniques along with diffusion bonding, thin film palladium-13wt% chromium (PdCr) alloy micro strain gage sensors were successfully embedded into PCBN structures for potential tooling applications. This paper reports on the design, fabrication and characterization of a PCBN-embedded sensor array consisting of 3 sensing elements. The embedded sensors show good linearity and sensitivity.

MSEC_ICMP2008-72532

DETERMINATION OF CUTTING FORCES FOR MICRO MILLING

Shih-Ming Wang — *ME Dept., Chung- Yuan Christian University*
Zou-Sung Chiang — *Chung Yuan Christian University, Taiwan*
Da-Fun Chen — *Chung Yuan Christian Univ*

To enhance the implementation of micro milling, it is necessary to clearly understand the dynamic characteristics of micro milling so that proper machining parameters can be used to meet the requirements of application. By taking the effect of minimum chip thickness and rake angle into account, a new cutting force model of micro-milling which is function the instantaneous cutting area and machining coefficients was developed. According to the instantaneous rotation trajectory of cutting edge, the cutting area projected to xy-plane was determined by rectangular integral method, and used to solve the instantaneous cutting area. After the machining coefficients were solved, the cutting force of micro-milling for different radial depths of cut and different axial depths of cut can be predicted. The results of micro-milling experimental have shown that the force model can predict the cutting force accurately by which the optimal cutting parameters can be selected for micro-milling application.

Symp 4-7 NEW DEVELOPMENTS IN NANOMANUFACTURING, NANOMETROLOGY AND APPLICATIONS

MSEC_ICMP2008-72012

FRACTAL DIMENSION AND MULTIFRACTAL SPECTRA OF INGAN/GAN SELF-ASSEMBLED QUANTUM DOTS FILMS

K.T. Lam — *Leader University*

The surface shape and microstructure of semiconductor thin films, especially nanometer thin films, has important influence to construct such physical characteristics as electricity, magnetic and optics nature to the thin films, etc. In this work, we use the fractal dimension and multifractal spectra to study the surface morphology of InGaN/GaN self-assembled quantum dot (SAQD) films after annealed process. Samples used in this study were grown on (0001)-oriented sapphire (Al2O3) substrates in a vertical low-pressure metalorganic chemical vapor deposition (MOCVD) reactor with a high-speed rotation disk. The fractal dimension and multifractal spectra can be used to describe the influence of different annealed conditions on surface characterization. Fractal analysis reveals both the average surface roughness and root-mean-square roughness of nanostructure surfaces are decreased after the thermal annealing process. It can be seen that a smoother surface was obtained under an annealing temperature at 800ÂºC, and it implies that the surface roughness of this case is minimum in all tests. The results of this paper also descried a mathematical modeling method for the observation of the fractal and multifractal characteristics in a semiconductor nanostructure films.

MSEC_ICMP2008-72033

MODELING AND SIMULATION OF FOCUSED ION BEAM BASED SINGLE DIGITAL NANO HOLE FABRICATION FOR DNA AND MACROMOLECULE CHARACTERIZATION

Jack G. Zhou — *Drexel University*
Guoliang Yang

In this paper we will use top down approach in nano-fabrication method to make single-digit nanoholes, and to use the nanohole for DNA and RNA characterization. There are three major steps towards the fabrication of a single-digit nanohole. 1) Preparing the freestanding thin film by epitaxial deposition and electrochemical etching. 2) Making sub-micro holes (0.2 ?m to 0.02?m) by focused ion beam (FIB), electron beam (EB), atomic force microscope (AFM), or other methods. 3) Reducing the hole to less than 10 nm by epitaxial deposition, FIB or EB induced deposition. One specific aim for this paper is to model, simulate and control the focused ion beam machining process to fabricate holes which can reach single-digit nanometer scale on solid-state thin films. Preliminary work has been done on the thin film (30 nm in thickness) preparation, sub-micron hole fabrication, and ion beam induced deposition, and results are presented.

MSEC_ICMP2008-72151

APPLICATION OF NICKEL NANOPARTICLES IN DIFFUSION BONDING OF STAINLESS STEEL SURFACES

Santosh Tiwari — *OREGON STATE UNIVERSITY*
Brian K Paul — *OREGON STATE UNIVERSITY*

In this study, the effect of nickel nanoparticles (NiNPs) interlayer application to transient liquid-phase diffusion brazing was investigated. The primary focus was to bond stainless steel 316L laminae in a stack using a Nickel

nanoparticles interlayer and to compare the bondline of the sample with the conventionally bonded and nickel-phosphorous interlayer (NiP) brazed samples for microstructure evolution and bond strength. The bonding was carried out in a vacuum hot press and the bonding parameters were kept same for all the samples: bonding temperatures 1000°C, bonding pressure 1000 psi, heating rate 10°C/min and dwell time of 2 hrs. The cross sections of the bonded samples were investigated for microstructure evolution using optical microscopy and scanning electron microscopy (SEM). The interdiffusion of the diffusing species across the bond line (interface) was evaluated by wavelength dispersive spectroscopy (WDS). X-ray diffraction technique (XRD) is proposed to determine the formation of any brittle intermetallic phases along the bond line and tunneling electron microscope (TEM) to confirm the same. Bond strength will be measured with the help of samples bonded according to ASTM standards.

Symp 4-8 ULTRA-PRECISION AND MICRO/NANO FORMING OF MATERIALS

MSEC_ICMP2008-72099

THE PREPARATION AND PROPERTIES OF ZINC OXIDE/SILVER/ZINC OXIDE MULTILAYER TRANSPARENT CONDUCTIVE OXIDE THIN FILMS DEPOSITED BY A D. C. MAGNETRON SPUTTERING SYSTEM

Zhiyong Qiu — *Tokyo University of Science*
Pangpang Wang — *The University of Tokushima*
Ri-Ichi Murakami — *The University of Tokushima*

In resent work, new multilayer thin films with (ZnO)/Ag/ZnO sandwich structure were produced on glass and PET substrates by a d.c. magnetron sputtering system. As a few nanometer thick silver layer was embedded between two layers of zinc oxide, the multilayer thin films were greatly improved the electrical properties and the high transmittance in the visible range (wavelength from 380~780 nm). The influences of the preparation process and thickness of the silver layer on the electrical and optical properties of the multilayer thin film were studied. For a ZnO/Ag/ZnO multilayer thin film, the transmittance in the visible range was more than 80%, and the resistivity was a very low value of about 1Ã—10-4 ??cm. It was clear for the ZnO/Ag/ZnO multilayer thin film to show the good optoelectronic properties when the silver intermediate layer might be a mesh structure and be not continuous structure.

MSEC_ICMP2008-72106

DEVELOPMENT OF A SMALL MACHINING CENTER EQUIPPED WITH NANOMACHINING AND MEASUREMENT FUNCTIONS

Kiyonori Inagaki — *Tateyama Machine Co.,Ltd.*
Noboru Morita — *Toyama University*
Kiwamu Ashida — *National Institute of Advanced Industrial Science and Technology*
Jyunji Saito — *Tateyama Machine Co.,Ltd.*

We are developing a small precision machine tool that we call a 'nano-machining and measurement system'. The targeted machining resolution of this system is at the submicron to nanometer scale. The system comprises two machining functions and one measurement function. One machining function is scratch machining using a frictional force microscope (FFM) as a mechanism. We built in an NC control function that uses closed loop control to control the depth of cut, and the system uses a high-stiffness cantilever for the scratch-machining function. The high stiffness allows nano-machining of even hard and brittle materials such as silicon. Another machining function is the milling function using an original miniature tool that mounted a very small diamond. This also allows micro machining. The measurement function incorporated into this system uses the same mechanism as the scratch-machining function, providing a degree of precision almost equal to that of atomic force microscopy. After constructing this system, we performed various machining experiments, which confirmed that the built-in NC closed loop control function performed correctly.

MSEC_ICMP2008-72120

TRIBOLOGICAL BEHAVIOR AND SURFACE CHARACTERISTICS OF METAL MICROTUBE IN FLARING TEST

Mohammad Ali Mirzai — *Tokyo Metropolitan University*
Kenichi Manabe — *Tokyo Metropolitan University*

Tribology is of greatest importance for quality of process and workpiece as well as process feasibility. Many researchers are trying to reveal the nature and real mechanism of tribological system for metal forming processes in both macroscale and microscale. Thus to there are many unknown problems in this filed that are still a source of concern especially in microscale. Therefore, investigations in order to develop understanding of tribologyical behavior and improve the quality of process and workpiece are needed. Pushing a conical tool into a tube until fracture onset that notated flaring test is a suitable method for evaluating the circumferential ductility and

material behavior of a tube. The authors had investigated the deformation behavior of the metal microtube in the flaring test. It seems that tribological behavior of the microtube in the flaring test is very important. In this study, the effect of tool asperity and the lubrication condition on tribological behavior, inner surface characteristics and deformation limit of metallic microtube in flaring test were investigated experimentally. The microtube used in this experiment is stainless steel (SUS 316L) and has a 500 um outer diameter and 50 um thickness. The flaring test of the microtube using a conical tool were conducted under dry and two kinds of lubricated-contact conditions as well as different tool surface roughnesses. As a result, it is found that the flaring load and deformation limit of the microtube increase when using a rougher tool. In addition, a spray-type fluorocarbon resin, as a solid lubricant, decreases the above characteristics, but lubrication oil, as a liquid lubricant, exhibits different behavior. Meanwhile, the surface roughnesses of the inner surface of the microtube along axial and circumferential directions reduce when using a rougher tool. From these results, the surface smoothing mechanism of the microtube in the flaring test and the influencing parameters on tribological behavior are discussed.

MSEC_ICMP2008-72135

MICROSCALE FLANGING USING QUASI-STATIC AND ELECTROMAGNETIC FORMING PROCESSES

Brad Kinsey — *University of New Hampshire*
Reid Vanbenthysen — *University of New Hampshire*
Peter Disalvo — *University of New Hampshire*
Jonathan Michaud — *University of New Hampshire*
Michael Blakely — *Hirotec America*
Jianhui Shang — *Hirotec America*

Past research has shown that scatter in material properties and springback (i.e., the elastic recovery of material after the tooling is extracted) increase as components are miniaturized to the microscale. At the macroscale, electromagnetic forming (EMF) has been shown to completely eliminate or at least decrease springback by varying the deformation mechanism. In EMF, a capacitor bank is charged and then quickly dissipated into a specially designed magnetic coil. A transient magnetic field is produced which induces eddy currents in the workpiece, and any other conductive material nearby. The magnetic fields in the coil and the workpiece are repulsive; thus, the workpiece is launched at a high velocity away from the coil. EMF at the macroscale requires a significant amount of stored energy. However at the microscale, EMF may be a viable process due to the reduced energy and force requirements and thus is being investigated in this work.

MSEC_ICMP2008-72152

LASER FORMING OF SINGLE CRYSTALLINE SILICON

Masaaki Otsu — *Kumamoto University*
Jumpei Oka — *Kumamoto University*
Kazuki Takashima — *Kumamoto University*

Weight reduction and high performance of electric devices and semiconductor devices are required for medical products. MEMS devices are promising, and silicon is used as substrates for micro scale components. Three-dimensional micro structures are required particularly for advanced MEMS devices. Single crystalline silicon has high strength, but it is brittle and difficult to form?plastically at room temperature. Laser forming process is useful for plastic forming of brittle materials. In laser forming process, materials are plastically deformed with thermal stress induced by rapid heating. When laser beam is irradiated to single crystalline silicon foils, single crystalline silicon foils are heated up and become ductile and easy to form plastically. So it may be possible to form micro-sized components made of single crystalline silicon by laser forming technique. In this study, single crystalline silicon foils was used for specimen and which plane direction was (001). Thickness of the specimen was 0.05mm. Length and width of specimen were 10mm and 2mm, respectively. A 50W Nd:YAG laser operating in both continuous wave mode and Q-sw pulsed mode was employed. Laser power and scanning velocity were varied under constant line energy density, and change of bending angle was investigated. Deformation behavior was also studied by using both scanning electron micrograph and optical micrograph. Specimen was fixed to a NC table at an end of specimen like a cantilever. Laser scanning direction was or . Just opposite surface of laser irradiation was observed by optical microscope. From the experimental results, bending of single crystalline silicon wafer by laser forming was succeeded, and followings were obtained. As number of scans increased, bending angle also increased almost linearly. Although laser line energy density was constant, bending angle was larger when laser power and scanning velocity were larger. Considering that processing time, when scanning velocity is higher, working time is short. Therefore, there is less heat diffusion and temperature gradient is much steeper. Then, temperature gradient is steeper and bending angle is higher, when scanning velocity is higher. Comparing laser operating mode, bending angle by CW mode was larger than that by Q-sw pulsed mode. Bending angle did not depend on laser scanning direction. So Line pattern in direction was observed by observed at just opposite surface of laser irradiation, however, laser scanning direction was changed.

MSEC_ICMP2008-72153

LASER FORMING OF THIN FILM METALLIC GLASS

Masaaki Otsu — *Kumamoto University*
Yuki Ide — *Kumamoto University*
J. Sakurai — *Tokyo Institute of Technology*
Seiichi Hata — *Tokyo Institute of Technology*
Kazuki Takashima — *Kumamoto University*

Weight reduction and high performance of electric devices and semiconductor devices are required for medical products. MEMS devices are promising, and to enhance reducing the device size and improving performance, it is necessary to fabricate them with not only two-dimensional but also three-dimensional structure in micrometer order. Those devices are ordinarily consisted of silicon because silicon is suitable for micro-manufacturing process such as photolithography and so on. Silicon has, however, crystal structure, and mechanical and physical properties depend on crystal direction. To solve crystal direction dependency of micro-device material, amorphous materials, especially, metallic glasses are tried to apply to micro-devices. Metallic glasses are brittle and difficult to deform plastically at room temperature. By means of laser forming process, materials are plastically deformed with thermal stress induced by rapid heating. If laser beam is irradiated to thin film metallic glass, it is considerable that those materials are heated up and become ductile and easy to form plastically. In the present study, working conditions were changed, and palladium base thin film metallic glass were bent by laser forming. Thin films of Pd-6at%Cu-17at%Si with a thickness of 0.028 mm, length of 10 mm and width of 1.45 mm, and thin films of Pd-40at%Ni-20at%P with a thickness of 0.017 mm, length of 10 mm and width of 1.45 mm were used for specimen. A 50W YAG laser was employed for forming. Bending angle was measured by a line scan type laser displacement sensor. By changing working conditions such as laser power, laser operation mode (continuous wave mode and Q-switch pulsed mode), scanning velocity and defocus length, variation of bending angle was investigated. From the experimental results, both thin films of Pd-Cu-Si and Pd-Ni-P were successfully bent for more than 85 degrees with 60 times scanning by laser forming process. Only Q-switch pulsed mode was succeeded and CW mode was failed. The reason is thought that the thickness of the films was too thin and when CW mode was used, heated area was spread wider than that by Q-switch pulsed mode and enough temperature gradient in thickness direction did not occurred. Comparing among bending angles of thin films of Pd-Cu-Si and Pd-Ni-P, films of Pd-Ni-P was much bent. But considering bending angle is proportion to laser power and inversely proportion to square of film thickness, bending angles of both materials were almost equal.

MSEC_ICMP2008-72273

TENSILE AND MICRO STRETCH BENDING EXPERIMENTS FOR STUDYING STAINLESS STEEL 304 FOIL FOR MICRO SHEET FORMING

Jenn-Terng Gau — *Northern Illinois University*
Chi-Han Chen — *National Cheng Kung University*
Rong-Shean Lee — *National Cheng Kung University*

Tensile test and a micro stretch bending test were conducted to study the behavior of the stainless steel 304 foils for micro sheet forming. In this study, 4 different thicknesses stainless steel 304 foils were used as specimens while 5 micro deep draw dies were used for micro stretch bending experiments. By observing the tensile test results, it can be found that the stainless steel 304 foils with T/D (thickness/average grain diameter: the numbers of grains throughout the metal thickness) 10. By observing the results of the micro stretch bending experiments, it can be concluded that the stainless steel foils with T/D>10 have less springback amount and smaller springback deviation in comparison with those with T/D10 for micro sheet forming application.

MSEC_ICMP2008-72418

CHARACTERISTIC BEHAVIOR OF NANOIMPRINT OF PT-BASED METALLIC GLASS

Yasunori Saotome — *Tohoku University*
Yasuyuki Fukuda — *Graduate student, Gunma University*
Hisamichi Kimura — *Tohoku University*
Akihisa Inoue — *Tohoku University*

Metallic glasses are amorphous structured materials and exhibit perfect Newtonian viscous flow in the supercooled liquid state and superior nano-formability under very low stresses, since the materials are most useful materials for nanoimprint, a promising method for mass production of micro- and nano-devices with low cost. In the previous study, we fabricated the nano-dies with periodic structure of 50nm or less in intervals by FIB assisted CVD and Reactive Ion Etching (RIE) of SiO2, and by using these dies, nanoimprint of Pt-based metallic glass was performed. We observed traces of slip at nanoimprinted area on the surface of the specimen due to the macroscopic material flow associated with compressive deformation. The results demonstrate the performance of the metallic glass for fabrication of nanodevices such as a patterned media.

MSEC_ICMP2008-72488

INFLUENCE OF SURFACE TOPOGRAPHICAL INTERACTION BETWEEN TOOL AND MATERIAL IN MICRO DEEP DRAWING

Tetsuhide Shimizu — *Tokyo Metropolitan University*
Yushiro Murashige — *Tokyo Metropolitan University*
Kuniyoshi Ito — *Seki Corporation*
Ken-Ichi Manabe — *Tokyo Metropolitan University*

Micro forming technology has been paid great attention as one of the most economical mass production methods for sub-millimeter-scale microparts. Although tools and dies are essential for the manufacture of microformed parts, the fundamental knowledge and technological data on their fabrication have not been accumulated. Therefore, establishing design manuals and codes for tools, dies and blank materials for microforming is important for realizing high-precision forming technology. One of the most important process factors for the micro metal forming related to the tool/material design is the interfacial behavior between material and tool. Especially in micro scale region, it is preferred not to use lubricant from the standpoint of not only environmental load but also releasability from tools, lubricant clogging , and the effects of meniscus and viscous force on formability. In dry friction conditions, predominant factor over the frictional behavior between the tool and the material is the contact behavior of surface topography. In miniaturization of the dimensions for sheet metal forming, the relative ratio of the surface asperities of tools and blanks to the outer dimensions become larger than that in the case of the conventional macroscale process. This means that the surface asperities may largely affect frictional behavior, so that it would also affect processing characteristics and accuracy of products. Within the above background, we focused on the surface topography of tool and blank materials in the micro-deep drawing and aimed to clarify the contact behavior effect of surface asperities on microforming characteristics from the viewpoint of the design of tools and materials. In this report, micro-deep drawing for producing cups of 0.7mm in diameter and 0.02mm in thickness was conducted by using three different kinds of tools and two different kinds of materials, which have different surface properties manufactured by ion sputtering and air-blasting. To evaluate the effects of surface properties on micro formability and forming accuracy, punch force, surface accuracy, thickness strain distribution of microcups was experimentally investigated. Additionally, using the FE model that considers surface roughness, which was validated in the last report, the effect of surface roughness on formability was also analyzed in different tool/material surface conditions. Compared with experimental data, the effect of interaction of surface asperities between tool and materials on the frictional behavior and also on the global forming behavior in micro forming process was discussed.

Track 5 Biological Technologies

Symp 5-2 MANUFACTURING PROCESSES FOR BIOMEDICAL APPLICATIONS: THEORY, APPLICATIONS AND EDUCATION

MSEC_ICMP2008-72134

STUDY OF STRUCTURED POROGEN METHOD FOR BONE SCAFFOLD FABRICATION

Lin Lu — *Drexel University*
Jack G. Zhou — *Drexel University*
Peter Lelkes — *Drexel University*
David Wootton — *Cooper Union*

The increasing demand on bone scaffolds has promoted the development of tissue engineering fabrication technique for manufacturing bone scaffold. In this study, a novel structured porogen method for bone scaffold fabrication has been explored. This method has demonstrated highly efficient and reproducible fabrication of structured bone scaffolds which mimics the bone structure. By using commercially available Drop on Demand (DDP) system and three dimensional printer (3-DP) system, at first designed structured porogens can be manufactured, and then bone scaffolds can be fabricated by injecting the biocomposite materials into the porogens. The mechanical properties of the fabricated scaffolds using DDP system have been characterized. The biocompatibility of our fabricated scaffolds using 3-DP has been examined and degradation rate of various composite materials has been tested. With incorporating of bioactive calcium phosphate into the composite materials, the mechanical strength and bioactivity of the scaffolds made by the structured porogen method can be improved significantly. This structured porogen method has a potential to be used on various Solid Freeform Fabrication systems which allows each system to use a single ubiquitous building material to fabricate multiple biomaterial scaffolds with sufficient mechanical integrity.

MSEC_ICMP2008-72241

BUBBLE FORMATION MODELING IN MATRIX-ASSISTED PULSED-LASER EVAPORATION DIRECT WRITE

Yafu Lin — *Clemson University*
Kevin Foy — *Clemson University*
Yong Huang — *Clemson University*
Douglas B. Chrisey

Matrix-assisted pulsed-laser evaporation direct write (MAPLE DW) is emerging as a promising direct-write technology for printing microelectronics as well as biological constructs. To widely employ this technology, understanding of its physical mechanism is of need. In this study, the bubble formation process in MAPLE DW of glycerol-water coating is modeled based on the nucleation-based phase explosion theory. Based on the proposed model, the bubble diameter after expansion and cooling and bubble pressure can be predicted. Although the prediction overall overestimates the bubble diameter during the MAPLE DW experiments, the proposed model is considered satisfactory in reasonably predicting the bubble diameter as a first step endeavor for this complex process. It is expected that the introduction of more accurate models for energy loss should further help improve the model prediction accuracy.

MSEC_ICMP2008-72242

MODELING OF BUBBLE EXPANSION-INDUCED CELL MECHANICAL PROFILE IN LASER-ASSISTED CELL DIRECT WRITING

Wei Wang — *Clemson University*
Gang Li — *Clemson University*
Yong Huang — *Clemson University*

Cell damage due to the mechanical impact during laser-assisted cell direct writing has been observed and is a possible hurdle for broad applications of fragile cell direct writing. The objective of this study is to investigate the bubble expansion-induced cell mechanical loading profile in laser-assisted cell direct writing using the Arbitrary-Lagrangian-Eulerian based method. Some conclusions have been drawn as follows. The cell velocity oscillates initially and then smoothes out gradually with a constant ejection velocity. Both the cell acceleration and pressure can be very high at the beginning period of bubble expansion and then quickly approaches zero in an oscillation manner. A high viscosity can lead to an observable velocity increment at the initial stage, but the ejection velocity decreases. The pressure magnitude decreases when the distance is large, and a larger initial pressure induces a larger cell pressure as expected. This study serves as a foundation to further investigate the cell damage mechanism in laser-assisted cell

direct writing to improve the effectiveness and efficiency of cell direct writing techniques.

MSEC_ICMP2008-72243

NUMERICAL STUDY AND SCALE ANALYSIS OF INNER AND OUTER DIAMETERS PREDICTION IN FABRICATION OF HOLLOW FIBER MEMBRANES FOR NERVE REGENERATION

Jun Yin — *Clemson University*
Nicole Coutris — *Clemson University*
Yong Huang — *Clemson University*

Recently the semi-permeable hollow fiber membrane (HFM) is finding promising applications in promoting axonal outgrowth for nerve repair and regeneration. It is of interest to model the phase inversion-based HFM fabrication process and control the fabricated HFM geometry. The effect of gravity and surface tension which is frequently ignored in general fiber spinning should be carefully addressed in HFM fabrication modeling. Both the volume of fluid (VOF) method and the scale analysis have been applied to appreciate the effect of gravity and surface tension on the HFM geometry profile. The VOF method-based simulation results reveal that both the gravity and/or surface tension significantly reduce the predicted radii/diameters, while the scale analysis reveals that the gravity or surface tension affects the HFM fabrication process dynamics. Both the approaches warrant the need of including the gravity and surface tension in HFM fabrication process modeling.

MSEC_ICMP2008-72248

INK-JET AS A MANUFACTURING METHOD FOR DRUG DELIVERY APPLICATIONS

Bogdan V. Antohe — *MicroFab Technologies, Inc.*
David B. Wallace — *MicroFab Technologies, Inc.*

Recent drug delivery applications have further stressed the need for precise dosage in the context of complex delivery vehicles. Ink-jet technology incorporates data-driven, non-contact techniques that enable precise, picoliter volumes of material to be deposited with high speed and accuracy at target sites (even onto non-planar surfaces) and thus has emerged as a front runner for drug delivery applications. Being data-driven, ink-jet dispensing is highly flexible and can be readily automated into manufacturing lines. Moreover, the ability to precisely target the delivery location reduces the waste, an important factor when the active biological materials to be deposited are high value / high cost. Some of the applications that have made use of ink-jet methods for the dosage and distribution of the biologically active agent are: application of the drugs onto drug eluting stents; generation of drug loaded microspheres; fabrication of polymeric nerve conduits loaded with nerve growth factor; and coating of the active components onto specialized patches for transdermal delivery. In the drug eluting stent area, precise amounts of antirestenotic drugs were deposited with high repeatability onto cardiovascular stents. The amount of drug loaded and its spatial distribution were digitally controlled by the translational and rotational motion systems, the distribution (pattern) of the drops printed and total number of printing passes. The resulting stents delivered their drug payload at rates similar to those loaded by conventional spraying methods while the drug loading efficiency and repeatability were substantially higher. In another application that targets the reduction of the side effects in chemotherapy, monodisperse polymeric microspheres for localized delivery of anticancer drugs were obtained by using drop-on-demand and continuous mode jetting. The microsphere desired size and monodispersity were achieved by controlling a combination of mechanical and electrical jetting parameters. Ink-jet manufacturing was used to fabricate biodegradable polymeric nerve conduits for peripheral nerve regeneration. In this application a gradient of nerve growth factor was created in the conduit walls. A more recent application has emerged in the delivery of the active components through transdermal patches. The latest patch configurations consist of microneedles that have to be individually targeted with the component to be delivered. Due to the size, shape and distribution of the needles ink-jet is one of the options for this application too. This paper will provide details on the manufacturing applications of ink-jet technology in the field of drug delivery described above and will discuss future potential uses and opportunities.

MSEC_ICMP2008-72290

EXPERIMENT, THERMAL SIMULATION AND CHARACTERIZATIONS ON TRANSMISSION LASER COATING OF HYDROXYAPATITE ON METAL IMPLANT

Chang Ye — *Purdue University*
Gary Cheng — *Purdue University*

Coating of bioceramic material â□“ Hydroxyapatite â□“ on metal implant has attracted many attentions in biomedical industry recently because its combination of good mechanical property and biocompatibility. However, most of current coatings are lack of coating adherence to the substrate, and/or degraded biocompatibility. It is due to the weak coating/substrate interfacial strength and/or decomposition as a result of high temperature processing. The cell-tissue attachment is affected by the degraded biocompatibility. In this paper, an innovative method â□“ transmission laser coating is investigated to coat HAp on Ti substrate with low temperature processing. This process enhances the HAp/Metal interfacial property of current

coatings, while maintaining good biocompatibility. Experiments are conducted using a continuous Nd-YAG laser. Multiphysics simulation is conducted to simulate the temperature distribution in coatings and substrates during TLC processing. X-ray energy dispersion spectrum is used to measure the chemical composition of HAp coatings after TLC process. Cell culture study is conducted to observe the biocompatibility after TLC of HAp particles. TLC processing will open new ways of producing biocompatible bioceramic coatings under controlled thickness and low processing temperature.

MSEC_ICMP2008-72296

MECHANICAL PROPERTIES OF PDMS AND INFLUENCES BY MICROMACHINING PROCESSES

Jianren Sun — *University of Central Florida*
Christopher Bock — *University of Central Florida*
Quanfang Chen — *University of Central Florida*

Microfluidics is both a science and a technology that offers great and perhaps even revolutionary capabilities to impact the society in the future. Polydimethylsiloxane (PDMS) has been widely used in fabricating microfluidic systems but few efforts were made in the past on mechanical properties of PDMS. Very importantly there is no report on influences of microfabrication processes which normally involve chemical reaction processes. A comprehensive investigation was made by authors to study fundamental issues regarding chemical emersion and their effects on mechanical properties of PDMS. Results shown in this work can be used to guide future developments of microfluidics in utilizing PDMS especially those devices involve actuation of PDMS membranes.

Symp 5-3 ADVANCES IN MEDICAL MICRO/NANO MANUFACTURING AND ITS APPLICATIONS

MSEC_ICMP2008-72054

DESORPTION-LIMITED MECHANISM OF RELEASE FROM POLYMER NANOFIBERS

Srikar Raman — *University of illinois at chicago*
Alexander L. Yarin — *University of Illinois at Chicago*
Constantine M. Megaridis — *University of Illinois at Chicago*
A. V. Bazilevsky — *University of Illinois at Chicago*

This work examines the release of a model water-soluble compound from electrospun polymer nanofiber assemblies. Such release attracts attention in relation with biomedical applications, such as controlled drug delivery. It is also important for stem cell attachment and differentiation on biocompatible electrospun nanofiber scaffolds containing growth factors, which have been encapsulated by means of electrospinning. Typically, the release mechanism has been attributed to solid-state diffusion of the encapsulated compound from the fibers into the surrounding aqueous bath. Under this assumption, a 100% release of the encapsulated compound is expected in a certain (long) time. The present work focuses on certain cases where complete release does not happen, which suggests that solid-state diffusion may not be the primary mechanism at play. We show that in such cases the release rate can be explained by desorption of the embedded compound from nanopores in the fibers, or from the outer surface of the fiber in contact with the water bath. After release, the water-soluble compound rapidly diffuses in water, whereas a release rate is determined by the limiting desorption stage. A model system of Rhodamine 610 fluorescent dye embedded in electrospun monolithic Poly(methylmethacrylate) PMMA or Poly(caprolactone) PCL nanofibers, or in nanofibers electrospun from PMMA/PCL blends, or in core/shell PMMA/PCL nanofibers is studied. Both the experimental results and theory point at the above-mentioned desorption-related mechanism and the predicted characteristic time, release rate, and effective diffusion coefficient agree fairly well with the experimental data. A practically important outcome of this surface release mechanism is that only the compound on the fiber and pore surfaces can be released, whereas the material encapsulated in the bulk cannot be freed within the time scales characteristic of the present experiments (days to months). Consequently, in such cases complete release is impossible. We also demonstrate how

the release rate can be manipulated by the polymer content and molecular weight affecting nanoporosity and the desorption enthalpy, as well as by the nanofiber structure (monolithic fibers, fibers from polymer blends and core-shell fibers). In particular, it is shown that by manipulating the above parameters, release times from tens of hours to months can be attained.

MSEC_ICMP2008-72189

MICROSTRUCTURING AND BIOFUNCTIONALISATION OF ALUMINA SURFACES TO ENHANCE ABRASION RESISTANCE AND SUPPRESS BACTERIAL BIOFILM GROWTH

Laura Treccani — *University of Bremen, Bioceramics Group*
Prof. Kurosch Rezwan — *University of Bremen*

Biofouling and erosion of material surfaces are two of the major challenges in fluid transport or food processing systems which contain micro-abrasive particles. Biofouling represents a serious public health risk as uncontrolled growth of pathogenic microorganisms such as bacteria may cause serious epidemic outbreaks and mass diseases. Micro abrasion of material surfaces caused by particles in the fluid system diminishes the service life of fluid handling devices. The aim of this research project is the fabrication of novel microstructured biofunctionalized alumina surfaces that show high resistance against abrasion and prevent bacterial biofilm formation on the surface. To avoid biofilm formation specific biomolecules, such as natural proteins and enzymes which present innate antibacterial properties, are employed to functionalize alumina surfaces. Abrasion surface resistance is obtained by specifically designed microstructures, which furnish at the same time protection of the immobilized antibacterial biomolecules on the surface. The application of such engineered surfaces addresses aqueous systems with possible usage in fluid transport devices and food processing chains where biofouling must be prevented.

MSEC_ICMP2008-72198

COMPARISON OF THREE MICROSTRUCTURE FABRICATION METHODS FOR BONE CELL GROWTH STUDIES

Marzellus Groãÿe Holthaus — *University of Bremen*
Prof. Kurosch Rezwan — *University of Bremen*

Different micropatterning techniques were applied to elucidate the potential for cell proliferation studies on calcium phosphate surfaces. Sintered hydroxyapatite (HA) platelets were microstructured by three different techniques: Aerosol jet printing (M3DÂ®), laser ablation and microcontact printing via polyÂ¬dimethylÂ¬siloxane (PDMS) stamps. The microÂ¬structures were designed as channels between 1000 and 3000 micron in length, 10 to 220 micron in width and 5 to 110 micron in height. An optical profilometer, a Scanning Electron Microscope (SEM) and X-ray diffraction were used to characterize the microstructures. Cell proliferation tests were carried out by incubating the microstructured ceramic samples in complete cell media for a maximum of seven days. Osteoblast-like cells (MG-63) were used for testing. Each sample was immersed in media in which the cells were already seeded. Imaging was performed by SEM and Fluorescence Microscopy. The cells proliferated on all three differently fabricated microstructures. Cell growth was observed in the microchannels as well as on the microchannel walls or spacers. In particular it turned out, that the microtopology can provoke the cells to elongate aligned to the direction of the microchannels. Non-directional growth was observed on non-structured areas. All three differently fabricated hydroxyapatite microÂ¬structuring methods seem to be attractive and promising techniques for use in bone cell growth studies. The applied fabrication techniques show many advantages for fundamental research in the field of cell interaction with ceramic microstructures and may exhibit possible methods of structuring implant surfaces.

MSEC_ICMP2008-72405

DEVELOPMENT OF MEMBRANE MICRO EMBOSS FOLLOWING EXCIMER LASER ABLATION (MEME-X) PROCESS? AND ITS APPLICATION TO PRESSURE-DRIVEN MICRO ACTIVE CATHETER

Masashi Ikeuchi — *Nagoya University*
Koji Ikuta — *Nagoya University*

MeME-X process was proposed and developed to break-through the conventional miniaturization limit of the pressure-driven micro active catheter by two orders of magnitude. The world's smallest micro active catheter of 300 micrometer in diameter was successfully fabricated using MeME-X process. The catheter has a bendable bellows at the tip made of thin biocompatible polymer membrane. The bellows is composed of a series of folded micro-chambers and microchannels. The folded-chambers expand on one side by increasing inner water pressure using syringe, thus the whole bellows bends toward one direction within 0 to 180 degree. This micro active catheter should be useful for safe intravascular surgery in narrow and complicated blood vessels.

Symp 5-5 OTHER BIOLOGICAL APPLICATIONS

MSEC_ICMP2008-72202

DESIGN AND FABRICATION OF A ROLLER IMPRINTING DEVICE FOR MICROFLUIDIC DEVICE MANUFACTURING

Athulan Vijayaraghavan — *University of California*
Stephen Jayanathan — *University of California*
Moneer M Helu — *University of California*
David Dornfeld — *University of California*

Microfluidic devices are gaining popularity in a variety of applications, ranging from molecular biology to bio-defense. However, the widespread adoption of this technology is constrained by the lack of efficient and cost-effective manufacturing processes. This paper focuses on the roller imprinting process, which is being developed to rapidly and inexpensively fabricate micro-fluidic devices. In this process, a cylindrical roll with raised features on its surface creates imprints by rolling over a fixed workpiece substrate and mechanically deforming it. Roller imprinting aims to replace processes that were developed for laboratory scale prototyping which tend to not be scalable and have high equipment requirements and overheads. We discuss the limitations of PDMS soft lithography in large-scale manufacture of microfluidic devices. We also discuss the design, fabrication, and testing of a simple roller imprinting device. This imprinter has been developed based on the principles of precision machine design and is implemented using a three-axis machine tool for actuation and position measurement. A framework for the micro-machining of precision imprint rolls is also presented.

MSEC_ICMP2008-72341

MICRO MANUFACTURING USING ADVANCED HYBRID MICROSTEREOLITHOGRAPHY FOR 3-D MICRO CHEMICAL DEVICES

Kengo Kobayashi — *Nagoya Univesity*
Koji Ikuta — *Nagoya University*

Our group has developed a new free-surface microstereolithography apparatus with high laminate resolution and accuracy for hybrid microstereolithography. We applied a feedback control system to adjust the surface level of the photo-curable polymer constantly and precisely. Moreover, by modifying the design of the squeegee used to laminate the photo-curable polymer in the apparatus, we reduced the height of the meniscus just behind the squeegee. Through this modification, the laminate resolution of the apparatus was refined to 10 micrometers. Using the apparatus thus developed, we successfully miniaturized a biochemical IC chip, a microfluidic device which have three-dimensional hybrid microstructure. Compared with earlier microstructures, this advanced apparatus for free-surface microstereolithography can fabricate much smaller microstructures with much smoother surfaces. Henceforth we expect that this achievement will be a key technology to innovate polymer MEMS (MicroElectro-Mechanical Systems), microfluidic devices and other fields.

MSEC_ICMP2008-72411

DEVELOPMENT OF MOUTHPIECE TYPE REMOTE CONTROLLER FOR SERIOUS DISABILITY PERSONS- BASIC INVESTIGATION OF POSSIBILITY OF USING RFID TECHNIQUE FOR REMOTE CONTROLLER Â□“

Shojiro Terashima — *Niigata Institute of Technology*
Takuya Kitazawa — *Niigata Institute of Technology*
Eiichi Satoh — *Niigata Institute of Technology*
Kazuo Kotake — *Elite Ltd.*
Isao Sakamaki — *National Instruments Japan*

Disability persons like cervical cord injury have a lot of difficulties even in the activities of daily living, such as turn room light's switch ON/OFF and drive electric powered wheelchair. A variety of operation devices have been developed for such serious disability people by many researchers and companies in these years; voice or breath control, head motion control and eye movement control system etc-. They have own merits and demerits respectively, so still now, there are need to develop another types of operation devices. The tongue movement is also available and one of solutions to apply to some operation devices for disability persons.In this study, we have tried to develop the mouthpiece type remote controller for those serious disability people. This remote controller has passive RFID transponders but no battery. In order to develop the mouthpiece remote controller, we need to know the basic characteristics of RFID and what type RFID should be applied to this mouthpiece remote controller. Therefore, we investigated the basic characteristics of RFID transponders; 134.2 kHz and 13.56 MHz type. The MCR (Maximum Communication Range) was measured under three kinds of environmental condition of in the atmosphere, in the water and in the meat. Every RFID transponders of 134.2 kHz and 13.56 MHz type has enough MCR under every environmental condition. Then we developed trial mouthpiece remote controller using 13.56MHz transponders. This trial remote controller was examined same test. The results indicated that this trial controller has enough performance to apply to mouthpiece remote controller for disability persons. To make sure that this trial

controller was able to control electric powered wheelchair, we tried to operate some target. For the first attempt, we tried to operate a model car. TR3-MD001E was used for the RFID identifier system. NI 9263 and cRIO 9014 were used to control the model car. With this system, we could get success in operating a model car by pushing the switches on the mouthpiece remote controller by tongue.

Track 6 Other Conference Events

Symp 6-1 MSEC AND ICM&P POSTERS

MSEC_ICMP2008-72515

MEDICAL DEVICE COATING USING INK-JET TECHNOLOGY

Gareth Walsh — *Labcoat Ltd*

1.0 Abstract Summary Labcoat has incorporated Ink-Jet technology into its JAC Systemâ„¢ to target the location and quantity of coating applied to a medical device and more particularly in the case of a stent implant to apply a low dose of drug and carrier to the desired surfaces only of the device.

MSEC_ICMP2008-72040

THE EFFECT OF FINE PARTICLES ON METAL SURFACE IN MCF(MAGNETIC COMPOUND FLUID) POLISHING

Shimada Kunio — *Fukushima University*
Zheng Yaoyang — *Fukushima University*

We have demonstrated experimentally that the polishing effect using our developed intelligent fluid, magnetic compound fluid (MCF), is greater than that using previously developed intelligent fluids, i.e., magnetic fluid (MF) and magneto-rheological fluid (MRF). We succeeded in float polishing with a large clearance utilizing a newly developed magnetic responsive fluid, MCF, which was improved by the addition of a-cellulose, thereby achieving a clearance as great as 8mm. We also clarified the mechanism of the new polishing technique. A comparison of the MCF polishing effect with those of techniques using the ordinary magnetic responsive fluids, MF and MRF, showed the polishing effect of MCF to be greater than those of MF and MRF. The MCF polishing technique is applicable to many types of polishing, widening the variety of the uses of magnetic float polishing (MFP). The present paper describes the results of polishing the surface of various materials by the present MCF polishing technique as investigated by optical and electronic measurements. The effects of the magnetic and abrasive particles on the surface were clarified.

MSEC_ICMP2008-72085

EFFECT OF PLASTIC STRAINING ON WORKING LIFE UNDER CYCLIC LOADING

Kazumasa Sugai — *Gifu University*
Minoru Yamashita — *Gifu University*
Naoya Nishimura — *Gifu University*
Toshio Hattori — *Gifu University*
Joji Sato — *Res. Inst. Machinary & Materials Gifu Pref.*

The effect of the plastic deformation on the fatigue property was investigated with consideration of the strain level, the surface roughness and the residual stress. The test materials were a commercially available aluminum alloy sheet A5052 and a mild steel sheet SPCC, whose nominal thickness was 3 mm. Bending fatigue test was carried out using a Schenk-type bending fatigue apparatus at room temperature, where the sine stress wave was imposed on the specimen with 30 Hz. The specimen shape was a round notched one with the radius of 30 mm, whose narrowest width was 20 mm. The strain gage was bonded for the measurement of the surface stress. The pre-strained sheet with several strain level were prepared, which underwent the simple tension or the V-bending deformation. In the latter, the residual stress distributing through thickness resulted. The plastic straining by a simple tension elevated the fatigue strength in proportion to the strain level. However, the ratio in the increase of the fatigue strength due to the simple tension was smaller than that of the yield strength. When the surface was smoothed by an emery paper showing the comparable roughness to the unstrained specimen, the degree of the increase in fatigue strength became remarkably greater for the A5052 material. Therefore, this phenomenon is attributed to the roughened surface property by the plastic deformation, where the notch effect possibly decreases the fatigue life. However, the degree of the increase in fatigue strength was rather small for SPCC material. The fatigue life decreased for the V-bent specimen. This is presumably due to the tensile residual stress field and the roughened surface, which agreed with the effect of mean stress on fatigue life as the Goodman relation considering the surface roughness.

MSEC_ICMP2008-72086

DEFORMATION BEHAVIOR OF WOOD IN BIAXIAL COMPRESSION AND ITS STRENGTH EVALUATION

Haruhiko Mori — *Gifu University*
Minoru Yamashita — *Gifu University*
Naoya Nishimura — *Gifu University*
Toshio Hattori — *Gifu University*

The wood bar with square cross-section was biaxially compressed about the cross-sectional plane. It deformed

under the plane strain condition decreasing the volume, where the length was almost unchanged. The wood material was Sugi which was a kind of Japanese cedar and the sap wood was selected for the specimen. The objective is to investigate the effect of the compressive condition on the strength of the compressed wood. The biaxial compression apparatus was designed to prevent the gap generation between the material and the tool. This is a remarkable aspect of the apparatus that achieves the compressive stress field in the whole material during deformation in order to prevent the crack opening in the material. The compressive force in the biaxial compression was almost constant during the collapse of the cell. Finally it rose rapidly due to the densification. The deformation pattern of the annual rings in the cross-section showed an undulating one by being compressed in the tangential direction of the annual rings as well as the radial direction under the biaxial compressive condition. The stripe pattern of all side surfaces held a similarity in comparison with that before compression. This seems a very attractive feature for the natural look of the wood. The four-point bending test was conducted. The surface strain was measured by a strain gage during the loading and unloading processes. The specific Young's modulus in the longitudinal direction (fiber direction) elevated as the compressive ratio in volume increased. When the compressive ratio in volume was about 400 %, the elastic modulus attained a value of about 40 GPa, which was about 5 times greater than that of the uncompressed specimen. The hysteresis property in the relationship between the bending moment and the surface strain was improved in the biaxial compressed wood.

MSEC_ICMP2008-72090

FABRICATION OF HIGH ASPECT RATIO X-RAY GRATING USING X-RAY LITHOGRAPHY

Daiji Noda — *University of Hyogo*
Hiroshi Tsujii — *University of Hyogo*
Kazuma Shimada — *University of Hyogo*
Wataru Yashiro — *The University of Tokyo*
Atsushi Momose — *The University of Tokyo*
Tadashi Hattori — *University of Hyogo*

X-ray radiographic imaging technique has found applications in fields such as medical, biological, inspection, material science, and so on. However, it is not enough to get clear X-ray images of samples with low absorbance, such as biological soft tissues. To resolve this problem, we proposed a method using an X-ray Talbot interferometer (XTI) of X-ray phase imaging. The XTI is made up of two X-ray gratings. But, the fabrication of X-ray gratings is very difficult because it is required a thickness of over 20 um even for Au that has a high X-ray absorptive material. On the other hand, X-ray lithography technique is used as one of the technologies for fabricating micrometer size micro-structures since it uses highly directive a synchrotron radiation. This technique has very advantage to fabricate a high aspect ratio structure required for X-ray gratings with a pitch of several micrometers. Then, we have fabricated the X-ray gratings with narrow pitch and large area using X-ray lithography technique. The X-ray grating having pitch of 5.3 um and height of about 30 um are realized in this technique. The quantitative phase reconstructions were performed at BL20XU of Spring-8. In contrast to normal tissue, cancer was clearly discriminated as dark spots, the necroses within a malignant tumor being expressed as white spots. This result suggests that XTI is a novel and simple method for phase sensitive X-ray radiography. These demonstrations of the XTI are a promising method for many applications.

MSEC_ICMP2008-72159

BASIC STUDY ON USEFULNESS OF MAGNETIC COMPOUND FLUID (MCF) RUBBER AS MATERIAL FOR MICROWAVE HEATING

Shimada Kunio — *Fukushima University*
Zheng Yaoyang — *Fukushima University*

This report describes the application of magnetic compound fluid (MCF) rubber as a material for microwave heating. MCF rubber is one of several new composite materials utilizing MCF as a newly developed magnetic responsive fluid developed by Shimada. The temperature of water in a PP container enveloped by MCF rubber in a microwave oven was measured at various mass concentrations of magnetic particles in the MCF rubber. The measurements were compared to those of MCF rubber in a microwave oven. The results showed an optimum mass concentration in relationship to the increase or decrease of the water temperature. At less than about 50 wt% and more than about 90 wt% of the magnetic particles in the MCF rubber, changes in the water temperature were small but those of the MCF rubber were large. However, in the range of about 60 â□“ 80 wt%, changes in the water temperature were large but those of the MCF rubber were small. To explain the experimental data, we derived a simple microwave heating theory and measured experimental data for the complex permittivity and permeability of the MCF rubber. This could partly explain the experimental results qualitatively. We also found in the present study that iron particles are better for the MCF rubber in microwave heating than copper or nickel particles. In conclusion, the MCF rubber is a useful material for microwave heating in a microwave oven.

MSEC_ICMP2008-72175

PROCESSING ON HOT EMBOSS MOLDING FOR A SMALL CAPACITIVE INCLINATION SENSOR

Kazufumi Nishimoto — *University of Hyogo*
Naoya Ishizawa — *University of Hyogo*
Hiroaki Miyake — *University of Hyogo*
Toshiaki Sakai — *3-1-2 Kouto, Kamigori*
Satoshi Nishida — *Nanocreate Co., Ltd*
Hiroyasu Ueda — *TOKAI RIKA Co., Ltd.*
Koichi Itoigawa — *TOKAI RIKA Co., Ltd.*
Daiji Noda — *University of Hyogo*
Tadashi Hattori — *University of Hyogo*

In recent years, micro fabrication technology development that is able to produce high-volume and low-cost production for micro devices is demanded. Nanoimprint technology has been expected to decrease process and produce cost better than conventional Micro Electro Mechanical System (MEMS) process. We inquired into hot emboss molding process to make a small capacitive inclination sensor. The sensor has a feature that is 5mm x 5mm x 3mm in size. Thus, this sensor is expected to application to field where posture control is needed by reason that the size is smaller than conventional sensor. Molding for the capacitive inclination sensor with round fluid channel structure was fabricated. We inspected that the condition of molding temperature, mold pressure and exfoliate temperature. In the results, Optimization for molding conditions of the capacitive inclination sensor by hot emboss was successful. Consequently, the 40-micrometer high molding pattern of the sensor was printed to polycarbonate (PC) correctly. An electrode that is fabricated to only the bottom of channel structure by ultraviolet (UV) lithograph and Cu etching for detect the electric capacity was fabricated successfully. The sensor was bonded between the upper molded part and under molded part by the surface property modification using H2O ion irradiation. Therefore we could have made up the prototype of a small capacitive inclination sensor. Aftertime, we will inspect performance assessment of the capacitive inclination sensor. (225 word)

MSEC_ICMP2008-72194

FABRICATION OF THE 3 DIMENSION RESIST MICROSTRUCTURE USING X-RAY DIFFRACTION AND APPLYING TO LIGA PROCESS

Yoshitaka Sawa — *Sawa Plating Co., Ltd.*
Kyo Tanabiki — *University of Hyogo*
Daiji Noda — *University of Hyogo*
Tadashi Hattori — *University of Hyogo*

With cellular phones and other information processing equipments, it is understandable that the market demands higher performance. To meet such demands, the development of parts with reduced size and increased performance are under way. For size reduction and performance improvement, microstructures and microsystems are attracting engineers' attention. At present, the most promising fabrication technology for microstructure is LIGA process. At the molding process of LIGA, a cast of especially high aspect ratio structure is said that it's difficult to pull out from the mold. But, it's generally known that the mold releasing property of a structure is improved if the structure is tapered at least 1 or 2 degrees. In this research, we newly propose to use the diffraction exposure technique. Diffraction is caused by providing a clearance between the resist and the X-ray mask. The tapered structure can be fabricated by the diffraction exposure technique. The structure fabricated is the line and space comprising 60?m pitch lines and processed depth is 200?m. The experiment parameters of exposure are gap, DOSE and slit width. Varying these parameters, at the maximum, we achieved a taper angle of about 4 degrees. Next, we electroformed the master that taper angle is 2.5 degrees. We could partially copy the master pattern well. In the future, it is planed that fabricating fine shaped mold by improving the conditions of electroforming and finally, studying relationships between tapered shapes and mold release property through the molding.

MSEC_ICMP2008-72301

INTERFACIAL BEHAVIOR OF FIBER/MATRIX BASED ON OF INTERPHASE

Chang Junjie — *dalian maritime university*

The energy propagation behavior of longitudinal elastic wave by an elastic fiber embedded in a finite viscoelastic matrix with debonded interphase is studied by a time domain finite element method. The fiber is presently assumed to be of a right cylindrical shape, and let the incidence longitudinal wave vertical with the fiber axis and propagate in the plane vertical to the fiber. In this circumstance the problem to analyzing is two-dimensional and governing equations according to the Hooke's law for plane strain. In this study, several models of composite materials were proposed, and the energy propagation of ultrasonic waves in these model composites was simulated with both reflection and transmitted occurring at bonded interfaces. The simulation was conducted by PZFlex analysis code, a time domain finite element program. The characteristics of ultrasonic wave propagation in these model composites are discussed. As an illustrative example, the transmitted energy and reflection energy are computed for circular cylindrical glass fiber in epoxy matrix of various conditions. The influence of the interphase material properties and the extent of interface debonding as well as its orientation relative to the incidence plane longitudinal wave on the energy propagation

behavior is discussed in detail, and its arrangement were clarified.

MSEC_ICMP2008-72338

A BOSS FORMING TECHNIQUE FOR DEEP-DRAWN PRODUCT

Keiichi Morishita — *Gifu University*
Zhrgang Wang — *Gifu University*

Backward extrusion is the most common method of forming bosses within product cases. However, backward extrusion requires a very large forming load, and has the disadvantage of producing dimple defects when forming thin sheets. To overcome this disadvantage, we investigated a method of bottom compression drawing to replace backward extrusion. Bottom compression drawing is a technique in which, during normal drawing, back pressure from the counter punch that opposes the drawing punch applies a load on the blank, so that compressive force acts on the bottom face of the blank. Bosses are formed at the same time as the case is formed as a result of this drawing. Since tension produced by the drawing load acts on the bottom face of the blank in this forming method, it is anticipated that yield stress will be reduced, the influence of friction will be diminished, and the machining load will become smaller. Backward extrusion and bottom compression drawing were compared using FEM analysis in the formation of solid bosses. The results showed that bottom compression drawing could form a piece with about 60% of the forming load used with backward extrusion; that the forming load could be further reduced with small friction conditions; and that dimple defects were less likely to occur with bottom compression drawing than with backward extrusion.

MSEC_ICMP2008-72343

V-BENDING OF METAL PLATES

Nobuhiro Kanada — *Gifu University*
Zhrgang Wang — *Gifu University*
Keiichi Morishita — *Gifu University*
Shota Ikeido — *Gifu University*

To produce products of high accuracy with press brakes, in general the punch stroke is adjusted and trial bends are repeated until the target angle is obtained. This is because there is no established theory for controlling the springback that occurs with elastic recovery of the material when it is removed from the die, in order to stabilize product angle accuracy. In this study we conducted V-bending simulations using FEM analysis. From the results we sought the stroke that would give the target angle and studied the characteristics of V-bending. We also investigated the validity of the simulations from comparisons with experiments. The following results were obtained. The product angle decreased monotonously as machining stroke increased, a flexion point appeared near the die groove angle, and the rate of change became larger.The amount of springback was larger with larger die groove widths. The amount of springback and the configuration during processing differs with differences in the material being shaped. Therefore, product angle differs with the same stroke. The difference between FEM analysis and experimental results was slight, but in some cases exceeded the target accuracy by Â±0.25°. Further study is needed.

MSEC_ICMP2008-72357

DEVELOPMENT OF A METHOD TO EVALUATE TRIBOLOGICAL PERFORMANCE OF LUBRICATION COATINGS FOR COLD FORGING

Ryuichi Tokunaga — *Gifu University*
Zhrgang Wang — *Gifu University*
Shinobu Komiyama — *Gifu University*

In backward extrusion type friction tests, tensile and compressive strain that is created in the side of a cylinder coated with a lubricant in a placing process, with a placing ratio of 71.4%, causes damage to the adhesive state of the coating. This damage is enhanced because of backward extrusion against that surface, making this a harsh process for solid coatings, for which we conducted a comprehensive evaluation of adhesion to the material, compliance to the expanding surface area, and seize resistance. In addition, from the position after forging of a center line drawn on the workpiece in advance, we could estimate the coefficient of friction between the outer die and workpiece. A die was designed and produced using FEM, and a test was conducted using a bonderized coating and an applied alternative coating. This test method is thought to be able to evaluate, with good responsiveness, the normal friction state of the lubrication coating on a processed surface, and will make a significant contribution as a method of evaluating lubrication coatings.

MSEC_ICMP2008-72372

PRECISION OF FEM SIMULATION IN INJECTION MOLDING

Shingo Ozu — *Gifu University*
Zhrgang Wang — *Gifu University*

The aim of this study was to investigate the optimum design for an injection molding die using simulation technology. The first step was to investigate the fluidity of resin, transferability of the mold surface pattern, and flow defects in injection molding of a spiral-shaped, thin-walled part. In conducting the tests, differences were seen in the

surface roughness of the molded part and mold. Comparison of the test and simulation revealed that while fluidity predictions with MPI agreed qualitatively with experimental results, there was a quantitative difference. Changing resin temperature had a greater effect than changing mold temperature on fluidity. The locations where defects occurred could be predicted using MPI.

MSEC_ICMP2008-72452

FATIGUE CRACK GROWTH BEHAVIOR OF HIGH CARBON STEEL (SM53C) BY USING INDUCTION HARDENING

Hyunbae Jeon — *GyeongSang National University*
Taehoon Song — *Department of Mechanical and Precision Engineering, Gyeongsang National University*
Sungho Park — *Department of Mechanical and Precision Engineering, Graduate School, GyeongSang National University*
Sunchul Huh — *Research Center for Aircraft parts Technology, Gyeongsang National University*
Wonjo Park — *Department of Mechanical and Aerospace Engineering, Gyeongsang National University*

Recently, with the high performance and efficiency of machine, there have been required the multi-functions in various machine parts, such as the heat resistance, the abrasion resistance and the stress resistance as well as the strength. Fatigue crack growth tests were carried out to investigate the fatigue characteristics of high carbon steel (SM53C) experienced by high-frequency induction treatment. The influence of high-frequency induction treatment on fatigue limit was experimentally examined with the special focus on the variation of surface microstructure and the fatigue crack initiation and propagation through fractography. Also, the shape of hardening depth, hardened structure, hardness, and fatigue-fracture characteristics of SM53C composed by carbon steel are also investigated.

MSEC_ICMP2008-72453

A STUDY ON THE TRIBOLOGY CHARACTERISTICS AND PROCESSING OF MOSI2 COMPOSITES

Sungho Park — *Department of Mechanical and Precision Engineering, Graduate School, GyeongSang National University*
Wonjo Park — *Department of Mechanical and Aerospace Engineering, Gyeongsang National University*
Sunchul Huh — *Research Center for Aircraft parts Technology, Gyeongsang National University*
Ilsu Han — *School of Materials , Arizona State University*

In this study, monolithic MoSi2, 20 vol.% SiC particles-reinforced MoSi2 matrix, SiC/MoSi2 composite and 20 vol.% ZrO2 particles-reinforced MoSi2 matrix, ZrO2/MoSi2 composite was fabricated by hot pressed sintering at 1350oC under 30 MPa during 60 min. Vickers hardness and sliding wear resistance of the monolithic MoSi2, ZrO2/MoSi2 and SiC/MoSi2 composite was investigated at room temperature. Wear behavior test carried out by the pin on disk wear tester. Silicon nitride ball was used to wear test. The ZrO2/MoSi2 composite has shown the very excellent wear resistance compared with monolithic MoSi2 and SiC/MoSi2 composite at room temperature.

MSEC_ICMP2008-72482

FASTENING FORCE MONITORING SYSTEMS FOR BOLTED JOINTS USING SEMICONDUCTOR STRAIN SENSORS

Toshio Hattori — *Gifu University*
Kenji Nurikabe — *Gifu University*
Takashi Hayakawa — *Gifu University*
Naoya Nishimura — *Meijo University*
Minoru Yamashita — *Gifu University*
Yoshimizu Iida — *Hitachi Eng. & Service Co. Ltd.,*
Toshiaki Kobari — *Hitachi Eng. & service Co. Ltd.,*
Hiroyuki Ohta — *Hitachi Ltd.,*

Lately there happened many loosening or failure accidents in bolted joints, such as trailer's wheel/hub joint structures and airplane mechanical systems. To avoid these accidents and increase the safety for long life operation of these traffic systems an idea of fastening force monitoring system were proposed, and availability of these systems in traffic or industrial fields were discussed. Lately the semiconductor strain sensor is attracted considerable attention for it's sufficient sensitivity, linearity and

stability, so a semiconductor strain sensor were chosen for the monitoring sensor. The fundamental characteristics of these sensors were examined, and the twenty times higher sensitivity compared with traditional wire strain gages, linearity of less than 3.3% deviation and high stability of less than 1.4% / ? under temperature change were confirmed. And availability of semiconductor strain sensor and wireless data transmission systems for fastening force or loosening behavior monitoring systems of bolted joints was examined.

MSEC_ICMP2008-72510

GREEN MANUFACTURING OF ELECTRICITY FOR STATIONARY INDUSTRIAL APPLICATIONS

Zulfiqar Ali-Qureshi — *University of Windsor*

On-site power generation in industrial plants are desirable, however, this may not contributes a significant source of pollution to the environment. In order to lower the potential impact on the environment in terms of less toxic emissions, to save useless cost and the sustainability, manufacturer's responsibilities become more than end-of-pipe control and includes end-of-life management. Green manufacturing is the method that minimizes waste and pollution achieved through product and process life cycle design. The cradle to grave analysis in the green manufacturing system provides the complete analysis in every aspect of the sustainable manufacturing system for policy makers to take decisions. In this paper the renewable source of alternate energy manufacturing system has been analyzed for production of power. The renewable energy from hydrogen and (green gas synthetic natural gas) for generation of electricityhas been studied by focusing large stationary application set up in view. A prototype model has been developed in order to draw analogy for establishing future Industrial power parks of mega energy productions in order to meet the peak load requirements of the electricity consumption. The results has been analyzed and comparison have also been made for the purpose to apply green industrial manufacturing process in renewable energy sector as much as possible for reducing waste with zero percent potential environmental burden on our eco-system.The life cycle assessment of the two fuels natural gas and hydrogen gas has been carried out for model eco-design in order to accomplish the goal. An Eco-design for 1kwh electricity generation by using renewable fuel is proposed for study in order to make a prototype concept upon the bases of which the analogy can be drawn for the mega power projects. The main purpose and aim of the study is to find out; the facts and convincing results which can enable the policy makers to understand in reality and the crux of the issue associated with the hydrogen economy as described by Bossel Ulf and Eliasson B. et al (2005) in their report and the future of renewable fuel by visualizing the power parks and general stationary applications. The aspects of Impact Assessment of the model have been presented here in this paper which upon are based upon life cycle assessment of the two fuels natural gas and hydrogen gas. The earlier work in this regard which has been made by the Angelo Riva et al (2006) and Pamela Spath et al (2001) has been found general But an attempt has been made in this paper to present more specific results for a model eco-design in order to establish a case for a green gas as mentioned by Mozaffarian et al (2004).

MSEC_ICMP2008-72546

APPLICATION OF ENVELOP ANALYSIS AND WAVELET TRANSFORM FOR FAULT DETECTION IN LOCAL GEARBOXES FAILURE

Dong Sik Gu — *Gyeongsang National University*
Byeong Keun Choi — *Gyeongsang National University*
Jeong Hwan Lee — *Gyeongsang National University*
Byeong Su Kim — *Gyeongsang National University*
Jong Duk Son — *Pukyeong National University*
Bo Suk Yang — *Pukyeong National University*
Achmad Widodo — *Diponegoro University*

Vibration analysis is widely used in machinery diagnosis and the wavelet transform has also been implemented in many applications in the condition monitoring of machinery. In contrast to previous applications, this paper examines whether acoustic signal can be used effectively along vibration signal to detect the various local fault, in local fault of gearboxes using the wavelet transform. Moreover, envelop analysis is well known as useful tool for the detection of rolling element bearing fault. In this paper, acoustic emission (AE) sensor is employed to detect gearbox damage by installing them around bearing housing at driven-end side. Signal processing is conducted by wavelet transform and enveloping to detect the fault all at once gearbox and bearing using AE signal. Result of fault detection is presented using some general statistical features and a proposed new feature (RGF: Ratio of Gear Frequency) for gear fault calculated from AE signal with different condition.

MSEC_ICMP2008-72560

IMPACT OF NATIONAL SCIENCE FOUNDATION NEXT GENERATION MANUFACTURING: WHERE ARE WE NOW?

Karen Wosczyna-Birch — *CT Comm-Tech Colleges' College of Technology Regional Ctr. for Next Gen. Mfg*
Paola Jaramillo — *Board of Trustees, CT Comm-Tech Colleges' College of Technology Regional Center for Next Gen. Mfg*
Kerry Simoneau — *CT Comm-Tech Colleges' College of Technology Regional Ctr. for Next Gen. Mfg*
Robert Simoneau — *Keene State College*

In 2004, the College of Technology received an NSF ATE award to establish the Regional Center for Next Generation Manufacturing (RCNGM), DUE-ATE# 0402494. Its unique governance, strengthened by its partners, has ensured the success of the COT- RCNGM. The COT-RCNGM is in its fourth year of operation and has catalyzed technician and engineering education throughout Connecticut through its 2+2+2 seamless pathways and utilization of industry and university validated curriculum. The COT-RCNGM has leveraged NSF funding and has received over $400,000 in cash donations and another $650,000 through in-kind support. Over the last three years the COT-RCNGM has engaged 247 faculty members from community colleges; 49 faculty members and deans from the public and private 4-year institutions. In addition, the COT-RCNGM actively engaged 500 middle and high school teachers. These efforts directly involved 30,000 students. The broader impact is both regional and national, as the COT-RCNGM collaborates with 11 Advanced Technology Education Centers and 9 Advanced Technology Education Projects. The following paper focuses on a review of the College of Technology Regional Center for Next Generation Manufacturing throughout its four years of operation. The paper review will highlight the accomplishments and goals that have successfully strengthened the Center throughout the years.

MSEC_ICMP2008-72561

DEVELOPMENT OF THE PROCESS OF HONEYCOMB SEAL FOR GAS TURBINE

Kyu-Taek Han — *Pukyong National University,School of Mechanical Engineering*

In this research, numerical approach for modeling the behavior of honeycomb core material is studied. Also, the optimal forming process of the honeycomb core is developed and the rolling process is analyzed. The part of the honeycomb is modeled using the commercial S/W, CATIA. And the rolling process is simulated using finite element code, DEFORM-3D. The standard honeycomb has a uniform hexagonal structure defined by the material, cell size, cell wall thickness and bulk density. The simulation results are reflected to the forming process design for the honeycomb core.

MSEC_ICMP2008-72565

RESEARCH OF OPTIMUM MODEL SIZE FOR SHOT PEENING SIMULATION

Masahiro Kitamura — *Meiji University*
Katsuji Tosha — *Meiji University*

This paper presents several analyses on a dent profile produced by a single shot using a finite-elements package. A finite element model is discussed in order to clarify the influences of peening conditions and characteristics of shot and work materials on the surface aspect, which is closely related to several peening effects. In addition, the influence of the size of work material on the dent form was also investigated.

MSEC_ICMP2008-72566

EFFECT OF CHARACTERISTICS OF PEENED SURFACE ON FLOW RESISTANCE

Hiromitsu Kiyoto — *Meiji University*
Katsuji Tosha — *Meiji University*

This paper experimentally considers the influence of the dimple produced by shot peening on the flow resistance. In order to clarify the influence of surface characteristics on flow resistance, test cylinders were shot peened under various conditions. The pressure distributions on the cylinder surface were measured with a small wind tunnel. The influences of air velocity, peening conditions and the cylinder diameters on drag coefficient were studied.

MSEC_ICMP2008-72569

FLEXIBLE GRIPPER SYSTEM FOR SMALL OPTICAL ASSEMBLIES

Mikko Remes — *Tampere University of Technology*
Riku Heikkilã¤ — *Tampere University of Technology*
Timo Prusi — *Tampere University of Technology*
Taeho Ha — *Korea Institute of Machinery and Materials (KIMM)*

Jun Yeob Song — *Intelligent Machine Systems Research Center, Korea Institute of Machinery and Materials*
Chang Woo Lee — *Intelligent Machine Systems Research Center, Korea Institute of Machinery and Materials*
Reijo Tuokko — *Tampere University of Technology*

This poster presents gripper tool for assembly of small lens components. Machine vision system is used for detecting the position of the lenses in gripper. Smallest component is 4 millimeters in diameter. The microgripper consisted two parts, the frame and the tool. The tool is removable so that it could be changed for different objects. In the microgripper frame there is two negative pressure channels. One channel is for attaching the tool to the frame and the other negative pressure channel is used for the tool to grab hold of the manipulated object. The vision solution uses preprocessing algorithms to find the edge of the lense. From the edge Hough transformation is used for detecting the center point of the circle and the orientation of the lens. The hough transformation for circular patterns makes it possible to detect the center point even if the endge line is partially covered. After the center point is located the offset for robot could be calculated. This kind of arrangement enables precision assembly.

MSEC_ICMP2008-72573

ULTRA HIGH-SPEED MICRO-MILLING SPINDLE

Said Jahanmir — *Mohawk Innovative Technology, Inc.*
Hooshang Heshmat — *Mohawk Innovative Technology Inc.*
Zhaohui Ren — *Mohawl Innovative Technology, Inc.*
Michael Tomaszewski — *Mohawk Innovative* Technology, Inc.
James Walton, Ii — *Mohawk Innovative Technology, Inc.*
John E Lawler — *Mohawk Innovative Technology. Inc.*

Product miniaturization has led to the development of micro-manufacturing technology. Industries such as defense, medical, industrial packaging, and transportation require the manufacturing of small-sized precision components with miniaturized features. Currently these parts are being fabricated with silicon technology, with large scale machines or with small desk-top machines. For efficient material removal and fast production rates, the speed at the cutting point should be comparable to the speeds achieved in macro-machining. While the present micro-machining systems offer spindle speeds on the order of 100,000 rpm, the small cutting tools (50 micron to 1 mm diameter) used in micro-machining limit the surface speeds achieved at the cutting point. This causes a severe limitation on production rates, increases tool wear, and limits the degree of dimensional tolerances and precision that can be obtained. A new ultra-high-speed micro-spindle has been developed for micro-milling that can be used at rotational speeds as high as 500,000 rpm. The fully assembled MiTiUltraâ„¢ Spindle measures only 2 cm in diameter with a height less than 4 cm. Since conventional ball bearings or fluid lubricated journal bearings cannot be used at speeds beyond 300,000 rpm for any extended period of time, the MiTiUltraâ„¢ uses a set of journal and thrust foil bearings. Prior to fabrication of the micro-spindle, rotordynamic analysis of the rotor with an attached cutting tool confirmed that the rotor would be stable at the desired speeds. The cutting tool was then attached to the rotor using a shrink-fit approach. The micro-spindle was integrated with a 2-axis micro-milling machine. Cutting experiments were performed on an aluminum alloy and steel at speeds greater than 300,000 using 50 and 300 micron end-mills. Vibration spectra for free rotation and during cutting confirmed the dynamic stability of the micro-spindle. The vibration spectrum was dominated by the operating frequency and was free of deleterious vibrations. Some low frequency peaks associated with cutting were evident but did not pose any difficulty. The increase in rotational speed to 450,000 rpm in micro-milling of aluminum alloy allowed an increase in feed rate to nearly 800 mm/min (the maximum feed rate available by the positioning stage), thus increasing the material removal rate by more than two orders of magnitude. The dimensional accuracy of several straight cuts made at different feed rates and depths of cut was measured. Micro-machining at such high speeds, and in combination with high feed rates, has never been achieved before.

MSEC_ICMP2008-72575

SEMISOLID POWDER FORMING FOR MICRO MANUFACTURING

Yufeng Wu — *Iowa State University*
Gap-Yong Kim — *Iowa State University*

A novel Semisolid Powder Forming (SPF) technique is investigated for potential application in net-shape manufacturing of miniature parts. Conventional methods such as forging requires high force and casting suffers shrinkage defects. These issues can be overcome by forming alloy materials at semisolid state. SPF is based on semisolid processing technique, but replaces bulk feedstock with readily available powders. This enables fabrication of tailored structure by mixing different powders. However, very little is known of the behavior of semisolid powder flow, phase segregation phenomena, and micro-cavity filling characteristics of semisolid powders. Therefore, this project aims to identify important processing parameters and study their effects. Preliminary study was performed on the effects of pre-compact on the microstructure and phase

segregation. Significant phase segregation was observed between the small channel area and the base of the sample.

MSEC_ICMP2008-72576

FORCE MODELING OF THE MICRO-GRINDING PROCESS

Hyung-Wook Park — *Korea Institute of Machinery & Materials*
Steven Liang — *Manufacturing Research Center (MaRC), Georgia Institute of Technology*
Jong-Kweon Park

Mechanical micro-grinding with micro/meso-grinding wheels is a micro-machining process for fabricating micro/meso-sensors and actuators. The quality of these fabricated parts is affected by micro-grinding process conditions, micro-grinding wheel properties, and microstructure of materials. Therefore, modeling of micro-grinding is necessary. In this study, the new predictive model for micro-grinding was developed by consolidating mechanical and thermal effects within the single grit interaction model at micro-domain. In order to assess thermal effects, the thermal model based on a moving heat source is integrated within the developed model. This model quantitatively predicts micro-grinding forces based on micro-grinding wheel topography and material properties including crystallographic effects. To validate this predictive model, the experiments based on the micro-grinding setup were performed. Then, a comparison between experimental data and analytical predictions was conducted in view of the overall micro-grinding forces in the x and y directions.

MSEC_ICMP2008-72580

SIMULATION STUDY OF MICRO ASSEMBLY MACHINE FOR LENS MODULE

Dug Hee Moon — *Department of Industrial and Systems Engineering, Changwon National University*
Bing Lin Zhang — *Department of Industrial and Systems Engineering, Changwon National University*
Jin Wook Kim — *Department of Industrial and Systems Engineering, Changwon National University*
Jun Yeob Song — *Intelligent Machine Systems Research Center, Korea Institute of Machinery and Materials*
Chang Woo Lee — *Intelligent Machine Systems Research Center, Korea Institute of Machinery and Materials*

Virtual manufacturing (VM) is well known as the effective technology for developing a new product, new equipment and new manufacturing system, and three-dimensional (3D) simulation is a core technology in VM. 3D simulation involves both mechanical simulation and discrete event simulation. This paper introduces a case study of implementing 3D mechanical simulation for developing a semi-automatic assembly cell in a Korean optical factory. This factory produces a lens module that is the part of a phone-camera. The newly designed assembly cell pursues the concept of micro-machine. In the conceptual design and the initial design phases for equipment, 3D mechanical simulation using CATIAÂ® and IGRIPÂ® is conducted. As a result, various design error are detected and modified and the cycle time is reduced by changing the operational logic

MSEC_ICMP2008-72584

3D HOLLOW POLYMERIC MICROSTRUCTURES OBTAINED BY PARTIAL MOLDING FOR SHEAR-PROTECTING CELL CONTAINERS WITHIN MICROFLUIDIC CHANNEL

Sung-Hoon Lee — *Seoul National University*
Kahp-Yang Suh — *Seoul National University*
Min-Cheol Park — *Seoul National University*
Chan-Ick Park — *Seoul National University*
Hong-Nam Kim — *Seoul National University*

The ability to capture living cells inside a microfluidic channel in a scalable, shear-protecting manner is important for the development of high-throughput cell screening and biological analysis. Here, we present a simple soft lithographic method to integrate highly optimized, hollow polymeric microstructures within a microfluidic channel for cell docking and shear protection. The 3D hollow polymeric microstructures were generated by partial molding of polymethyl methacrylate (PMMA) through a solvent-assisted capillary molding technique. The molded polymeric microstructures were used to capture budding yeast cells, Saccharomyces cerevisiae, within a microfluidic channel and the response of yeast cell was observed upon stimulation by the mating pheromone (@-factor) or high osmolarity (KCl) by monitoring the expression of green fluorescent protein (GFP) over time. Also, the shear-protecting ability was evaluated by quantitatively analyzing the intensity of fluorescence from docked and non-docked cells. It was found that the fluorescence intensities of docked cells were slightly decreased when stimulated by @-factor and were increased when stimulated by high osmolarity even for a long-term exposure to a laminarly flowing stream, whereas that of non-docked cell was decreased drastically within a short period of time by both stimulations. These experimental findings were in good agreement with computational fluid dynamics (CFD) simulations.

MSEC_ICMP2008-72585

THE MICRO PATTERN FORMING ON THE METAL SUBSTRATE USING AN FREQUENCY FORMING PROCESS

Hye-Jin Lee — *Korea Institute of Industrial Technology (KITECH)*
Jong-Pil Choi — *Kangwon National University*
Byeong-Hee Kim — *Kangwon National University*
Seongouk Kim — *Space Solution Inc.*
Junhee Shin — *Space Solution Inc.*
Andy Chu — *Space Solution Inc.*
Nak-Kyu Lee — *Korea Institute of Industrial Technology (KITECH)*
Geun-An Lee — *Korea Institute of Industrial Technology (KITECH)*
Hyoung-Wook Lee — *Chungju National University*
Sung-Min Bae — *Hanbat National University*
Moon-Young Hwang — *Hyechon College*
Jung-Han Song — *Korea Institute of Industrial Technology*

In this Research, the frequency forming method is suggested to micro pattern forming on the metal substrate and the optimal frequency can be manufactured micro pattern on the metal substrate is researched using an experimental method. So many researchers study about micro forming technology such as micro deep drawing, press forming, forging, extrusion etc. But if we want to make a micro pattern on the surface of metal substrate, we must use multi-step forming process to maintain the size of product or substrate. The frequency forming method can be used to solve this problem because the frequency forming method makes the surface to be a vibration mode status and easily deform the surface profile of mold. This paper describes the frequency forming system and optimal frequency range to make a micro pattern on the metal substrate (Cu materials). The frequency range can be classified to high frequency, super sonic range, and low frequency range.

MSEC_ICMP2008-72591

EXPERIMENTAL STUDY OF SUBMERSED GAS-JETTING EDM

Xiaoming Kang — *Shanghai Jiao Tong University*
Wansheng Zhao — *Shanghai Jiao Tong University*
C. J. Tang — *Shanghai Jiao Tong University*
L. S. Ding — *Shanghai Jiao Tong University*

A new method called submersed gas-jetting EDM was proposed, in which the high-pressure gas working as the dielectric medium, is blown throughout the inner hole of a tubular electrode, and machining liquid around the gas plays significant roles of helping cooling and debris evacuation but doesn't involve in the discharge directly. Experiments were conducted to investigate the influence of polarity, pulse duration, peak current, gas pressure and different gas/machining liquid combination. The comparison of submersed gas-jetting EDM and dry EDM indicated that this new method revealed higher material removal rate (MRR), better surface quality and equivalently minute electrode wear.

MSEC_ICMP2008-72593

INTERFACIAL STRENGTH EVALUATION IN GLASS FIBER REINFORCED COMPOSITES USING THE CRUCIFORM SPECIMEN METHOD

Shinji Ogihara — *Tokyo University of Science*
Hajime Kato — *Tokyo Unverstiy of Science*

In fiber reinforced composite materials, the interface between the fiber and the matrix plays a key role in mechanical properties of composite materials. Therefore, a more accurate evaluation method of the interface is necessary to develop better fiber reinforced composite materials. Many techniques are used for evaluating the interfacial properties. An interfacial strength evaluation method using cruciform specimens has a feature that it can avoid the influence of the stress singularity at the free edge. The purpose of the present study is to verify the validity of the cruciform specimen experimentally and analytically. A GF/Epoxy model composite is used. The initiation and propagation of interfacial debonding in both cruciform specimen and straight specimens are experimentally clarified. Moreover, stress analysis using finite element method (FEM) is conducted.

MSEC_ICMP2008-72594

NET SHAPE PROCESSING OF MICRO/MESO-SCALE STEM WITH GROOVES, STEPS AND THREADS BY CROSS WEDGE ROLLING

Isao Kuboki — *Shizuoka Institute of Science and Technology*

A new mass production technique using cold multistage forging and form rolling for the fabrication of a wristwatch part called the "winding stem" has been investigated. The winding stem, which has minute diameters and a long complicated shape, comprising grooves, steps and threads, can be fabricated into its final shape by cold multistage forging and form rolling in a fairly short time (about 3 seconds), which is one-eighth of the time required for the conventional turning process. In particular, the grooves, steps and threads of the final product can be simultaneously

formed in only one stroke by form rolling (cross wedge rolling) with tabular shaped tools characterized by wedges which allows the diameter of the blank produced by cold forging to be reduced and increased, that are cut into the final product. The success of this process depends on being able to suitably design the tool, taking into consideration the flow of the material. The machine used for cross wedge rolling is able to accurately adjust the position of each tool by dividing the tool into four sections, and has the feeder that the blank accurately bites to the tool. Cracks are not observed on the surface or inside of the products successfully cross wedge rolled. The maximum bending load of the products quenched after cross wedge rolling is Pmax = 16.1N, which is approximately 20% larger than that of products fabricated by the conventional turning process. Next, various finishing treatments on the surfaces of tabular shaped tools have been carried out. The treatments' effects on the lifetime of these tools have been investigated. In cross wedge rolling, it is possible to reduce the wear experienced by tools to a greater extent by applying TiCN coating to their surface rather than by DLC coating and to even further decrease the degree of wear by applying cementation and plasma nitriding to the tools. Tools subjected to multi-stage surface treatments, such as coating with TiCN after plasma nitriding, show markedly reduced wear. Employing these multi-stage surface-treated tools in the cross wedge rolling process makes it possible to minimize the dimensional changes in sizes of products and manufacture products in large volumes that exceed 7Ã— 105 pieces.

MSEC_ICMP2008-72595

SEARCH FOR NOVEL MEMS MATERIALS USING A COMBINATORIAL METHOD

Seiichi Hata — *Tokyo Institute of Technology*

A new combinatorial method to deposit thin film alloys using arc plasma, termed combinatorial arc plasma deposition (CAPD), was applied to search for novel compositions of thin film metallic glasses (TFMGs) as new MEMS materials. The CAPD setup includes three arc plasma guns (APGs), with each gun shooting pulse-like plasma of constituent elements at specific time intervals to deposit a compositionally graded thin film alloy on a SiO2 substrate. The deposited thin film was separated into 1,089 samples (the size of each is 1x1mm2) on the substrate. The samples together are called the thin film library. First, a Pd-based thin film library was deposited to search for the lowest resistivity composition of Pd–Cu–Si TFMGs for MEMS microprobes. The Pd81Cu5Si14 (at.%) sample exhibited the lowest absolute resistivity of 64 ohm cm and a supercooled liquid region (SCLR) temperature range (DTx = Tx - Tg) of 50 K. Next, we discovered a novel Ru–Zr–Al TFMG using CAPD. Differential scanning calorimetry revealed that sputter-deposited samples with the composition Ru65Zr30Al5 showed an SCLR. Moreover, the sample exhibited superior mechanical properties and wear resistance for microprobes..

MSEC_ICMP2008-72596

REDUCTION OF FRETTING WEAR USING DLC COATING SHIM INSERTS

Mai TAKASHIMA — *Nagoya University*
Tsuyoshi Kuroda — *Nagoya university*
Naoto OHTAKE — *Nagoya University*
Makoto MATSUO — *iMott Inc.*
Yoshinao IWAMOTO — *iMott Inc*
Masanori SAITO — *Tokyo Institute of Technology*
Masao KUMAGAI — *Kanagawa Industrial Technology Center*
Makoto Kano — *Kanagawa Industrial Technology Center*
Hiroshi KIMOTO — *Kobe Material Testing Laboratory*
Masaru SHINOHARA — *KURITA SEISAKUSYO Co., Ltd.*

The purpose of this study is to find the way to reduce wear of cast iron (FCD)/aluminum components that are usually applied to automotives and to extend the lifetime of them. This time, we designed a stainless steel shim. We fabricated continuous DLC (C-DLC) films and segment-structured DLC (S-DLC) films on the steel substrates by Plasma Based Ion Implantation and Deposition (PBII&D) method, then evaluated the tribological and fatigue characteristics of the shim by ball-on-disk test and bending fatigue test. This S-DLC excels in strain and abrasive wear resistances compared to continuous DLC film. As a result, S-DLC film showed more excellent tribological properties than that of C-DLC film and gave high abrasion resistance. These results led us to the conclusion that S-DLC coated SUS shim has a remarkable effect on reducing wear of FCD/Al components and improving the lifetime due to the reduction of the abrasive wear.

MSEC_ICMP2008-72598

DEFORMATION MACHINING: A NEW HYBRID PROCESS

Bethany Woody — *UNC Charlotte*
K. Scott Smith — *University of North Carolina at Charlotte*
Jian Cao — *Northwestern University*
John Ziegert — *Clemson University*
Ted Belytschko — *Northwestern University*
Tim Foecke — *NIST*
Ming Li — *Alcoa Technical Center*

Deformation Machining is a novel hybrid process that combines two manufacturing techniques -- single point incremental forming (SPIF) and thin part machining. Integrating these two processes on one 3-axis CNC machine and in one setup provides the ability to create parts with geometries normally requiring a 5-axis machine or that were previously difficult or impossible to make. Thin part machining involves using a special tool and unique machining strategy to create thin walls and floors that can be as thin as sheet metal. SPIF is forming using a tool that only contacts the sheet metal at a single point. The tool follows a path that incrementally deforms the work piece into the desired geometry. Deformation Machining has the potential to provide a unique new manufacturing capability, enabling the creation of structures that are monolithic, less expensive, more accurate, and have unique geometries. The impact of successful development and implementation of Deformation Machining will result in savings in three areas: equipment/ fabrication costs, higher accuracy for the parts, and weight reduction. However, the real benefit will come from the freedom which this new process gives designers to conceive new structures that cannot be made using existing processes.

MSEC_ICMP2008-72599

MICROMIXING WITH 3D POROUS STRUCTURE FABRICATED USING HIFU

Hai Wang — *University of Washington*
Wei Li — *University of Washington*

In chemical and biological applications, mixing on the micro scale is important and has been considered one of the most challenging tasks. With a trend for polymeric microfluidic systems, a simple yet effective micromixer is highly desirable. We present a novel passive micromixer with 3D porous microstructure fabricated using high-intensity focused ultrasound (HIFU). The 3D porous microstructure can split, stretch, fold and break flows in microfluidic channels effectively and thus dramatically improve the mixing efficiency. The selective HIFU foaming technique is low-cost and biocompatible. We report on the performance of the porous micromixer in this communication. The design and fabrication is described. The effects of the foaming process parameters are discussed. The performance of the proposed micromixer is demonstrated with a flow visualization experiment. It is shown that the porous micromixer performs effectively under a wide range of Reynolds numbers. Sufficient mixing is achieved with a short mixing length and Reynolds numbers as low as 0.1.

MSEC_ICMP2008-72600

EFFECT OF SKEW OF DRIVING ROLLERS ON SURFACE DAMAGES UNDER ROLLING FATIGUE CONDITION

Koji Fujimoto — *The University of Tokyo*
Akihiro Yuuki — *Isuzu Motors Limited*

In this study, rolling contact fatigue tests were carried out in order to clarify the effects of the skew on the damages or the crack propagations due to rolling fatigue. In this experiment, the testing machine of the three rollers type was used, in which the skew can be given between a follower (specimen) and two driving rollers. After the rolling tests, the damages on the rolling surfaces of the specimens were observed. Furthermore, the specimens were cut so that the propagation directions of fatigue cracks could be investigated. As the results of the observation, it has been made clear that the direction of the crack propagation coincides distinctly with that of the plastic flow of surface layer due to tangential traction induced by the skew.

MSEC_ICMP2008-72601

FUEL CELLS ASAP: AUTOMATED STACK ASSEMBLY PROCESS

Christina Laskowski — *Rensselaer Polytechnic Institute*
Stephen Derby — *Rensselaer Polytechnic Institute*

As demand for PEM fuel cells rises, stack assembly must transition from a highly manual process to a highly automated one. This poster documents work completed towards a robotic, fully automated PEM-based stack assembly processing cell. Current assembly methodology is analyzed; industrial manufacturing theory is discussed relevant to the fuel cell industry. A manufacturing cell is then constructed, using two Kuka 6-DOF robots. Each robot is outfitted with a different custom-designed end effecter. A custom parts feeder sends these parts to the robots, while a linearly-actuated, self-leveling cart receives them and shuttles the growing stack from one station to the next. Meanwhile, a vision system corrects for MEA/gasket misalignment prior to placement. The system works well in

many respects, although there are some timing concerns. Future work includes documenting process test statistics, balancing of the manufacturing line, and integration of statistical process control (SPC) and leak testing controls.

MSEC_ICMP2008-72603

ANALYSIS BY EELS WITH ALUMINUM SURFACE FILM SECTION GENERATED WITH CHEMICAL POLISHING

Emi Shindou — *Musashi Institute of Technology*
Akira Yoshida — *Musashi Institute of Technology*
Naoki Hamamura — *Musashi Institute of Technology*
Eiji Yuasa — *Musashi Inst. Tech.*
Naoto OHTAKE — *Nagoya University*

Chemical polishing solution for aluminum based on mixtures of phosphoric and nitric acid to be responsible for the air pollution with hazardous gaseous emission such as NOx during the chemical polishing process, and for the water pollution due to the effluent of waste water that contains phosphate and nitrates.?Hence, we developed to apply an alkaline solution containing sodium hydroxide and sodium persulfate as a solvent and an oxidizing agent, respectively, to polish aluminum. And exceptionally bright surface of aluminum could be obtained by using this polishing solution. The surface layer of polished aluminum surface was cut to thin film by the ultra-microtomy, and then it was analyzed by electron energy loss spectroscopy (EELS), for clarify on the polishing mechanism. As result, Al2O3 and Al(OH)3 compounds were detected, those compounds were consisting of (Al2O3-Al(OH)3-Al2O3) 3 layer structure.

MSEC_ICMP2008-72605

LIGHTWEIGHT DESIGN OF AUTOMOTIVE CHASSIS USING FATIGUE PROPERTIES AND FINITE ELEMENT ANALYSIS

Ali Bagherzadeh — *Amirkabir University of Technology*
Mojtaba Javaheri — *Amirkabir University of Technology*

The object of this work is to represent a numerical method based on experimental results, in order to replace a sport utility van (SUV) chassis made of ST 52 steel (ST chassis), with a Niobium -and- Vanadium microalloyed (MA) steel one (MA chassis). The purpose was improving fatigue strength whilst reducing its total weight by applying some modifications in the thicknesses of the chassis wings. Fatigue tests under stress and strain control conditions were carried out on the samples prepared from the ST 52 and microalloyed steel strips. Thicknesses of the microalloyed chassis wings were determined using Finite Element Method (FEM) analysis considering static and dynamic loading conditions. Also the mechanical strength and fatigue of the mentioned steels are compared and discussed. Despite the higher ultimate tensile strength of ST 52 steel the studied microalloyed steel shows approximately 15 (MPa) higher fatigue strength.

MSEC_ICMP2008-72607

MICRO PUNCHING SYSTEM USING PUNCH AND DIE MADE BY EDM

Toshihiko Mori — *Nagoya Universury*
Mark Broomfield — *Nagoya University*
Teruaki Mikuriya — *Nagoya University*

Abstract: the new micro punching system is a mehtod of production of micro-holes of 10-50 âµm diamtere using a specially made tungsten and die. For construction of the suystem, new processes of electric discharge machining (edm) to produce a tungsten and a micro-die hole were developed, and computer programs to control the movement of the punch holder, and the material to be punched were written. Micro punches with diamteres from 19 âµm to 85 âµm were produced on trial. The punch and die wereplaced on a micro-die set and die hole was machined. The die set was placed on the micro- press and trial punching was conducted. Micro-punching was conducted using a 50 âµm diameter micro punch on 50 âµm thick aluminum, 30 âµm thick copper and 20 âµm thick stainless steel foils. Concequently, the effective length for punching was determined to be from 90 âµm to 120 âµm. With the aid of a scanning electron microscope the sheared surfaces of the holes produced appeared truly round, clean, free of burrs and without deformation. The punch tool surface showed no signs of noticeable cracks or deformation even after repaeted.

MSEC_ICMP2008-72612

ON PERMANENT WRINKLES IN A TUBE-HYDROFORMED AUTOMOTIVE PART

Fuh-Kuo Chen — *National Taiwan University*

In the present study, the permanent wrinkles occurred in a tube-hydroformed automotive part was examined by both the finite element analysis and the actual tube-hydroforming production processes. The finite element simulation results confirm that the excessive material gathered in a local deep wrinkle area that resulted from the preceding operations, including bending operation and pre-forming operation, leads to the occurrence of permanent wrinkles in the finished part. A ratio of local excessive material (rw) produced in the preceding operations was

proposed as an index for accessing if the deep wrinkles could be removed in the hydroforming process. The proposed index that can be used to predict the occurrence of permanent wrinkle was applied to analyze the permanent wrinkles in the production part. Optimum bending angle and pre-forming die design were also developed and validated by the sound production part without the occurrence of permanent wrinkles.

Symp 6-2 GENERAL MEETINGS AND PLENARY TALKS

MSEC_ICMP2008-72622

ENERGY TECHNOLOGY AND THE ENVIRONMENT: ADVANCES IN RENEWABLES

James Maughan — *General Electric Corporation*

In meeting society's increasing demand for energy, the environmental impact of any particular choice is emerging as a business factor as significant as efficiency, fuel availability, security, or even cost. This in turn is driving the development of new technologies that reduce environmental impact, often at the expense of other factors, forcing larger choices to be made. This lecture will focus on the promise and perils of some of these new energy technologies under development at GE Energy and elsewhere. Options range from improving current technologies such as steam-cooled gas turbines, coal gasification with CO2 sequestration, nuclear power, and wind turbines to advancing newer potential solutions such as solid oxide fuel cell hybrids, organic photovoltaics, hot dry rock energy, superconducting electrical systems, and a broad hydrogen economy. Particular focus is given to advances in wind turbine technology, the fastest growing renewable energy source today and where GE has recently built a $7B business. No single technology is likely to be the entire answer. Each will challenge engineers well in to the future. Continuous technology development, however, will create the options from which to choose energy sources that are cost effective, secure, and environmentally sustainable.

MSEC_ICMP2008-72623

ESTIMATION THEORY OF CREEP BEHAVIOR ON FIBER REINFORCED THERMOPLASTICS

Reiji Nakamura — *Keio University*

Structure and parts in some machines which are made with some engineering polymers usually show creep deformation. In the case of delicate machines, the deformation according to time and temperature becomes a problem. Composition of reinforcements in resin is well known to decrease the creep progress but it is very difficult to estimate them with the theoretical analysis and calculation by FEM method recently. One of the reasons is this phenomenon sometimes shows non-linearity. Now some influencing factors such as physical aging, crystallinity, polymerization, moisture, water absorption and filer composition on viscoelastic behavior have been found, but their effects on creep deformation have not been obtained quantitatively. The effect of filer composition on creep behavior was researched quantitatively at first. For GFRP of polycarbonate with perfectly physical aging treatment, creep compliance Dc(t) under some temperature conditions were measured and it was confirmed that all creep behavior were presented by master curves Dc(t') on specimens of each fiber volume fraction and also one grand master curve Dc (t'')on all master curves of several FRPS was obtained by some shift factors such as temperature shift factors and modulus shift factor. Because it was found that "Time-Temperature superposition principle" was adaptive, creep strain curve to real time of several FRP is able to be calculated with the grand master curve and some shift factors, using linear visco-elastic theory. The effect of physical aging on creep deformation was researched on FRP of PC. From these results, it was found that the effect of these factors is able to be presented by a shift factor same as the effect of fiber contents. In addition we can estimate the creep process of FRPs, which are several fiber contents under some kind of physical aging conditions on arbitrary temperature.

MSEC_ICMP2008-72624

CURRENT MANUFACTURING INDUSTRIES IN SOUTH ASIA AND R&D IN SINGAPORE

Atsushi Danno — *Singapore Institute of Manufacturing Technology*

While there was some slowdown in the G3 (US, Japan, European Union) economies in these few years, the economies of ASEAN countries and India continued to see robust expansion supported both by domestic demand and external trade. These economy in Asia has been mainly based on the transfer of production base for the components of transport (automobile), electrical/electric devices and plastic/chemical products, etc from G3 countries. The main

benefit of production in Asia was higher cost competitiveness of products, which was supported by a lower labor cost in Asian countries. However, the recent improvement in production technology was remarkable in Asian countries. The environment-friendly manufacturing is to be developed widely in Asian countries for keeping their higher competitiveness in global market in future. Singapore manufacturing industry has held 25~30% of domestic GDP and been composed mainly of electronics products (30%), chemicals (30%) and biomedical/ precision engineering products (20%). Recently, it faces to a severe competitiveness in Asian countries because of relatively higher labor cost in Singapore and the remarkable expansion of manufacturing industries in other Asian countries. In such the situation, Singapore has strongly push forward with R&D in the chemicals/pharmaceutics, biomedical manufacturing, aerospace (repairer, component manufacturing, engine assembling, etc.), medical technology & devices, advanced material & its processing as well as automotive devices (Communication technology, etc.) for strengthening their global competitiveness in future manufacturing industry. These R&D are performed under collaborations of the national institutes, national universities and multi national companies in Singapore.

MSEC_ICMP2008-72625

MERCHANT MEDAL RECIPIENT

Jim Bryan —

Merchant Medal Recipient

MSEC_ICMP2008-72613

HYBRID MICRO-COMPOSITE E-SPRINGS FOR VEHICLE SUSPENSION SYSTEMS

Salah Elmoselhy — *University of Cambridge, UK*

Student Competition Presentation

MSEC_ICMP2008-72614

COLLAPSIBLE AND PORTABLE BED DESIGN

Rigoberto Hernandez — *University of Texas, Pan American*

Student Competition Presentation

MSEC_ICMP2008-72615

GRAIN PACKING CONTROL FOR NEAR INFRARED LABORATORY ANALYSIS

Lidia Agelet — *Iowa State University*

Student Competition Presentation

MSEC_ICMP2008-72616

COMPARISON OF QUASI-STATIC AND ELECTROMAGNETIC FLANGING AT THE MICROSCALE

Reid Vanbenthysen — *University of New Hampshire*

Student Competition Presentation

MSEC_ICMP2008-72617

THREE CYLINDRICAL DIE FORCED THRU-FEED SPLINE ROLLING ADAPTATION

David Willens — *Worcester Polytechnic Institute*

Student Competition Presentation

MSEC_ICMP2008-72618

AUTOMATED MANUFACTURING OF A ROCKET CANDY DISPENSER

Christina Laskowski — *Rensselaer Polytechnic Institute*

Student Competition Presentation

MSEC_ICMP2008-72619

EXPERIMENTAL ANALYSIS OF DIE WEAR

Rui Zhou — *Northwestern University*

Student Competition Presentation

MSEC_ICMP2008-72620

'WAX ME UP' –PORTABLE SKI WAXER

Todd Spitz — *Columbia University*

Student Competition Presentation


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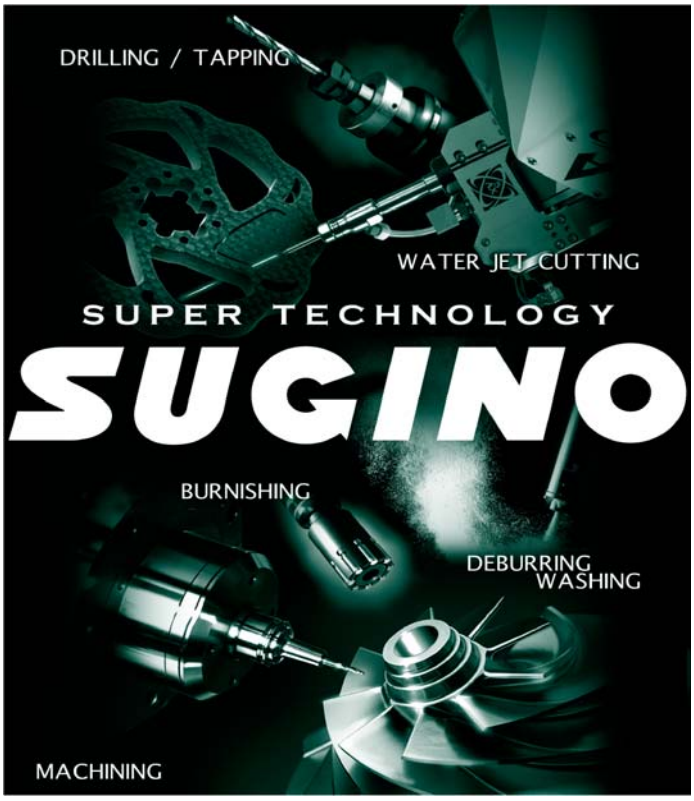
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1. **Co-organizers:** Profs. Yung C. Shin and John P. Sullivan (Purdue University)

2. **Program chairs:** Profs. Brad Kinsey (U. of New Hampshire) and Yong Huang (Clemson)

3. **Time and Location**
   Location: Purdue University, West Lafayette, Indiana

   Time: Oct. 4- Oct. 7, 2009

4. **Important Dates**
   - Statement of intent to submit paper: February 1, 2009
   - Submission of full manuscript for review: March 30, 2009

5. **Site access and travel options: air travel and ground transportations,**
   Purdue University is located in West Lafayette, Indiana (126 miles southeast of Chicago, 65 miles north of Indianapolis). Traveling to Lafayette - West Lafayette can be accomplished by Air, Auto or Bus, and Rail, and easily accessible from I-65. Regular shuttle services are provided from both the Indianapolis airport (every 2 hours) and the Chicago O'Hare airport (every 3 hours).

6. **Lodging**
   Next to the Stewart Center is the Purdue Memorial Union ($90 for queen, $98 for double) and Hilton Garden Inn within the walking distance ($80-90). For additional overflow, more than 1600 rooms are available in motels within five miles of campus.

7. **Planned activities**
   Campus Tour, Industry Tour, Spouse and Guest Program


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