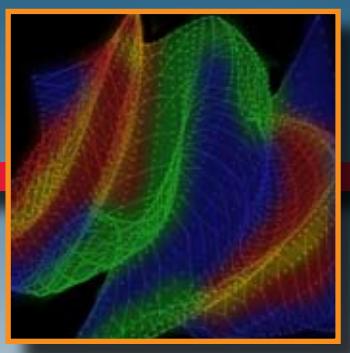
Linking Science and Technology for Global Solutions

TMS2008

137th Annual Meeting & Exhibition

March 9-13, 2008
Ernest Morial Convention Center
New Orleans, Louisiana, USA



Register before February 11 at www.tms.org/annualmeeting.html

TMS2008

137th Annual Meeting & Exhibition

March 9-13, 2008
Ernest Morial Convention Center
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TMS 2008 is bringing top materials scientists and engineers from around the world together to address some of today's global challenges:

- Resolving technology and techno-management issues for the production of aluminum, metal castings, steel, automotive and electronic materials
- Optimizing energy utilization and addressing enviromental impacts
- Developing materials for high-performance applications
- Achieving process improvement for a variety of materials under a variety of conditions
- Preparing future materials scientists and engineers

These issues and more are presented in 56 symposia covering four major themes:

Light Metals
Extraction, Processing, Structure and Properties
Emerging Materials
Materials and Society

TMS 2008 addresses these global challenges with traditional programming presenting new developments, such as . . .

9th Global Innovations Symposium
Aluminum Reduction Technology
Bulk Metallic Glasses
Magnesium Technology 2008
Materials in Clean Power Systems III
Ultrafine Grained Materials

. . . with new partnerships represented . . .

American Physical Society and TMS present Integrated Computational Materials Engineering symposia.

The Chinese Society for Metals delegation, led by Professor Liu Yongcai, deputy secretary general, and the Indian Institute of Metals delegation, led by Dr. Sanak Mishra, vice president and chairman of the ferrous division, provide perspective in the Materials and Society symposia.

LEARN • NETWORK • ADVANCE

Linking Science and Technology for Global Solutions

. . . and new perspectives for discussion . . .

Climate Change and Greenhouse Gas Emissions
Features leaders from the world's largest aluminum companies: Alcan, Alcoa, BHP Billiton, Chalco and Hydro Aluminum

Energy Conservation in Metals Extraction and Materials Processing
Presents current and potential technology and methodologies for energy saving techniques

IOMMMS Global Materials Forum 2008: Creating the Future MS&E Professionals
Highlights approaches from China, India, Japan and the United States

Materials for Infrastructure: Building Bridges in the Global Community
Includes special guided tour for symposium attendees covering the geology of the Katrina disaster. See page 27 to learn how you can leave a lasting impression on New Orleans!

Role of Engineers in Meeting 21st Century Societal Challenges
Addresses energy, transportation, housing, health and recycling issues

Sloan Industry Centers Forum: Techno-Management Issues Related to Materials-Centric Industries
Considers aluminum, metal processing, steel, automotive, paper and wood

With 56 symposia, three short courses, six lectures, eight networking receptions, 130+ exhibitors, one free collected proceedings CD-ROM, and thousands of your colleagues from 70 countries, TMS 2008 offers you the opportunity to learn, network and advance global solutions for today's materials challenges.

Register online at www.tms.org/annualmeeting.html or see page 22.

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Aluminum Alloys: Fabrication, Characterization and Applications
Aluminum Reduction Technology
Carbon Dioxide Reduction Metallurgy
Cast Shop Technology
Characterization of Minerals, Metals and Materials
Computational Thermodynamics and Kinetics
Electrode Technology
Frontiers in Process Modeling
Magnesium Technology 2008
Materials Informatics: Enabling Integration of Modeling and Experiments in Materials Science
Recycling

Related Lecture and Short Courses:

- *"Innovations in Steel Production – Animations for Aluminium Technologies?"*
- *Furnace Systems and Technology*
- *Grain Refinement of Aluminium Alloys: Theory and Practice*
- *Greenhouse Gas Emissions*

See page 12 for details.

Extraction, Processing, Structure and Properties

3-Dimensional Materials Science
9th Global Innovations Symposium: Trends in Integrated Computational Materials Engineering for Materials Processing and Manufacture
Acta Materialia Gold Medal Symposium: Recent Developments in Rare Earth Science and Technology
Advances in Roasting, Sintering, Calcining, Preheating and Drying
APS Frontiers of Computational Materials Science
Aqueous Processing
Biological Materials Science
Bulk Metallic Glasses V
Carbon Dioxide Reduction Metallurgy
Characterization of Minerals, Metals and Materials
Complex Oxide Materials: Synthesis, Properties and Applications
Computational Thermodynamics and Kinetics
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Deformation Twinning: Formation Mechanisms and Effects on Material Plasticity – Experiments and Modeling
Emerging Interconnect and Packaging Technologies
Emerging Methods to Understand Mechanical Behavior
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Mechanics and Kinetics of Interfaces in Multicomponent Materials Systems
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Pyrometallurgy
Recent Industrial Applications of Solid-State Phase Transformations
Recycling
Refractory Metals 2008
Structural Aluminides for Elevated Temperature Applications
Ultrafine-Grained Materials: Fifth International Symposium

Related Lectures:

- *"Computational Modeling of Metals Processing: Past, Present and Future"*
- *"Smelting and Refining – Faster, Smoother, Cheaper, Safer"*
- *"High Performance Structural Metals: an Undervalued but Critical Enabling Technology"*
- *Nanoscale Metal Silicides*

See page 11 for details.

Emerging Materials

2008 Nanomaterials: Fabrication, Properties and Applications
3-Dimensional Materials Science
4th Lead-Free Solders Technology Workshop
9th Global Innovations Symposium: Trends in Integrated Computational Materials Engineering for Materials Processing and Manufacture
Acta Materialia Gold Medal Symposium: Recent Developments in Rare Earth Science and Technology
Advances in Semiconductor, Electro Optic and Radio Frequency Materials
Biological Materials Science
Bulk Metallic Glasses V
Carbon Dioxide Reduction Metallurgy
Characterization of Minerals, Metals and Materials
Complex Oxide Materials: Synthesis, Properties and Applications
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Hume-Rothery Symposium: Nanoscale Phases
Materials in Clean Power Systems III: Fuel Cells, Hydrogen, and Clean Coal-Based Technologies
Materials Informatics: Enabling Integration of Modeling and Experiments in Materials Science
Mechanics and Kinetics of Interfaces in Multicomponent Materials Systems
Micro-Engineered Particulate-Based Materials
Neutron and X-Ray Studies for Probing Materials Behavior
Particle Beam-Induced Radiation Effects in Materials
Phase Stability, Phase Transformations and Reactive Phase Formation in Electronic Materials VII
Recycling
Structural Aluminides for Elevated Temperature Applications
Ultrafine-Grained Materials: Fifth International Symposium

Related Short Course:
- *Nanomechanical Characterization*

See page 13 for details.

Materials and Society

Climate Change and Greenhouse Gas Emissions
IOMMMS Global Materials Forum 2008: Creating the Future MS&E Professionals
Materials for Infrastructure: Building Bridges in the Global Community
National Materials Advisory Board Town Hall Meeting on Assessing Corrosion Education
Role of Engineers in Meeting 21st Century Societal Challenges
Sloan Industry Centers Forum: Techno-Management Issues Related to Materials-Centric Industries

About Materials and Society
Many of the programs and activities fit broadly under the umbrella of Materials and Society–from many symposia and presentations in the technical program to the community outreach that will be performed on-site. Many invited speakers will examine opportunities for the materials science and engineering community to proactively address the complex technological, professional, educational, societal, environmental, infrastructural and economic issues that challenge the sustainability of today's world. We are all challenged to improve the world as we know it for those in developing countries and to secure it for future generations.

Related Lecture and Short Course:
- *"Design for the Other 90%"*
- *Greenhouse Gas Emissions*

See page 11 for details.

Turn to the alphabetical listing of the symposia on the following pages for descriptions.

2008 Nanomaterials: Fabrication, Properties and Applications

…development, manufacture and application of functional nanomaterials

- Functional applications of nanomaterials
- Nanostructure fabrication
- Carbon nanostructures
- Quantum-dots

3-Dimensional Materials Science

…advanced characterization, modeling and microanalysis

- 3-D visualization and modeling
- 3-D microstructural evolution
- Microscopy techniques
- Microanalysis methods

4th Lead-Free Solders Technology Workshop

…TMS-Surface Mount Technology Association forum addressing critical needs

- Solder systems
- Packaging technologies
- Reliability
- Legislation

9th Global Innovations Symposium: Trends in Integrated Computational Materials Engineering for Materials Processing and Manufacture

...TMS-American Physical Society plenary discussions of advancements in materials modeling across length scales, and manufacturing impact

- Nuclear materials
- Ceramics
- Aluminum
- Nanomaterials

Acta Materialia Gold Medal Symposium: Recent Developments in Rare Earth Science and Technology

…in honor of Karl Gschneidner Jr.

- Single crystals
- Characterization and properties
- Novel applications
- Recent advancements

Advances in Roasting, Sintering, Calcining, Preheating and Drying

…state-of-the-art in processing technologies

- Iron ore
- Alumina
- Rotary kiln systems

Advances in Semiconductor, Electro Optic and Radio Frequency Materials

…development, fabrication and application of emerging technologies

- Medical device semiconductors
- Nanomaterials
- Photovoltaics

Alumina and Bauxite

…mining and refining of raw materials for aluminum production

- Alumina refinery design and development
- Alumina refinery safety and integrity
- Bauxite and digestion
- Precipitation

Aluminum Alloys: Fabrication, Characterization and Applications

…advancements in aluminum for today's marketplace

- Alloy characterization
- Alloy development
- Aluminum products and applications

Aluminum Reduction Technology

…conversion of alumina to aluminum

- Alternative processes
- Anode design and operation
- Cell fundamentals and phenomena
- Environmental and plant improvements
- Process control developments

Aluminum Reduction Symposium Organizer Martin Iffert: *"(This symposium) has a strong focus on sustainability and environmental aspects in the aluminum smelting process. This includes firsthand information about the European emission trading scheme and the influence on energy prices, smelter economy and environment."*

APS Frontiers of Computational Materials Science

…American Physical Society forum on progress in computational materials methods

Aqueous Processing

…recent progress

- Alternative leaching processes
- Precious metals
- Process-stability relationships
- New strategies and techniques

Biological Materials Science

…development of biological materials and biomaterial devices

- Biocompatibility
- Mimicking biological systems
- Bioinspired design
- Mechanical and environmental response

Bulk Metallic Glasses V

…state-of-the-art development

- Mechanical behavior
- Characterization
- Modeling
- Processing

Carbon Dioxide Reduction Metallurgy

(sponsored by TMS, American Iron and Steel Institute, and Canadian Institute of Mining, Metallurgy and Petroleum)

…state-of-the-art carbon dioxide metallurgical reduction and decreased use of carbon

- Green production of light metals
- Green production of steel
- Carbon sequestration
- Electrochemical reduction of carbon dioxide

Cast Shop Technology

…melting and metal treatment of aluminum

- Sustainability and environmental issues
- Cast house operations and melting
- Cast shop safety
- Casting, solidification and microstructures

Characterization of Minerals, Metals and Materials

…techniques for characterizing materials across a spectrum of systems and processes

- Characterization of mechanical and physical properties of materials
- Characterization of processing of materials
- Characterization of structure across length scales

Climate Change and Greenhouse Gas Emissions

…industry leaders discuss progress and challenges for the materials industries

- Alcan
- Alcoa
- BHP Billiton
- Chalco
- Hydro Aluminum

Complex Oxide Materials: Synthesis, Properties and Applications

…interdisciplinary forum bridging materials research and application

- Novel functional oxide thin films
- Nanostructures
- Oxides for energy technologies
- Ferroelectrics, multiferroics, piezoelectrics and dielectrics

Computational Thermodynamics and Kinetics

…TMS-American Physical Society symposia on fundamental modeling methods and application for materials structures

- Integrated Computational Materials Engineering (ICME)
- Microstructure properties and evolution
- Phase transformations
- Nanoscale systems

Creating the ICME Cyberinfrastructure: an Interdisciplinary Technology Forum

...TMS-American Physical Society roundtable

- State-of-the-art capabilities
- CyberDesign
- Roadmapping development needs

Deformation Twinning: Formation Mechanisms and Effects on Material Plasticity–Experiments and Modeling

…progress in fundamentals of deformation twinning

- Texture, twinning and hardening
- Constitutive modeling
- Electron microscopy
- Flow and fracture

Electrode Technology

(formerly Carbon Technology)

…anodes and cathodes used in aluminum reduction

- Sustainability and environmental issues
- Anode technology and production
- Carbon anodes
- Inert anode materials

Emerging Interconnect and Packaging Technologies

…advanced lead-free solder and packaging technologies

- Electromigration
- Microstructures and characterization
- Processing and reliability issues
- Whisker growth, design and modeling

Emerging Methods to Understand Mechanical Behavior

…advanced characterization and analytical methods

- Orientation imaging microscopy
- Texture evolution
- Nanomechanical testing
- Static, dynamic and cyclic testing

Energy Conservation in Metals Extraction and Materials Processing

…technologies to reduce energy consumption for material production

- Energy and environmental conservation
- Enhanced energy efficiency
- Alternate technologies
- Modeling, simulation and application experiences

Enhancing Materials Durability via Surface Engineering

…recent advancements in surface engineering and modification for life enhancement

- Coatings for environmental, thermal and wear resistance
- Residual stresses
- Graded and novel structures
- Modeling

Frontiers in Process Modeling

…advancing materials development

- Hot-rolling technologies
- Deformation of materials
- Primary metal production

Hael Mughrabi Honorary Symposium: Plasticity, Failure and Fatigue in Structural Materials–from Macro to Nano

…deformation and fracture mechanisms

- Single crystals
- Mathematical modeling
- Cyclic, static and dynamic loading
- Damage evolution

Help to celebrate Professor Hael Mughrabi's lifelong accomplishments at a dinner held in his honor on Monday, March 10.

See the registration form on page 22.

Hot and Cold Rolling Technology

…advanced hot- and cold-rolled products

- Texture development
- Process modeling
- Surface quality

Hume-Rothery Symposium: Nanoscale Phases

…fundamentals of structure and stability of nanoscale phase materials

- Microstructural evolution and stability
- Nano/tera scale integration
- Microscopy
- Nanowires, nanovolumes and nanocrystaliization

IOMMMS Global Materials Forum 2008: Creating the Future MS&E Professionals

…global forum with speakers representing TMS, Association for Iron & Steel Technology, Chinese Society for Metals, Indian Institute of Metals, Japan Institute of Metals, and Mining and Materials Processing Institute of Japan

- Pre-college/K-12
- Innovative university education programs
- Lifelong learning
- International cooperation
- Innovative use of technology

Magnesium Technology 2008

…all aspects of magnesium production, properties and application

- Primary production
- Alloy development
- Performance
- Global market

Materials for Infrastructure: Building Bridges in the Global Community

(sponsored by TMS, Chinese Society for Metals, and Indian Institute of Metals)

…forum devoted to infrastructure needs for the global community

- Buildings
- Public utilities
- Bridges

Materials in Clean Power Systems III: Fuel Cells, Hydrogen, and Clean Coal-Based Technologies

…in-depth coverage of advances in clean power

- Fuel cells
- Hydrogen
- Clean coal

Materials Informatics: Enabling Integration of Modeling and Experiments in Materials Science

...TMS-American Physical Society symposium advancing techniques and application of materials informatics

- Titanium alloys
- Superalloys
- Neural networks
- CyberDesign

Materials Processing Fundamentals

…design, synthesis and control of materials processes and processing

- Solidification processing
- Optimization of thermomechanical processing
- Numerical simulations
- Microstructural evolution

Mechanical Behavior, Microstructure and Modeling of Ti and Its Alloys

…progress towards predictive constitutive and damage models for titanium

- Refinement and processing
- Microstructural evolution
- Microstructure-property relationships
- Modeling and property prediction

Mechanics and Kinetics of Interfaces in Multicomponent Materials Systems

…performance-enabling interfaces across materials systems and applications

- Metal-ceramics, metal-semiconductors and metal-polymer interfaces
- Creep
- Electromigration
- Dynamic and static performance

Micro-Engineered Particulate-Based Materials

…production, characterization and utilization

- In situ nanocomposites
- Corrosion and passivation
- Aluminum
- Stainless steel

Minerals, Metals and Materials under Pressure

…interdisciplinary forum connecting theory and experiment

- Pressure-induced phase transformations
- Simulations and modeling
- High rate plasticity
- Damage and failure mechanisms

National Materials Advisory Board Town Hall Meeting on Assessing Corrosion Education

…review current status and address future needs

- Effectiveness of existing engineering curricula
- Actions to enhance corrosion-based skill and knowledge base of graduating and practicing engineers

Neutron and X-Ray Studies for Probing Materials Behavior

…progress in advanced materials characterization

- Mechanical response
- Thermal treatment
- Texture development
- Microstructural evolution

Neutron Symposium Organizer Rozaliya Barabash:
"The idea to put together two diffraction methods will demonstrate the uniqueness of both of them and mutual complementary possibilities."

Particle Beam-Induced Radiation Effects in Materials

…experimental and theoretical radiation materials science

- Damage evolution
- In situ analysis
- Radiation-induced diffusion
- Nanoscale testing

Phase Stability, Phase Transformations and Reactive Phase Formation in Electronic Materials VII

…thermodynamics and kinetics for phase stability electronic materials

- Phase evolution and stability
- Electro- and thermo-migration
- Solder interfacial reactions

Pyrometallurgy

…advanced pyrometallurgical methods

- Nonferrous pyrometallurgy
- Lead refining
- Titanium production
- Smelter improvements

Recent Industrial Applications of Solid-State Phase Transformations

…utilizing phase transformations for new products

- TRIP steels
- Friction stir welding
- Nickel-based alloys
- Magnesium

Recycling

…recycling of engineered materials today

- Light metals
- Electronic materials
- Precious metals
- Reducing environmental impact

Refractory Metals 2008

…processing and performance

- Oxidation and thin films
- Processing and mechanical deformation

Role of Engineers in Meeting 21st Century Societal Challenges

…AIME keynote session on energy, transportation, housing, health and recycling

Sloan Industry Centers Forum: Techno-Management Issues Related to Materials-Centric Industries

…in-depth coverage of business issues facing aluminum, steel, automotive, wood, paper and metal processing industries

Structural Aluminides for Elevated Temperature Applications

…fundamentals and application

- Alloy design
- Processing and fabrication
- Microstructure-property relationships
- Applications

Ultrafine-Grained Materials: Fifth International Symposium

…technological advancements in design, manufacture and application

- Severe plastic deformation
- Nanocrystalline materials
- Thermal stability
- Deformation and fracture

Women in Science Breakfast Lecture*
"Design for the Other 90%"

Monday, March 10 • 7 to 8 a.m.

Speaker: **Cynthia E. Smith**, Curator, "Design for the Other 90%" Exhibit, Smithsonian's Cooper-Hewitt, *National Design Museum*

"Design for the Other 90%" explores a growing movement among designers to develop solutions for the 5.8 billion people across the globe (90 percent of the world's total population) not traditionally served by the professional design community. Through local and global partnerships, individual designers and organizations are finding unique ways to address the lack of basic necessities faced by the poor and marginalized around the world.

**Advance registration required*

Young Leaders Tutorial Luncheon Lecture
"Computational Materials Science & Engineering: What is it and how do we Take Advantage?"

Monday, March 10 • noon to 1:30 p.m.

Speaker: **Katsuyo Thornton**, Assistant Professor, Materials Science and Engineering, *University of Michigan*
Recipient of the TMS Early Career Faculty Fellow Award

This lecture will address why experimentalists and theorists should become familiar with and utilize many of the standard materials science and engineering computational tools. An overview of the available methodologies, their applications and case studies will be presented.

Note: An optional box lunch may be purchased on the registration form.

Institute of Metals/Robert Franklin Mehl Lecture
"High Performance Structural Metals: an Undervalued but Critical Enabling Technology"

Monday, March 10 • 12:30 to 1:30 p.m.

Speaker: **James C. Williams**, Department of Materials Science and Engineering, *The Ohio State University*

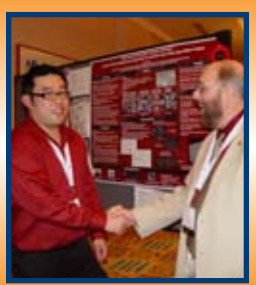
This talk will describe some of the past advances in structural materials and outline some important opportunities going forward. The reality (or lack thereof) of some of the trendy topics also will be assessed and some relative value comparisons will be offered.

William Hume-Rothery Award Lecture
Nanoscale Metal Silicides

Monday, March 10 • 2 p.m.

Speaker: **L.J. Chen**, Department of Materials Science and Engineering, *National Tsing Hua University*

In this talk, an historical account of evolving roles of metal silicides in the context of integrated circuits device applications will be presented. Epitaxial growth of metal silicides on silicon and formation of amorphous interlayers in the metal/Si systems will be reviewed. In addition, synthesis and applications of metal silicide nanowires will be described, and the future outlook will be addressed.



Show your support for the upcoming leaders of our profession!

Attend the TMS Technical Division Student Poster Contest.
Monday, March 10
5 to 6:30 p.m.

Leave a Lasting Impression on New Orleans

Turn to page 27 to learn how you can help the city that has welcomed the TMS Annual Meeting & Exhibition many times.

Extraction & Processing Division Luncheon Lecture*

"Computational Modeling of Metals Processing: Past, Present and Future"

Tuesday, March 11 • 12:30 to 2 p.m.

Speaker: Brian G. Thomas, Wilkins Professor, Mechanical Engineering, *University of Illinois*; Director, *Continuous Casting Consortium*

This talk will recall the early days of process modeling as well as cover recent examples, including fluid flow, heat transfer and stress analysis of processes such as continuous casting of steel. The future of computational modeling will also be contemplated.

**Advance registration required*

Extraction & Processing Division Distinguished Lecture

"Smelting and Refining–Faster, Smoother, Cheaper, Safer"

Tuesday, March 11 • 2 to 2:45 p.m.

Speaker: David G.C. Robertson, Professor, Metallurgical Engineering, *University of Missouri-Rolla*

The purpose of research and development in pyrometallurgy is to achieve at least one of the goals mentioned above (faster, smoother, cheaper, safer). This lecture will review how basic research at the university can contribute to meeting these important goals, using examples mainly from work carried out by the author and his colleagues.

Light Metals Division Luncheon Lecture*

"Innovations in Steel Production–Animations for Aluminium Technologies?"

Wednesday, March 12 • 12:30 to 2:30 p.m.

Speaker: Reiner Kopp, Professor Emeritus, *Institute of Metal Forming, RWTH Aachen University*

This lecture outlines some highlights of manufacturing new steel products and asks the question as to whether or not these innovations in steel could be animations for the development of aluminium products.

**Advance registration required*

For greater detail on any of the annual meeting lectures and speakers, visit www.tms.org/annualmeeting.html.

Grain Refinement of Aluminium Alloys: Theory and Practice

Short Course • Sunday, March 9 • 8 a.m. to 6 p.m.

Instructors
Paul Cooper, *London and Scandinavian Metallurgical Co.*
Douglas Granger, *GRAS*
Wolfgang Schneider, *Hydro Aluminium GmbH*
Peter Schumacher, *University of Leoben*
David StJohn, *Cast Metals Manufacturing*

Who Should Attend
- Professional or technical representatives in the aluminium casting industry
- University researchers

Learn About
- Fundamentals of nucleation and grain growth
- Fundamentals of grain refinement with TiB2 and TiC
- Grain refiner alloys, grain refiner tests and grain size measurement
- Influence of grain refinement on product quality
- Practice of grain refinement in DC casting and shape casting
- Influence of casting conditions on grain refinement

Greenhouse Gas Emissions

Short Course • Sunday, March 9 • 9 a.m. to 3:30 p.m.

Instructors
Halvor Kvande, *Hydro Aluminum*
Jerry Marks, *J. Marks & Associates*
Alton Tabereaux, *Consultant*

Who Should Attend
- HSE professionals
- Aluminum industry operational employees
- Others wanting to learn more about greenhouse gas emissions and their reduction

Learn About
- Environmental challenges facing the global aluminum business
- Reducing greenhouse gas emissions from aluminum smelters
- Anode effects in industrial electrolysis cells
- Action plans and activities to minimize future negative environmental impact and achieve a greener future

Nanomechanical Characterization

Tutorial • Sunday, March 9 • 1 to 5 p.m.

Instructors
Erica T. Lilleodden, *GKSS Research Center*
Brad L. Boyce, *Sandia National Laboratories*

Who Should Attend
- Scientists and engineers interested in mechanical behavior of materials at small scales, particularly nanoscale and nanostructured materials and micro and nanoscale devices
- Students, post-doctoral researchers, early career as well as senior scientists and engineers involved in academic research and industrial applications of thin films and nanomaterials subject to mechanical loads

Learn About
- Current state-of-the-art test methods
- Emerging methods
- Nanoindentation-based techniques
- MEMS-based techniques

Furnace Systems and Technology

3rd Annual Workshop • Monday Afternoon, March 10-Wednesday, March 12

Presentations from 15 companies covering:
- Basic combustion, energy savings and furnace productivity improvement
- Melting furnaces
- Burners designs
- Emissions and abatement
- Recirculating process furnaces
- Metal circulation, cleaning and dross processing
- Casting
- Refractory issues and practices
- Contract engineering
- Rotary delac/decorating systems

Get additional details about these courses and register online at www.tms.org/annualmeeting.html or see page 22.

President's Welcoming Reception

Sunday, March 9 • 6 to 8 p.m.

Seven Networking Receptions for Select Symposia

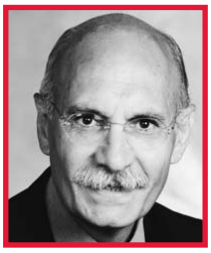
Visit www.tms.org/annualmeeting.html for details.

137th TMS and AIME Honors and Awards Presentation

With Installation of 2008 TMS President

Tuesday, March 11 • 6 p.m. Reception (Cash Bar) • 7 p.m. Dinner

Robert D. Shull
2007 TMS President



Diran Apelian
2008 TMS President

Dan Thoma
2007 AIME President

Join us as we honor those outstanding individuals who have contributed greatly to materials science and engineering through TMS and AIME. Following the awards presentation, the TMS 2007 and 2008 presidents will address the society. Order your tickets on the registration form.

About the 2008 TMS President

Diran Apelian is Howmet professor of engineering and director of the Metal Processing Institute at Worcester Polytechnic Institute, where he has worked for more than 15 years. Professor Apelian's research interests and expertise are in materials processing, and specifically, solidification and net-shape manufacturing. He is credited for pioneering work in various areas of solidification processing: molten metal processing and filtration of metals; aluminum foundry engineering; plasma deposition; and spray casting/forming. Professor Apelian has more than 400 publications to his credit and four books, which he has co-edited. He has served on, and chaired, several national materials advisory boards for the National Research Council. Professor Apelian has been an active member of TMS for more than 30 years and is the chair of the steering committee for this year's materials and society symposia.

Society Awards

TMS Fellow Class of 2008

- Tsu-Wei Chou, *University of Delaware*
- Campbell Laird, *University of Pennsylvania*
- David E. Laughlin, *Carnegie Mellon University*
- S. Lee Semiatin, *U.S. Air Force Research Laboratory*

Alexander R. Scott Distinguished Service Award
J. Wayne Jones, *University of Michigan*

Application to Practice Award
Gregory Yurek, *American Superconductor*

Bruce Chalmers Award
Alain Karma, *Northeastern University*

Champion H. Mathewson Award
Adam Badri, *Royal Dutch Shell*

Early Career Faculty Fellow
Katsuyo Thornton, *University of Michigan*

Educator Award
Robert L. Snyder, *Georgia Institute of Technology*

Institute of Metals/Robert Franklin Mehl Award
James C. Williams, *The Ohio State University*

John Bardeen Award
Pallab Bhattacharya, *University of Michigan*

Leadership Award
Bruce A. MacDonald, *National Science Foundation*

Robert Lansing Hardy Award
Ken Gall, *Georgia Institute of Technology*

TMS Foundation Shri Ram Arora Award
Sasanka Deka, *National Chemical Laboratory*

William Hume-Rothery Award
L.J. Chen, *National Tsing Hua University*

Division Awards

Electronic, Magnetic & Photonic Materials Division

Distinguished Scientist/Engineer Award
Iver Anderson, *Iowa State University*

Distinguished Service Award
Sung Kang, *IBM*

Extraction & Processing Division

Distinguished Lecturer
David G.C. Robertson, *University of Missouri-Rolla*

Distinguished Service Award
V. Ramachandran, *RAM Consultants*

Science Award
- Ortavio Fortini, *Carnegie Mellon University*
- Richard Fruehan, *Carnegie Mellon University*

Technology Award
- Alex Moyano, *Codelco-Chile*
- Carlos Caballero, *Codelco-Chile*
- Roberto Mackay, *Codelco-Chile*
- Pedro Morales, *Codelco-Chile*
- Domingo Cordero, *Codelco-IM2*
- Jonkion Font, *Codelco-IM2*

Light Metals Division

Distinguished Service Award
Barry Welch, *Welbank Consulting*

Light Metals Award
- Sebastien Leboeuf, *Alcan Inc.*
- Claude Dupuis, *Alcan Inc.*
- Bruno Maltais, *STAS*
- Marc-Andre Thibault, *STAS*
- Einar Smarason, *Alcan Iceland Ltd.*

Technology Award
Alton Tabereaux, *Technical Consultant*

Materials Processing & Manufacturing Division

Distinguished Scientist/Engineer Award
Brian Thomas, *University of Illinois*

Structural Materials Division

Distinguished Scientist/Engineer Award
S. Lee Semiatin, *U.S. Air Force Research Laboratory*

Distinguished Service Award
Marc Meyers, *University of California, San Diego*

Other Awards

2008 Acta Materialia Inc. Gold Medal Award
Karl A. Gschneidner Jr., *Iowa State University and Ames Laboratory, U.S. Department of Energy*

AIME Distinguished Service Award
Alexander R. Scott, retired, *The Minerals, Metals & Materials Society*

AIME Honorary Member
Robert H. Wagoner, *The Ohio State University*

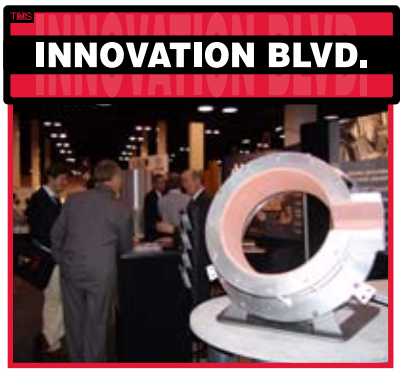
Visit Science Avenue, Technology Avenue or Innovation Boulevard in the exhibition hall where 130+ exhibitors have the newest products and services you need to advance your work.

Exhibition Hours:
Monday, March 10 • noon to 6 p.m.
Tuesday, March 11 • 9:30 a.m. to 5:30 p.m.
Wednesday, March 12 • 9:30 a.m. to 3 p.m.

Enjoy a hosted grand opening reception on Monday, March 10, 5 to 6 p.m., and a snack break on Wednesday, March 12, 12:15 to 2 p.m., while you visit with representatives from these industries:

Light Metals Production and Processing

- Cast shop technology: combustion and furnace technology, grain refiners/hardeners, molten metal filtration and pumps, refractory and insulation products
- Industrial process control and automation, sensors
- Primary production equipment and services: carbon technology and supplies, combustion and furnace technology, HF measurement systems, industrial gases



Materials Research and Development

- Characterization equipment: analysis, instrumentation, measurement, microscopy, x-ray fluorescence
- Emerging materials: biomaterials, fuel cells, nanomaterials
- Materials for R&D: alloys, rare earths, precious metals, minerals, chemicals
- Surface processes: coatings, thin films, surface modification

Products and Services for the Materials Science and Engineering Profession

- Professional services: consulting, contracting, engineering, R&D
- Publishers: journals, reference publications
- Software Vendors: design, modeling, process simulation, thermodynamics, phase diagrams
- Technology resources: collaborative programs and centers, national laboratories, nongovernmental organizations

To become an exhibitor or sponsor an event, contact:
Joe Rostan • (724) 776-9000, ext. 231, or (800) 759-4TMS • jrostan@tms.org

Our Sponsors

BP Coke..... Registration Counter
Burner Dynamics Inc.....Registration Bag Insert
Carbone Savoie..... Coffee Break
ConocoPhillips .....General Meeting
Elsevier Ltd. ..... Exhibit Hall Snack
GE Water & Process Technologies.....Lanyards
Harbison-Walker Refractories .....Event Signs, Banner and Information Booth
Hatch..... Coffee Break (Monday Morning)
Jacobs Consultancy Inc. ..... *TMS Today* Newsletter (Tuesday)
Life Cycle Engineering.....Registration Bag Insert
Mitsubishi International Company.....General Meeting
Oxbow Carbon & Minerals LLC.....General Meeting
SEC Carbon (Sumitomo).....Registration Bag Insert
Sentech Precimeter Inc......Registration Bag Insert
SGL Carbon LLC..... Coffee Break
Solios Environnement.....Registration Bags
TCP Petcoke Corporation .....General Meeting
Thermo-Calc Software Inc. .....Registration Bag Insert
Vabco .....Coffee Break (Monday Afternoon)

Exhibiting Companies	Booth No.
ABB Analytical	606
Acuity VCT	
(formerly Benchmark Automation)	232
Alcan Group	309
Aleastur	704
Almeq Norway AS	428
ALTECH SMV Ltd.	721
Aluminium International Today	TBD
Aluminium Times	TBD
Aluminum Corporation of China	222
AUMUND Foerdertechnik GmbH	722
B&P Process Equipment Systems LLC	331
BHS Marketing/Western Briquette	345
Bloom Engineering	304
Boreal Laser	136
Brochot	639
Bruker AXS	114
Buehler Ltd.	806
Burner Dynamics Inc.	110
Buss ChemTech AG	631
C.A. Picard International	233
Carl Zeiss MicroImaging	214
Carl Zeiss SMT	212
Ceradyne Inc.	100
Chongqing Runji Alloy Co Ltd.	814
CMI Novacast Inc.	113
Colt International	644
CompuTherm LLC	820
CSM Instruments	712
Cytec Industries Inc.	731
Dantherm Filtration Inc.	239
Darco Southern	104
DMC Clad Metal Division	738
EBSD Analytical Inc.	710
ECL	312
EDAX Inc.	707
Eirich Machines Inc.	211
Erico	705
FEI Company	730
FFE Minerals	223
GE Energy	322
GE Water & Process Technologies	324
Giesel Verlag GmbH-Verlag für Fachmedien	TBD
Gillespie & Powers Inc.	831
GLAMA Maschinenbau GmbH	613
GNA Alutech Inc.	724
Gouda Vuurvast	329
Graphite Engineering & Sales	209
Graphite Machining Inc.	332
Hamilton Research & Technology PVT Ltd.	832
Hauck Manufacturing Company	227
Heggset Engineering	238
Hencon BV	545
Hertwich Engineering	708
HMR Group AS	339
HRV Engineering Group	723
Hysitron	643
iCrane Systems	632
IMPEC AS	139
Industries 3R Inc.	206
Innovatherm GmbH + Co. KG	631
International Magnesium Association	TBD
Jayne Industries	101
JEOL USA Inc.	837
Jervis B. Webb Company	725
Kabert Industries	605
KB Alloys Inc.	621
KBM Affilips BV	715
KEMPE International	620
L.P. Royer Inc.	221
Laeis GmbH	631
Life Cycle Engineering	115
Light Metal Age	205
Maerz-Gautschi	600
Maruzen International Co. Ltd.	245
McAllister Mills Inc.	625
MECFOR Inc.	339
Mechatherm International Ltd.	626
Metallurg Aluminium	320
Metallurgical Society of CIM	745
Mid-Mountain Materials Inc.	213
MINTEQ International Inc.	118
Morgan AM&T/National Electrical Carbon	810
Murlin Chemical Inc.	201
N.A. Water Systems	821
Nalco Company	601
National Filter Media	739
NKM Noell Special Cranes GmbH	527
North American Manufacturing Co. Ltd.	432
Novelis	300
Olympus Micro Imaging Division	109
Opsis AB	220
Outotec Ltd.	321
Parker Hannifin	539
Pipeline Systems	127
Pyrotek Inc.	301
Resco Products	103
Rex Materials Group	533
Riedhammer GmbH	121
Rigaku	815
SELEE Corporation	501
Sente Software	231
SenTech Precimeter Inc.	805
Shenzhen Aida Aluminum Alloys Co. Ltd.	809
Shimadzu Scientific Instruments Inc.	344
SMV AS	720
Solios Environment	513
Starcyl Cylinders/MAC	203
STAS	609
Stellar Materials Inc.	700
SUAL Group	131
Taylor & Francis Group/CRC Press	819
Thermal Ceramics	507
Thermcon Ovens BV	804
ThermoCalc Software	444
Thermo Scientific Niton Analyzers	107
Thermo Scientific-Scientific Instruments	106
Thorpe Technologies Inc.	308
Urja Products PVT. Limited	713
Wagstaff Inc.	521
Zircar Ceramics Inc.	711

Students - Don't miss this opportunity!

TMS 2008 is a perfect opportunity for materials science and engineering students to learn how to prepare for a career in the materials field, make important professional contacts, and share enjoyable times outside the classroom with fellow students and professionals.

Students who are Material Advantage members may attend the technical sessions, lectures, exhibition and all student activities listed on this page for an advance registration fee of only $25. The advance registration fee for students who are not members is $50, which includes a free year of membership in the Material Advantage Student Program.

Sunday, March 9

2nd Annual Materials Bowl
Preliminary Elimination Rounds • noon
Championship Match • 8:30 to 9 p.m.

Team Registration Deadline: December 15, 2007

A total of $3,500 in prize money is awarded in this "Jeopardy"-style knowledge and trivia competition as well as the Materials Bowl Trophy! Currently, the trophy resides with the 2007 champions, Florida International University. Student chapters are invited to select a team of four chapter members to represent its school for the 2008 Materials Bowl. Eighteen teams will compete in preliminary elimination rounds, with the winners moving on to semifinal matches. The championship match will culminate at the Student Networking Mixer. View the official rules online and register your team early to be part of this exciting competition!

Orientation • 2 to 3 pm.
Find out all you need to know about student activities at TMS 2008 and meet other students with similar interests.

Career Forum • 3:30 to 5 p.m.
Representatives from key materials industries will provide personal insights on career preparation strategies, offer tips on how to develop and foster rewarding careers, and answer your questions.

Career Tips Session • 5 to 6 p.m.
Discover what human resource representatives are looking for when reviewing resumes and interviewing candidates.

Student Networking Mixer • 9 to 11 p.m.
This networking mixer provides a relaxed, casual and fun atmosphere for students, faculty members, and government and industry representatives to make connections and share experiences of professional growth.

Monday, March 10

TMS Technical Division Student Poster Contest • 5 to 6:30 p.m.
Deadline to Apply: January 10, 2008

Both undergraduate and graduate students are encouraged to participate in this dynamic and interactive event. Each of the TMS technical divisions is awarding $500 to the best undergraduate poster and $500 to the best graduate poster. A top prize of $2,500 is awarded by TMS for the "Best of Show" poster.

Ambassador Awards
Judges will select two student authors from among the poster award winners to receive the TMS Student Ambassador awards. The "ambassadors" will receive sponsorship from TMS to represent the society at a 2008 international conference. Two alternate ambassadors will also be chosen in the event the initial award winners are unable to attend the conference.

Visit www.tms.org/annualmeeting.html and click on the student page from the menu for full details about any of these student events.

Subsidize the Cost of Attending TMS 2008

Become a Student Monitor!
Deadline to Apply: December 29, 2007

Student monitors are assigned to attend technical sessions to assist as follows:
- Record the number of attendees for each paper presented in a given session.
- Report any malfunctions of audio/visual equipment to appropriate staff.
- Aid presenters with operation of room lights.

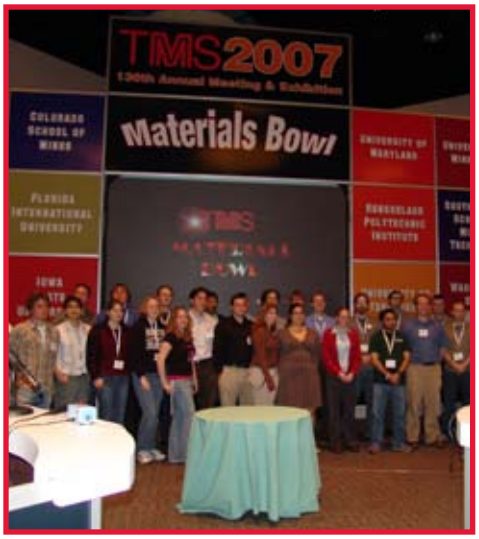
Monitors receive $40 for each one-half day session monitored. Monitor positions are filled as applications are received.

For more information about submitting an application:
- Visit www.tms.org/annualmeeting.html and click on the student page from the menu.
- Contact Cheryl Moore, technical programming assistant, at (724) 776-9000, ext. 252; (800) 759-4TMS; or cmoore@tms.org.

Apply for Travel Reimbursement!
Each Material Advantage chapter is eligible to receive $500 per calendar year in travel reimbursement for members to attend the TMS annual meeting. The travel reimbursement form must be submitted with original receipts by March 28, 2008.
Visit www.tms.org/annualmeeting.html and click on the student page from the menu for the form.

Donate a Door Prize

Student chapter members are asked to donate school logo items to the cache of items TMS will be donating for door prizes at the Student Networking Mixer. The more prizes donated, the better your chances to win! Let TMS know what you plan to bring to donate by e-mailing Bryn Stone at bstone@tms.org.



Collected Proceedings CD-ROM

To provide added value for attendees, those registering in the following categories receive a free CD-ROM containing select proceedings:

- Members
- Nonmember Authors
- Nonmembers
- TMS Senior Members
- Exhibitors Full Conference

The CD-ROM will include:

- Multiple symposia proceedings
- Keynote presentations
- Links to additional resource information
- Table of contents

Each symposium will be presented as an individual publication on the CD-ROM, with its own table of contents, standard publication reference numbers, and copyright information. Please visit www.tms.org/annualmeeting.html for a complete listing of the symposia to be included on the CD-ROM.

The CD-ROM is also available for purchase in advance on the registration form or on-site during the annual meeting. The cost per CD-ROM is $150; student price is $75.

Printed Proceedings

For those interested in purchasing printed copies of individual symposia, arrangements can be made before, during and after the annual meeting. To order in advance or after the meeting, contact:
TMS Customer Service • (724) 776-9000, ext. 256, or (800) 759-4TMS • E-mail jsmith@tms.org

Arrangements may also be made at the meeting by visiting the TMS Publications Sales area.

Register before February 11, 2008, to qualify for the advance registration rate. You save $100!

Two Ways to Register

1. Online at www.tms.org/annualmeeting.html with our secure form
2. Complete the form on the next page and mail or fax with your payment.

Your registration includes these valuable learning and networking events:

1. Technical Sessions (Monday through Thursday)
2. ICME Technology Forum* (Sunday)
3. Lead-Free Solders Technology Workshop* (Sunday)
4. Women in Science Breakfast Lecture* (Monday)
5. Young Leaders Tutorial Lecture+ (Monday)
6. Institute of Metals/Robert Franklin Mehl Lecture (Monday)
7. William Hume-Rothery Award Lecture (Monday)
8. Student Poster Contest (Monday)
9. Extraction & Processing Division Distinguished Lecture (Tuesday)
10. President's Welcoming Reception (Sunday)
11. Networking Receptions
12. Exhibition (Monday through Wednesday)
13. Hosted Grand Opening Reception in Exhibit Hall (Monday)
14. Snack Break in Exhibit Hall (Wednesday)
15. Collected Proceedings CD-ROM

*Please sign up to attend on the meeting registration form as space is limited.
+Young Leaders lecture is free. You may order lunch on the meeting registration form.

Location

All conference events, including registration, technical sessions and the exhibition, will take place at the Ernest N. Morial Convention Center; all committee meetings will be held at the Hilton New Orleans Riverside Hotel.

Advance Registrant Check-In and On-Site Registration, Hall J:

Sunday, March 9	11 a.m. to 8 p.m.
Monday, March 10	7 a.m. to 6 p.m.
Tuesday, March 11	7 a.m. to 5:30 p.m.
Wednesday, March 12	7 a.m. to 5 p.m.
Thursday, March 13	7 to 10 a.m.

Policies

Registration Policy

All attendees and meeting participants (authors, exhibitors, etc.) must register for the conference. Badges must be worn for admission to technical sessions, the exhibition and social functions.

Americans With Disabilities Act

TMS strongly supports the federal Americans with Disabilities Act (ADA) which prohibits discrimination against, and promotes public accessibility for, those with disabilities. In support of, and in compliance with, ADA, we ask those requiring specific equipment or services to contact TMS Meeting Services in advance.

Audio/Video Recording Policy

TMS reserves the right to all audio and video reproductions of presentations at TMS sponsored meetings. Recording of sessions (audio, video, still photography, etc.) intended for personal use, distribution, publication or copyright without the express written consent of TMS and the individual authors is strictly prohibited. Contact TMS Technical Programming at (724) 776-9000, ext. 212, to obtain a waiver release.

Photography Notice

By registering for the conference, all attendees acknowledge that they may be photographed by TMS personnel while at events, and that those photos may be used for promotional purposes.

Questions? Contact:

TMS Meeting Services • (724) 776-9000, ext 243, or (800) 759-4TMS

TMS2008

March 9-13, 2008 • New Orleans, LA

AM08-ADV

ADVANCE REGISTRATION FORM

Advance Registration Deadline: February 11, 2008

Payment must accompany form.
Forms received past this date will be processed at the on-site fee.

WEB **www.tms.org/AnnualMeeting.html**
Web registration requires credit card payment.

FAX **USA: (724) 776-3770**
Fax registration requires credit card payment.

MAIL **Return with payment to:** TMS Meeting Services, 184 Thorn Hill Road, Warrendale, PA 15086

1. Member of: ☐ TMS ☐ AIST ☐ SME ☐ SPE Member Number:_____
☐ Dr. ☐ Prof.
☐ Mr. ☐ Mrs. ☐ Ms. _____
Last Name First Name Middle Initial
Informal First Name to Appear on Badge:_____ Date of Birth:_____
mm / dd / yyyy
Employer/Affiliation:_____ Title:_____
Address: ☐ Business ☐ Home _____
City:_____ State/Province:_____ Zip/Postal Code:_____ Country:_____
Telephone:_____ Fax:_____
E-mail:_____

2. Registration Fees:

	Advance Fees Through 2/11/08		On-Site Fees After 2/11/08	
☐ Member	$555	M	$655	ML
☐ Nonmember Author *	$645	NMA	$745	NMAL
☐ Nonmember *	$705	NM	$805	NML
☐ Recent Graduate Member	$395	RG	$495	RGL
☐ Student Member ##	$25	STU	$50	STUL
☐ Student Nonmember ## *	$50	STUN	$100	STUNL
☐ TMS Senior Member	$395	RM	$495	RML
☐ TMS Retired Senior Member	$100	RS	$495	RSL
☐ Exhibitor Full Conference	$555	E	$555	EL
☐ Exhibit Only	$50	EO	$50	EOL

Registration TOTAL $_____

** Includes TMS membership for 2008*
Students must attach a copy of school student identification card.

3. Publications/Collected Proceedings:
Those registering at the member, nonmember author, nonmember, TMS senior member and exhibitor full conference levels will receive a free TMS 2008 collected proceedings CD-ROM.

The CD-ROM may also be purchased below. Note: CD-ROMS will not be available after the meeting. They must be picked up at the meeting; none will be shipped.

	Attendee	Student	Quantity
☐ CD-ROM	$150	$75	_____

Publications TOTAL $_____

Visit the Publications Sales area at the meeting to purchase CD-ROMs or print volumes of selected symposia proceedings. After the meeting, individual symposia proceedings volumes may be purchased online at the TMS Knowledge Resource Center, http://doc.tms.org.

4. Continuing Education:

	Advance Fees Through 2/11/08 Member	Nonmember
☐ Grain Refinement Short Course* (Sunday)	$475	$560
☐ Greenhouse Gas Emissions Short Course* (Sunday)	$475	$560
☐ Nanomechanical Characterization Tutorial (Sunday)	$100	$125

	Conference Registrants	Nonregistrants
☐ ICME Technology Forum (Sunday)	$0	$50
☐ Lead-Free Solders Technology Workshop (Sunday)	$0	$50

Continuing Education TOTAL $_____

* Includes meal

5. Furnace Systems and Technology Workshop:

	Member	Nonmember	Total
Monday 3/10/08-Wednesday 3/12/08	$200	$250	$_____

6. Social Function Tickets:

		Fee	Quantity	Total	
Mon. 3/10/08	Hael Mughrabi Honorary Dinner	$70	_____	$_____	MD
	"Women in Science" Breakfast	$0	_____	$_____	SB
Tues. 3/11/08	TMS-AIME Banquet	$70	_____	$_____	AD
	Tables of 8	$560	_____	$_____	AD8
	Table Sign to Read _____				
	Extraction & Processing Division Luncheon	$45	_____	$_____	EP
	Tables of 8	$360	_____	$_____	EP8
	Table Sign to Read _____				
Wed. 3/12/08	Light Metals Division Luncheon	$45	_____	$_____	LM
	Tables of 8	$360	_____	$_____	LM8
	Table Sign to Read _____				

Social Function TOTAL $_____

For any special dietary needs, please contact Meeting Services at (724) 776-9000, ext. 243.

7. Tutorial Luncheon Tickets:

Monday 3/10/08	Fee	Quantity	Total	
The Young Leaders Tutorial Lecture is free.				
You may purchase the optional box lunch for	$35	_____	$_____	EM

8. 2008 Membership Renewal: *For current TMS members only*

☐ Professional Member	$105	FM
☐ Recent Graduate (2006 or 2005)	$52.50	JM
☐ (ACerS/AIST/ASM/TMS) Material Advantage Student Member	$25	ST

9. Hands-On New Orleans Service Project:

	Amount	
☐ I wish to participate in the service project on Saturday, March 8.	$0	HOP
☐ I wish to contribute financially to the TMS Foundation for project costs.	$25	TFP

10. Payment Enclosed:

☐ Check, Bank Draft, Money Order

Make checks payable to TMS. Payment must be made in U.S. dollars drawn on a U.S. bank.

☐ Credit Card Expiration Date _____
Card No. _____
☐ Visa ☐ MasterCard ☐ Diners Club ☐ American Express
Cardholder Name _____
Signature _____

11. TOTAL FEES PAID $_____

Refund Policy: Written requests must be mailed to TMS, post-marked no later than February 11, 2008. A $75 processing fee is charged for all cancellations. **No refunds will be processed after February 11, 2008.**

Receive a special reduced rate by reserving your hotel before January 28, 2008.

Two ways to reserve your hotel:

1. Visit www.tms.org/annualmeeting.html and click on "Housing" from the menu.
2. Use the form on the next page.

About the Hilton New Orleans Riverside Hotel

The Hilton New Orleans Riverside Hotel is the headquarters hotel for this year's conference. It has a prime location with restaurants, shopping and entertainment close by. Located on the banks of the Mississippi River, the Hilton gives you the best New Orleans has to offer – all within easy walking distance.

Connected to the Hilton is the Riverwalk Marketplace, with more than 140 stores and a great food court. The historic French Quarter is a mere three blocks away, and the famous Aquarium of the Americas and the IMAX Theater is only one block away.

For Your Convenience

TMS has contracted a block of rooms at the Hilton New Orleans Riverside Hotel, and at an additional 15 hotels available through Travel Planners, to ensure attendees are able to obtain housing at reduced rates. Therefore, TMS has assumed a financial liability for any and all rooms in the block that are not reserved. TMS asks that you reserve your room at these hotels in order to limit financial liability for the overall success of the meeting. Thank you.

Guest Hospitality

A special guest hospitality area will be hosted each day from 7 a.m. to 9:30 a.m. in the Hilton New Orleans Riverside Hotel. TMS will sponsor a continental breakfast for the convenience of guests of meeting attendees.

Airport Shuttle

For discounted airport transportation, visit Airport Shuttle online at www.tms.org/annualmeeting.html and click on "Housing" from the menu.

TMS2008

137th Annual Meeting & Exhibition
March 9-13, 2008
Ernest Morial Convention Center, New Orleans, LA

HOUSING RESERVATION FORM

Mail or fax this housing form to:
Travel Planners Inc., 381 Park Ave. South, New York, NY 10016
FAX: (212) 779-6128 • PHONE: (800) 221-3531
In local New York City area or international, call (212) 532-1660.
(CHOOSE ONLY ONE OPTION.)

Making a reservation is easier than ever through Travel Planners' real-time Internet reservation system! Just log on to **www.tms.org/AnnualMeeting.html**, and click on "Housing Reservations." View actual availability, learn about hotel features and services, and obtain local city and sightseeing information. Most importantly, receive instant confirmation of your reservation!

Reservations must be received at Travel Planners by: Monday, January 28, 2008

Arrival Date _____ Departure Date _____

Last Name _____ First Name _____ MI _____

Company _____

Street _____ Address _____

City _____ State/County _____ Zip/Postal Code _____ Country _____

Daytime Phone _____ Fax _____

Additional Room Occupants _____

E-mail _____ (Confirmation will be sent via e-mail if address is provided.)

Nonsmoking Room Requested _____ Special Needs _____

Indicate 1st, 2nd, and 3rd hotel choice:

1. _____
2. _____
3. _____

Type of Accommodations: (check one)
☐ Single 1 person/1bed ☐ Double 2 people/1bed ☐ Twin 2 people/2 beds
☐ Triple 3 people/2 beds ☐ Quad 4 people/2 beds

If all three requested hotels are unavailable, please process this reservation according to: (check one) ☐ ROOM RATE ☐ LOCATION

HEADQUARTERS
Hilton New Orleans Riverside Hotel
$237 single/double
$287 Executive Towers single/double

Best Western St. Christopher Hotel
$139 single/double

Country Inn & Suites
$139 single/double

Courtyard by Marriott Convention Center
$179 single/double

Embassy Suites New Orleans Convention Center Hotel
$189 single/$209 double

Hampton Inn & Suites Convention Center
$169 single/double

Hilton Garden Inn New Orleans
$175 single/double

Hotel New Orleans (formerly Holiday Inn Select)
$159 single/double

Loews New Orleans Hotel
$209 single/double

Marriott New Orleans at the Convention Center
$249 single/double

Residence Inn by Marriott Downtown Convention Center
$189 single/double

SpringHill Suites by Marriott Convention Center
$179 single/double

St. James Hotel
$149 single/double

The Pelham Hotel
$139 single/double

W New Orleans
$199 single/double

Wyndham Riverfront
$199 single/double

In order to ensure that rooms are available for attendees, TMS has contracted a block of rooms at the headquarters hotel, Hilton New Orleans Riverside Hotel, along with each of the hotels listed. TMS assumes financial liability for any and all rooms that are not reserved in the blocks. Therefore, attendees are strongly encouraged to reserve rooms at the hotels listed. This will help to limit undue expenses and secure the success of TMS 2008. Thank you.

Confirmations: A confirmation is e-mailed, faxed or mailed from Travel Planners Inc. once the reservation has been secured with a deposit or credit card. The hotels do not send confirmations. If you do not receive a confirmation within seven days, please call Travel Planners Inc.

Changes/Cancellations: All changes and cancellations in hotel reservations must be made with Travel Planners Inc. until five business days prior to arrival and are subject to the individual hotel's cancellation policies. Cancellations and changes within five days of arrival MUST be made with the hotel directly. Many hotels impose fees for early departure. This rate is set by each hotel and may vary accordingly. Please reconfirm your departure date at the time of check-in.

Reservations/Deposits: All reservations are being coordinated by Travel Planners Inc. Arrangements for housing must be made through Travel Planners Inc. and NOT with the hotel directly. Reservations via Internet, phone or fax are accepted with a major credit card only. Housing forms and written requests are accepted with a major credit card or deposit of one night's room and tax payable to Travel Planners Inc. Check must be drawn in U.S. funds on a U.S. bank. No wire transfers are accepted. Deposit policies are set by each hotel and are outlined on the hotel confirmation.

Please read all hotel information prior to completing and submitting this form to Travel Planners Inc. Keep a copy of this form. Use one form per room required. Make additional copies if needed.

Deposit Payment: ☐ Check ☐ American Express ☐ MasterCard ☐ VISA ☐ Discover ☐ Diners

Account Number _____ Expiration Date _____

Cardholder Name _____ Authorized Signature _____

City and Katrina

Sunday, March 9 or Monday, March 10 • 1 to 4 p.m. • $35 per person

Explore all that makes New Orleans America's most European city. As you ride by beautiful Jackson Square, your tour guide will reconstruct the first days of the old French City. The sights and sounds of the mighty Mississippi River, St. Louis Cathedral, Cabildo and Pontalba buildings are some of the highlights of this area. You will continue past the French Market and the U.S. Mint.

Then, to New Orleans greatest challenge, the tour will proceed by the three levees that "breached" as the tour guide provides a chronology of events leading up to Hurricane Katrina and the days immediately following the disaster. You will travel through parts of the Ninth Ward and Lakeview, some of the hardest hit areas of New Orleans as well as witness the revival of the city by citizens who refuse to give up.

Next is Esplanade Avenue, the outermost boundary of the French Quarter, where you will see a stunning display of the many fine Creole homes with delicate wrought iron fences and balconies. Passing by one of the city's oldest cemeteries, you will learn about the unique above ground burial system. Across Bayou St. John is the spacious city park with its lush greenery and scenic lagoons. Located on the park's grounds is the New Orleans Museum of Art set among the overhanging oak trees and Spanish moss.

Continuing toward the lakefront, which was also affected by the hurricane, you will see Lake Pontchartrain with its lovely setting for exclusive residences, water sports, outdoor activities and many fine seafood restaurants. Following the crescent of the river to the old town of Carrollton and the route of the St. Charles streetcar, you will pass Tulane and Loyola Universities as the ancient oaks of Audubon Park come into view. The heart of uptown showcases some of the city's loveliest neighborhoods, while the Garden District is distinguished by its Greek revival architecture and splendid gardens.

Houmas House

Tuesday, March 11 • 9 a.m. to 1 p.m. • $40 per person

One of the most visited antebellum plantation homes near New Orleans is the Houmas House Plantation. With spectacular gardens, Houmas was used as the filming location for "Hush, Hush, Sweet Charlotte," starring Bette Davis.

Located in the small river community of Darrow, Houmas sits on a few acres on the Mississippi River, much smaller than the 20,000 acres that it once had. The house was built in 1840 by Col. John Smith Preston on land originally owned by the Houmas Indians.

The preservation of this home is superior, and the furnishings are period appropriate. It is lived in and entertained in, even today. Your guides, dressed in period costumes, make the history of this plantation home come alive for you!

Jean Lafitte Swamp Adventure

Wednesday, March 12 • 9:30 a.m. to 12:30 p.m. • $50 per person

Enjoy a journey by boat, Cajun style, into the heart of Louisiana's beautiful and natural swamplands. Your boat will travel deep into the swamps and meandering bayous of this exciting region. Be sure to bring your camera as you may encounter exciting and beautiful animals at any time–alligators, snakes, nesting eagles, egrets, white-tailed deer, mink and nutria. Your guide will be a native of the area who will bring history alive by recounting the exploits of pirate Jean Lafitte and his band as they plied these waters. Louisiana's mysterious waters, moss-draped bayous and the adventure of Jean Lafitte await you!

TMS2008

137th Annual Meeting & Exhibition
March 9-13, 2008
Ernest Morial Convention Center, New Orleans, LA

TOUR REGISTRATION FORM

Type or print clearly. Copy the completed form for your records.
Return this form with appropriate fee to:
MAIL: DMI-Conventions, Laura Swann, 4220 Howard Avenue, New Orleans, LA 70125
FAX: (504) 592-0529 / E-MAIL: lswann@visitnola.com / TELEPHONE: (504) 587-1604

Registration Deadline: February 27, 2008

All tour prices are in U.S. dollars and include all taxes, gratuities, entrance fees, etc. You will receive notification from DMI confirming availability of the tours you have selected. See below for refund cancellation policy.

Tour Attendee Information:

Last Name _____ First Name _____

Street _____ City _____

State/Province _____ Country _____ Postal Code _____

Home Telephone _____ Work Telephone _____

Fax _____ E-mail _____

Name of Hotel in New Orleans _____

Tours:	Hours	No. of People	Cost	Total
March 9, 2008 **City and Katrina Tour**	1 to 4 p.m.	_____x	$35	= $ _____
March 10, 2008 **City and Katrina Tour**	1 to 4 p.m.	_____x	$35	= $ _____
March 11, 2008 **Houmas House**	9 a.m. to 1 p.m.	_____x	$40	= $ _____
March 12, 2008 **Jean Lafitte Swamp Tour**	9:30 a.m. to 12:30 p.m.	_____x	$50	= $ _____
			Total (in U.S. dollars):	$ _____

Payment Information:
Credit card orders will be charged to your account upon receipt of your tour registration form.

☐VISA

☐MasterCard

Credit Card Number _____

Expiration Date _____

Name on Card _____

Signature (required) _____

REFUND/CANCELLATION POLICY
Cancellations received by February 27, 2008, will receive a refund less a $5 per tour administrative fee. Cancellations received after February 27, 2008, will not receive a refund. Should a catastrophic event occur that adversely affects the overall conference, written notice must be received by DMI Conventions for a refund subject to a $5 administration fee.
Cancellation requests must be made in writing and addressed to: DMI-Conventions, MMM308, 4220 Howard Avenue, New Orleans, LA 70125, or faxed to (504) 592-0529. Refunds will be made via check following the conference.

SOCIAL PROGRAM INFORMATION
Tickets will be distributed at the social program registration desk at the ENMCC, Hall I, for all preregistered guests. Early registration is recommended in order to guarantee your space. DMI has the right to cancel any tours if the minimum number of attendees is not met. If a tour is cancelled due to lack of minimum attendance, registrant will be notified by DMI after the registration deadline, and the registration fee refunded in full, unless an alternate choice is selected by registrant.

Hands On

Be The Change. Volunteer. | NEW ORLEANS

You Can Make a Difference in New Orleans

*Volunteer with **TMS** and "Hands On New Orleans" on Saturday, March 8, to make a direct impact on a community affected by Hurricane Katrina.*

The city of New Orleans and the surrounding Gulf Coast region continue to recover from the effects of Hurricane Katrina in 2005. TMS is partnering with Hands On New Orleans to take a team of volunteers into a community still rebuilding from the hurricane. You can help in one or more school renovation projects, such as enhancing science and math classrooms, painting science labs and classrooms, or landscaping.

Hands On New Orleans is affiliated with the national Hands On Network and specializes in developing and implementing high impact service projects. Since the hurricane, the local organization has leveraged the power of more than 4,000 visiting volunteers who gave more than 500,000 hours of service to the recovery and rebuilding of the Gulf Coast.

Saturday's Schedule

- Continental breakfast and project orientation
- Volunteers transported to project site with equipment and supplies provided
- Lunch on-site
- Evening reception

To be part of this special event, sign up on the conference registration form. Space is limited. You can also show your support by contributing $25 to the TMS Foundation to help offset the project costs.

Corporate sponsorship opportunities are also available by contacting:
Joe Rostan • (724) 776-9000, ext. 231, or (800) 759-4TMS • jrostan@tms.org

Leave a lasting impression on the city that has welcomed the TMS Annual Meeting & Exhibition many times.

All contributions to the TMS Foundation are tax deductible in the United States.
Pennsylvania residents may obtain the official registration and financial information of the TMS Foundation from the Pennsylvania Department of State by calling, toll-free within Pennsylvania, 1-800-732-0999. Registration does not imply endorsement.

Room	Sunday	Monday		Tuesday		Wednesday		Thursday
	PM	AM	PM	AM	PM	AM	PM	AM
271		Micro-Engineered Particulate-Based Materials: Session I	Micro-Engineered Particulate-Based Materials: Session II	Materials Informatics: Enabling Integration of Modeling and Experiments in Materials Science: Informatics and Materials Property Design	Materials Informatics: Enabling Integration of Modeling and Experiments in Materials Science: Informatics and Combinatorial Experiments and Materials Characterization	Materials Informatics: Enabling Integration of Modeling and Experiments in Materials Science: Informatics and Materials Theory and Modeling	Materials Informatics: Enabling Integration of Modeling and Experiments in Materials Science: Informatics and Cyberinfrastructure	
272		General Abstracts: Extraction and Processing: Session I	General Abstracts: Extraction and Processing: Session II	IOMMMS Global Materials Forum 2008: Creating the Future MS&E Professional	Materials for Infrastructure: Building Bridges in the Global Community: Session I	Materials for Infrastructure: Building Bridges in the Global Community: Session II	The Role of Engineers in Meeting 21st Century Societal Challenges -- AIME Keynote Session	
273		Ultrafine-Grained Materials: Fifth International Symposium: Modeling, Theory, and Property	Ultrafine-Grained Materials: Fifth International Symposium: Processing and Materials	Ultrafine-Grained Materials: Fifth International Symposium: Stability, Technology, and Property	Ultrafine-Grained Materials: Fifth International Symposium: Properties	Ultrafine-Grained Materials: Fifth International Symposium: Deformation Mechanisms	Ultrafine-Grained Materials: Fifth International Symposium: Structure and Evolution	
274		2008 Nanomaterials: Fabrication, Properties, and Applications: CNT	2008 Nanomaterials: Fabrication, Properties, and Applications: Nanomaterials Synthesis	2008 Nanomaterials: Fabrication, Properties, and Applications: Device	2008 Nanomaterials: Fabrication, Properties, and Applications: Application	2008 Nanomaterials: Fabrication, Properties, and Applications: Random Topics	2008 Nanomaterials: Fabrication, Properties, and Applications: Theory	
275		Emerging Interconnect and Packaging Technologies: Pb-Free Solders: Fundamental Properties, Interfacial Reactions and Phase Transformations	Emerging Interconnect and Packaging Technologies: Pb-Free and Sn-Pb Solders: Electromigation	Emerging Interconnect and Packaging Technologies: Advanced Interconnects	Emerging Interconnect and Packaging Technologies: Pb-Free Solder: Tin Whisker Formation and Mechanical Behavior	Emerging Interconnect and Packaging Technologies: Pb-Free Solders: Reliability and Microstructure Development	Emerging Interconnect and Packaging Technologies: Pb-Free Solders and Other Interconnects: Microstructure, Modeling, and Test Methods	
276		Hume-Rothery Symposium - Nanoscale Phases: Session I	Hume-Rothery Symposium - Nanoscale Phases: Session II	Hume-Rothery Symposium - Nanoscale Phases: Session III	Hume-Rothery Symposium - Nanoscale Phases: Session IV	General Abstracts: Electronic, Magnetic, and Photonic Materials Division: Session I	General Abstracts: Electronic, Magnetic, and Photonic Materials Division: Session II	
277		Complex Oxide Materials - Synthesis, Properties and Applications: ZnO Nanostructures and Thin Films	Complex Oxide Materials - Synthesis, Properties and Applications: Novel Functionality from Complex Oxide Heterointerfaces	Complex Oxide Materials - Synthesis, Properties and Applications: Functionally Cross-Coupled Heterostructures	Complex Oxide Materials - Synthesis, Properties and Applications: Epitaxial Oxides: Ferroelectric, Dielectric, and (Electro-)Magnetic Thin Films	Complex Oxide Materials - Synthesis, Properties and Applications: Scaling, Dynamics, and Switching	Complex Oxide Materials - Synthesis, Properties and Applications: Ferroelectric/ Dielectric Oxides	

Sunday	Monday		Tuesday		Wednesday		Thursday	Room
PM	AM	PM	AM	PM	AM	PM	AM	
	Advances in Semiconductor, Electro Optic and Radio Frequency Materials: Silicon-Based Optoelectronics and Microelectronics	Advances in Semiconductor, Electro Optic and Radio Frequency Materials: Compound Semiconductors and Beyond	Phase Stability, Phase Transformations, and Reactive Phase Formation in Electronic Materials VII: Session I	Phase Stability, Phase Transformations, and Reactive Phase Formation in Electronic Materials VII: Session II	Phase Stability, Phase Transformations, and Reactive Phase Formation in Electronic Materials VII: Session III	Phase Stability, Phase Transformations, and Reactive Phase Formation in Electronic Materials VII: Session IV		278
	Mechanics and Kinetics of Interfaces in Multi-Component Materials Systems: Mechanics of Adhesion, Friction and Fracture	Mechanics and Kinetics of Interfaces in Multi-Component Materials Systems: Nanoscale Structures and Simulations	Mechanics and Kinetics of Interfaces in Multi-Component Materials Systems: Mechanical Properties of Interfaces	Mechanics and Kinetics of Interfaces in Multi-Component Materials Systems: Interfacial Microstructures and Effects on Mechanical and Physical Properties	Mechanics and Kinetics of Interfaces in Multi-Component Materials Systems: Joint Session with Advances in Semiconductors, Electro Optic and Radio Frequency Materials			279
	Recent Developments in Rare Earth Science and Technology - Acta Materialia Gold Medal Symposium: Session I	Recent Developments in Rare Earth Science and Technology - Acta Materialia Gold Medal Symposium: Session II	Recycling: Electronics Recycling	Recycling: Micro-Organisms for Metal Recovery	Recycling: Light Metals	Recycling: General Sessions		280
	Advances in Roasting, Sintering, Calcining, Preheating, and Drying: Advances in Thermal Processing	9th Global Innovations Symposium: Trends in Integrated Computational Materials Engineering for Materials Processing and Manufacturing: Session I	9th Global Innovations Symposium: Trends in Integrated Computational Materials Engineering for Materials Processing and Manufacturing: Session II	Aqueous Processing - General Session: Aqueous Processing General Abstracts				281
	General Abstracts: Materials Processing and Manufacturing Division: Solidification and Casting	General Abstracts: Materials Processing and Manufacturing Division: Composition Structure Property Relationships I	General Abstracts: Materials Processing and Manufacturing Division: Composition Structure Property Relationships II	General Abstracts: Materials Processing and Manufacturing Division: Films, Coatings, and Surface Treatments	General Abstracts: Materials Processing and Manufacturing Division: Forging, Forming, and Powder Processing			282
	Materials Processing Fundamentals: Solidification and Deformation	Materials Processing Fundamentals: Process Modeling	Materials Processing Fundamentals: Powders, Composites, Coatings and Measurements	Materials Processing Fundamentals: Smelting and Refining	Pyrometallurgy - General Sessions: Pyrometallurgy			283
	Characterization of Minerals, Metals, and Materials: Emerging Characterization Techniques	Characterization of Minerals, Metals, and Materials: Characterization of Extraction and Processing	Characterization of Minerals, Metals, and Materials: Characterization of Microstructure and Properties of Materials I	Characterization of Minerals, Metals, and Materials: Characterization of Microstructure and Properties of Materials II	Characterization of Minerals, Metals, and Materials: Characterization of Microstructure and Properties of Materials III	Characterization of Minerals, Metals, and Materials: Characterization of Microstructure and Properties of Materials IV	Characterization of Minerals, Metals, and Materials: Characterization of Microstructure and Properties of Materials V	284

Room	Sunday	Monday		Tuesday		Wednesday		Thursday
	PM	AM	PM	AM	PM	AM	PM	AM
285		Emerging Methods to Understand Mechanical Behavior: Imaging Methods	Emerging Methods to Understand Mechanical Behavior: Digital Image Correlation	Emerging Methods to Understand Mechanical Behavior: Indentation and Dynamic Methods	Emerging Methods to Understand Mechanical Behavior: Subscale Methods	Emerging Methods to Understand Mechanical Behavior: Electron and Neutron Diffraction	Emerging Methods to Understand Mechanical Behavior: X-Ray Diffraction	
286		3-Dimensional Materials Science: ONR/DARPA Dynamic 3-D Digital Structure Program	3-Dimensional Materials Science: Large Datasets and Microstructure Representation I	3-Dimensional Materials Science: Large Datasets and Microstructure Representation II	3-Dimensional Materials Science: Modeling and Characterization across Length Scales I	3-Dimensional Materials Science: Modeling and Characterization across Length Scales II	3-Dimensional Materials Science: Modeling and Characterization across Length Scales III	3-Dimensional Materials Science: Modeling and Characterization across Length Scales IV
287		Recent Industrial Applications of Solid-State Phase Transformations: Superalloys and TRIP Steels/ Automotive Steels	Recent Industrial Applications of Solid-State Phase Transformations: Alloy Design, Microstructure Prediction and Control	Frontiers in Process Modeling: Metallurgical Reactors	Frontiers in Process Modeling: Casting and General Modeling	Energy Conservation in Metals Extraction and Materials Processing: Session I	Energy Conservation in Metals Extraction and Materials Processing: Session II	
288	Computational Thermodynamics and Kinetics: Poster Session	Computational Thermodynamics and Kinetics: Defect Structure I	Computational Thermodynamics and Kinetics: Defect Structure II	Computational Thermodynamics and Kinetics: Phase Field Crystal	Computational Thermodynamics and Kinetics: Functional Materials	Computational Thermodynamics and Kinetics: Phase Transformations	Computational Thermodynamics and Kinetics: Integrated Computational Materials Engineering	Computational Thermodynamics and Kinetics: Diffusion and Phase Stability
291		Magnesium Technology 2008: Magnesium Plenary Session	Magnesium Technology 2008: Wrought Alloys I	Magnesium Technology 2008: Wrought Alloys II	Magnesium Technology 2008: Wrought Alloys III	Magnesium Technology 2008: Advanced Magnesium Materials	Magnesium Technology 2008: Corrosion, Surface Finishing and Joining	
292			Magnesium Technology 2008: Primary Production	Magnesium Technology 2008: Thermodynamics and Phase Transformations	Magnesium Technology 2008: Casting	Magnesium Technology 2008: Alloy Microstructure and Properties	Magnesium Technology 2008: Creep Resistant Magnesium Alloys	
293		Aluminum Alloys: Fabrication, Characterization and Applications: Development and Applications	Aluminum Alloys: Fabrication, Characterization and Applications: Processing and Properties	Aluminum Alloys: Fabrication, Characterization and Applications: Modeling	Aluminum Alloys: Fabrication, Characterization and Applications: Alloy Characterization	Aluminum Alloys: Fabrication, Characterization and Applications: Corrosion and Protection	Aluminum Alloys: Fabrication, Characterization and Applications: Composites and Foams	
294				Carbon Dioxide Reduction Metallurgy: Mechanisms	Carbon Dioxide Reduction Metallurgy: Ferrous Industry	Carbon Dioxide Reduction Metallurgy: Electrolytic Methods		
295		Sustainability, Climate Change and Greenhouse Gas Emissions Reduction: Responsibility, Key Challenges and Opportunities for the Aluminum Industry	Cast Shop Technology: Sustainability in the Casthouse	Cast Shop Technology: Casthouse Operation	Cast Shop Technology: Melt Handling and Treatment	Cast Shop Technology: Foundry Ingots and Alloys	Cast Shop Technology: Casting Processes and Quality Analysis	Cast Shop Technology: Modelling
296			Alumina and Bauxite: HSEC	Alumina and Bauxite: Equipment	Alumina and Bauxite: Bauxite	Alumina and Bauxite: Additives	Alumina and Bauxite: Operations	Alumina and Bauxite: Precipitation/ Conclusion

Sunday	Monday		Tuesday		Wednesday		Thursday	Room
PM	AM	PM	AM	PM	AM	PM	AM	
		General Abstracts: Light Metals Division: Session I	General Abstracts: Light Metals Division: Session II	Electrode Technology Symposium (formerly Carbon Technology): Anode Manufacturing and Developments	Hot and Cold Rolling Technology: Session I	Aluminum Reduction Technology: Reduction Cell Modelling		297
		Aluminum Reduction Technology: Sustainability and Environment	Aluminum Reduction Technology: Cell Development Part I and Operations	Aluminum Reduction Technology: Process Control	Aluminum Reduction Technology: Aluminum Industry in Mid-East	Aluminum Reduction Technology: Fundamentals, Low Melting Electrolytes, New Technologies	Aluminum Reduction Technology: Cell Development Part II	298
		Electrode Technology Symposium (formerly Carbon Technology): Carbon Sustainability and Environment Aspects	Electrode Technology Symposium (formerly Carbon Technology): Anode Raw Materials and Properties	Electrode Technology Symposium (formerly Carbon Technology): Cathodes Raw Materials and Properties		Electrode Technology Symposium (formerly Carbon Technology): Cathodes Manufacturing and Developments	Electrode Technology Symposium (formerly Carbon Technology): Inert Anode	299
	Deformation Twinning: Formation Mechanisms and Effects on Material Plasticity: Experiments and Modeling: Twin Formation and Growth Mechanisms	Deformation Twinning: Formation Mechanisms and Effects on Material Plasticity: Experiments and Modeling: Twin Effects on Material Deformation I	Deformation Twinning: Formation Mechanisms and Effects on Material Plasticity: Experiments and Modeling: Twinning and Associated Defect Structures	Deformation Twinning: Formation Mechanisms and Effects on Material Plasticity: Experiments and Modeling: Twin Effects on Material Deformation II				383
	Mechanical Behavior, Microstructure, and Modeling of Ti and Its Alloys: Processing: Design, Control and Optimization	Mechanical Behavior, Microstructure, and Modeling of Ti and Its Alloys: Phase Transformation and Microstructure Development I	Mechanical Behavior, Microstructure, and Modeling of Ti and Its Alloys: Phase Transformation and Microstructure Development II	Mechanical Behavior, Microstructure, and Modeling of Ti and Its Alloys: Microstructure/ Property Correlation I	Mechanical Behavior, Microstructure, and Modeling of Ti and Its Alloys: Microstructure/ Property Correlation II	Mechanical Behavior, Microstructure, and Modeling of Ti and Its Alloys: Physical/ Mechanical Property Prediction		384
	Minerals, Metals and Materials under Pressure: New Experimental and Theoretical Techniques in High-Pressure Materials Science	Minerals, Metals and Materials under Pressure: Shock-Induced Phase Trans-formations and Microstructure	Minerals, Metals and Materials under Pressure: Electronic, Magnetic and Optical Properties of Materials under High Pressure	Minerals, Metals and Materials under Pressure: High Pressure Phase Transitions and Mechanical Properties				385

Room	Sunday	Monday		Tuesday		Wednesday		Thursday
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386		Hael Mughrabi Honorary Symposium: Plasticity, Failure and Fatigue in Structural Materials - from Macro to Nano: Dislocations: Work Hardening, Patterning, Size Effects I	Hael Mughrabi Honorary Symposium: Plasticity, Failure and Fatigue in Structural Materials - from Macro to Nano: High-emperature Mechanical Properties: Creep, Fatigue and Thermomechanical Fatigue	Hael Mughrabi Honorary Symposium: Plasticity, Failure and Fatigue in Structural Materials - from Macro to Nano: Dislocations: Work Hardening, Patterning, Size Effects II	Hael Mughrabi Honorary Symposium: Plasticity, Failure and Fatigue in Structural Materials - from Macro to Nano: Cyclic Deformation and Fatigue of Metals I	Hael Mughrabi Honorary Symposium: Plasticity, Failure and Fatigue in Structural Materials - from Macro to Nano: Mechanical Properties of Ultrafine-Grained (UFG) Metals I	Hael Mughrabi Honorary Symposium: Plasticity, Failure and Fatigue in Structural Materials - from Macro to Nano: Mechanical Properties of Ultrafine-Grained (UFG) Metals II	Hael Mughrabi Honorary Symposium: Plasticity, Failure and Fatigue in Structural Materials - from Macro to Nano: Cyclic Deformation and Fatigue of Metals II
387		General Abstracts: Structural Materials Division: Mechanical Behavior of Metals and Alloys	General Abstracts: Structural Materials Division: Mechanical Behavior of Materials	General Abstracts: Structural Materials Division: Structure/Property Relations	General Abstracts: Structural Materials Division: Novel Issues in Materials Processing	General Abstracts: Structural Materials Division: Microstructure/ Property Relations in Steel I	General Abstracts: Structural Materials Division: Microstructure/ Property Relations in Steel II	
388		Enhancing Materials Durability via Surface Engineering: Residual Stress Effects on Durability	Enhancing Materials Durability via Surface Engineering: Steel and Other Alloys Surface Durability	Enhancing Materials Durability via Surface Engineering: Superalloy Surface Durability	Enhancing Materials Durability via Surface Engineering: Novel Surface Durability Approaches National Academies Corrosion Education Study Commuity Town Hall Meeting	Refractory Metals 2008: Processing	Refractory Metals 2008: Characterization	Refractory Metals 2008: Properties of Refractory Metals
389		Particle Beam-Induced Radiation Effects in Materials: Metals I	Particle Beam-Induced Radiation Effects in Materials: Metals II	Particle Beam-Induced Radiation Effects in Materials: RIS and Multilayers	Particle Beam-Induced Radiation Effects in Materials: Ceramics and Nuclear Fuel Materials	Particle Beam-Induced Radiation Effects in Materials: Carbides, Semiconductors and Other Non-Metals	Particle Beam-Induced Radiation Effects in Materials: Nanostructures	
390		Biological Materials Science: Mechanical Behavior of Biological Materials I	Biological Materials Science: Implant Biomaterials I	Biological Materials Science: Bioinspired Design and Processing	Biological Materials Science: Scaffold Biomaterials	Biological Materials Science: Functional Biomaterials	Biological Materials Science: Mechanical Behavior of Biological Materials II	Biological Materials Science: Implant Biomaterials II
391		Neutron and X-Ray Studies for Probing Materials Behavior: Resolving Local Structure	Neutron and X-Ray Studies for Probing Materials Behavior: Diffraction at Small Dimensions	Neutron and X-Ray Studies for Probing Materials Behavior: Phase Transitions and Beyond	Neutron and X-Ray Studies for Probing Materials Behavior: Recrystallization	Neutron and X-Ray Studies for Probing Materials Behavior: Stresses/Strains and Structure	Neutron and X-Ray Studies for Probing Materials Behavior: Scattering and Understanding of Materials Properties	
392		Materials in Clean Power Systems III: Fuel Cells, Hydrogen-, and Clean Coal-Based Technologies: Plenary Session	Materials in Clean Power Systems III: Fuel Cells, Hydrogen-, and Clean Coal-Based Technologies: Gas Separation and CO_2 Capture	Materials in Clean Power Systems III: Fuel Cells, Hydrogen-, and Clean Coal-Based Technologies: Solid Oxide Fuel Cells: Metallic Interconnects	Materials in Clean Power Systems III: Fuel Cells, Hydrogen-, and Clean Coal-Based Technologies: Metallic Interconnects in SOFCs: Oxidation, Protection Coatings	Materials in Clean Power Systems III: Fuel Cells, Hydrogen-, and Clean Coal-Based Technologies: Metallic Interconnects and Sealing in SOFCs	Materials in Clean Power Systems III: Fuel Cells, Hydrogen-, and Clean Coal-Based Technologies: PEM Fuel Cells and Solar Technologies	Materials in Clean Power Systems III: Fuel Cells, Hydrogen-, and Clean Coal-Based Technologies: Hydrogen Technologies

Sunday	Monday		Tuesday		Wednesday		Thursday	Room
PM	AM	PM	AM	PM	AM	PM	AM	
	Bulk Metallic Glasses V: Structures and Mechanical Properties I	Bulk Metallic Glasses V: Structures and Mechanical Properties II	Bulk Metallic Glasses V: Structures and Modeling I	Bulk Metallic Glasses V: Structures and Mechanical Properties III	Bulk Metallic Glasses V: Glass Forming Ability and Alloy Development	Bulk Metallic Glasses V: Structures and Modeling II	Bulk Metallic Glasses V: Processing and Properties	393
	Structural Aluminides for Elevated Temperature Applications: Applications	Structural Aluminides for Elevated Temperature Applications: Mechanical Behavior	Structural Aluminides for Elevated Temperature Applications: FE and Other Alumindes	Structural Aluminides for Elevated Temperature Applications: Processing and Microstructure Control	Structural Aluminides for Elevated Temperature Applications: Phase and Microstructure Evolution	Structural Aluminides for Elevated Temperature Applications: New Class of Gamma Alloys - & - Poster Session	Structural Aluminides for Elevated Temperature Applications: Environmental Effects and Protection	394
		Sloan Industry Centers Forum: Techno-Management Issues Related to Materials-Centric Industries: Session I	Sloan Industry Centers Forum: Techno-Management Issues Related to Materials-Centric Industries: Session II					397
	Frontiers of Computational Materials Science: Session I							APS, Hall A
Poster Sessions: 2008 Nanomaterials: Fabrication, Properties, and Applications Computational Thermodynamics and Kinetics General Poster Session Hael Mughrabi Honorary Symposium: Plasticity, Failure and Fatigue in Structural Materials - from Macro to Nano Ultrafine-Grained Materials: Fifth International Symposium								Hall I 2

2008 Nanomaterials: Fabrication, Properties, and Applications: Poster Session

Sponsored by: The Minerals, Metals and Materials Society, TMS Electronic, Magnetic, and Photonic Materials Division, TMS: Nanomaterials Committee
Program Organizers: Seong Jin Koh, University of Texas; Wonbong Choi, Florida International University; Donna Senft, US Air Force; Ganapathiraman Ramanath, Rensselaer Polytechnic Institute; Seung Kang, Qualcomm Inc

Sunday PM Room: Hall I 2
March 9, 2008 Location: Ernest Morial Convention Center

Aluminum Alloy Based Nanocomposites Reinforced with Carbon Nanotubes: *Hyun-joo Choi*[1]; Donghyun Bae[1]; [1]Yonsei University

Aluminum alloy based nanocomposites reinforced with carbon nanotubes exhibiting high specific strength and toughness are produced by hot rolling of the ball-milled mixture of aluminum alloy powders and MWNTs (Multi-walled carbon nanotubes). Each of MWNTs is well dispersed during the milling and uniaxially aligned along the rolling direction. Especially, the tubes are found to be gradually filled with aluminum atoms as the milling time increases, providing the perfectly sticking interface between the MWNTs and the matrix. The strength of the composites increase with an increase of volume fraction of MWNTs up to 0.03, and the tendency is well matched with the conventional rule of mixture. Finally, the composite sheets containing 3 vol.% MWNTs with an area above 10 inch2 exhibit remarkably enhanced strength around 750MPa in tension tests. The details of reinforcing effects of nano-scale tubes including strengthening and toughening mechanism of the MWNTs will be presented.

Cladding of Different Metals and Composites by Laser Process and Their Effects on Mechanical Properties: *Ali Emamian*[1]; [1]University of Waterloo-Canada

Cladding is deposition of different material on base metal for different aims like corrosion and erosion resistance or wear resistance or all of them. Depending on type of service, clad material can be made from metal or composites. In this process, we are able to have different aspects of properties related to base metal and cladding material simultaneously. Cladding material will be selected according their abilities and compatibility with base metals and properties. The most important item which must be considered is that clad material has to be able to wet completely by metal surface and be compatible according their surface energies. Otherwise, we cannot have a strong bond between clad and base metal because clad material will be in global shape. In this case oxidation risk also will be increased because of increasing of particles' surface in global state.

Composition Evolution during FePt Nanoparticle Synthesis: *Chandan Srivastava*[1]; Jayendra Balasubramanian[1]; Gregory Thompson[1]; Christoffer Turner[1]; John Wiest[1]; [1]University of Alabama

FePt nanoparticles are candidate materials for future magnetic storage devices. Variation in composition and size from particle-to-particle is one of the factors limiting their application. In the present study, FePt nanoparticles were synthesized by two different synthetic routes: the iron pentacarbonyl route (involving the co-reduction of Fe and Pt precursors) and the superhydride route (involving a two step reduction of precursors). The mechanism of formation of particles was investigated by structural and compositional characterization of the reaction mixture, extracted at different stages of the synthesis. It was observed that the superhydride route produced particles with a narrower composition and size distribution than iron pentacarbonyl route. These differences will be discussed as a function of the evolution of composition during the synthesis. A Monte Carlo simulation has been performed supporting the mechanism theory and suggesting a thermodynamic limit for the incorporation of Fe into the core of FePt nanoparticles.

Dislocation Interactions with Σ11 Tilt Boundaries: *Joshua Askin*[1]; Richard Hoagland[2]; Peter Anderson[1]; [1]Ohio State University; [2]Los Alamos National Laboratory

Grain boundaries play a critical role in plasticity in nanocrystalline metals, where they act as both sources and sinks of dislocation content. A single set of grain misorientations can create a multitude of grain boundary structures, depending on the orientation of the grain boundary and rigid body translation of the two grains parallel to the grain boundary. Here we compare the interaction of several grain boundaries in the Σ11 tilt orientation with dislocations of differing Burgers vectors. Absorption is a common result, with the perfect dislocation dissociating into grain boundary dislocations or otherwise spreading its core on the grain boundary, lowering total system energy. The details of absorption vary both between boundaries and within a single boundary, as the local atomic configuration changes. Results from atomistic studies are viewed in the context of the gamma surface for the boundary and compared with Peierls-type continuum models of core spreading.

Effect of Nb and Sn on the Transformation of Alpha to Beta Titanium in Ti-35 Nb-2.5 Sn Alloy Using Mechanical Alloying: Abdel-Nasser Omran[1]; *K. Woo*[1]; D. Kim[1]; Sug Won Kim[1]; [1]Chonbuk National University, Divisions of Advanced Materials Engineering, Research Center of Industrial Technology

Titanium and its alloys have many uses in different medical fields. In titanium alloys, the principal effect of an alloying element is its effect on the alpha-to-beta transformation temperature. In this work, the niobium has been chosen as β stabilizer, and tin as reducer of elastic modulus. The starting materials were blended and milled using mixing machine (24hr) and high energy ball mill machine (1, 4, and 12 hr respectively). The particles size and phases of the produced powders were analyzed using XRD, SEM, TEM, and PSA. It was found that, the titanium was completely transformed from α to β Ti at milling time 12hr.

Electrical and Optical Properties of ZnO and Gallium Doped ZnO Thin Films Prepared by rf Magnetron Sputtering: Effect of Annealing and UV Radiation: *Ved Verma*[1]; Hoonha Jeon[2]; Minhyon Jeon[2]; Wonbong Choi[1]; [1]Florida International University; [2]Inje University

Zinc oxide (ZnO) and Ga doped (1wt%) zinc oxide (GZO) thin films are grown on SiO_2/Si and glass substrates at room temperature by rf magnetron sputtering. The structural properties of both ZnO and GZO thin films are investigated by high resolution x-ray diffraction and atomic force microscopy. Both the ZnO and GZO films grow in preferred orientation of <001> direction. However, GZO thin film shows higher surface roughness (rms~1.65 nm) than ZnO thin film (rms~1.0 nm). Electrical and optical properties of thin films are investigated by Hall Effect and UV-VIS-NIR spectrometer. Both the thin films show a transmittance, above 80%. The GZO thin films exhibit higher conductivity compared to that of ZnO thin films. With time, ZnO thin films show decrease in conductivity where as GZO thin films demonstrate a stable value, which can be attributed to the passivation of oxygen dangling bond by Ga atoms in GZO thin film.

Forming Surface Nanofilms on Particles of Dispersion Aluminium: *Sergey Lipko*[1]; Vladimir Tauson[2]; Boris Zelberg[1]; [1]Siberian Research and Design Institute for Aluminium and Electrode Industry JSC; [2]Institute of Geochemistry, SD, RAS

It is considered the influence of various chemical components on powder aluminium composition, produced using the method of gas dispersion of aluminium melt in nitrogen atmosphere and then annealed in different conditions. Powders with particles of different size 5-7 and about 20 mkm were examined. The presence of W makes better the structure of a film and promotes the formation of less strained nitride coating that was seen during comparative analysis of RFES width, pick no. 1s at half of maximum height after aluminium powder annealing in the presence of W in a sealed test-tube with air. It is anticipated that W has catalytic effect promoting the formation of nitric radicals that interact with particles' surface. W belongs to the group of elements with effect of integral accumulation in fine fractions of spray like Zn, Zr and some others (V.V. Skitina and others – DAN, 2003, v.390, no. 4, p.495-498).

Microstructures and Mechanical Properties of Carbon Nanotube/Metal Nanocomposites Processed by Molecular Level Mixing: *Kyung Tae Kim*[1]; Thomas Gemming[1]; Seung Il Cha[2]; Soon Hyung Hong[3]; Juergen Eckert[1]; [1]IFW Dresden; [2]NIMS; [3]KAIST

The carbon nanotube/Cu matrix (CNT/Cu) nanocomposite is fabricated by a novel fabrication process named molecular level process. The novel process for fabricating CNT/Cu composite powders involves suspending CNTs in a solvent by surface functionalization, mixing Cu ions with CNT suspension, drying, calcinating and reducing. The molecular level process produces CNT/Cu composite powders whereby the CNTs are implanted within Cu powders.

The CNT/Cu nanocomposites, consolidated by spark plasma sintering of CNT/Cu composite powders, show the characteristic microstructures which are homogeneous dispersion of CNTs in Cu matrix and interfacial bonding between CNT and Cu. Due to these microstructures, the mechanical properties of CNT/Cu nanocomposite shows about 3 times higher strength and 2 times higher Young's modulus than those of Cu matrix. This strengthening effect of carbon nanotubes is found to be the highest compared to other types of reinforcements for metal matrix composites.

Nanowires of AlN and Si_3N_4 Prepared from Amorphous Powders: Zhao Han[1]; Mei Yang[1]; Mingli Lv[1]; *Hongmin Zhu*[1]; [1]Beijing University of Science and Technology

Aluminum nitride and silicon nitride nano-powders were synthesized through a chemical reduction, of $AlCl_3$ and $SiCl_4$ by sodium in liquid ammonia. The product powders were amorphous and spherical agglutinating particles ranging from 1 to 10 nanometers in diameter. Single-crystalline aluminum nitride (AlN) and silicon nitride (Si_3N_4) nanowires with hexagonal structure were prepared by heating the amorphous nano-powders at 1300°C through 1450°C. The products obtained were characterized by X-ray diffraction(XRD), scanning electron microscopy(SEM), transmission electron microscopy(TEM), and selected area electron diffraction(SAED). The results revealed that the products were single-crystalline AlN and Si_3N_4 nanowires. The diameters of the nanowires ranged from 30 to 200 nm, and the lengths were from several micrometers to several decades of micrometers.

Novel Preparation and Characterization of Rare-Earth Nanoparticles and Nanocrystalline Bulks: *Xiaoyan Song*[1]; Jiuxing Zhang[1]; Nianduan Lu[1]; Markus Rettenmayr[2]; [1]Beijing University of Technology; [2]Friedrich-Schiller-Universität Jena

With a home-developed "oxygen-free" in-situ synthesis system, we produced a series of rare-earth nanoparticles with controllable size. In particular, we proposed an innovative route of preparing ultrafine nanocrystalline bulks with the sequentially performed processes: the amorphization of nanoparticles, nucleation and growth of the short-range ordered "clusters", and the complete nanocrystallization. By these procedures, the grain sizes in the resultant nanocrystalline bulks are much smaller than the initial nanoparticle sizes, representing the advantage of the present technique over the conventional power metallurgy methods. The microstructures and properties of the prepared nano rare-earths have been characterized systematically. The physical, thermal and mechanical properties of the prepared nanostructured bulks are found to be improved remarkably as compared with the conventional polycrystalline bulks. The present preparation technique has potentially wide applications to a big variety of metal nanomaterials that are active in the air.

Photoactive C60 Bridged Tetrameric Osmium and Ruthenium γ-Cyclodextrin Assemblies: Assembly and Spectroscopy: *Muath Atmeh*[1]; [1]Dublin Institute of Technology

Cyclodextrins display a rich host-guest chemistry. A particularly attractive proposition is to combine the properties of CD with luminophores, which may act as reporters of binding or other interactions at the cyclodextrin cavity. Ruthenium and osmium polypyridyl complexes are particularly attractive reporters in this regard because of their visible emission, their useful redox properties. In this contribution, we exploit this ability to design a tetrameric metallocyclodextrins containing photoactive Ru(II) polypyridyl units covalently bonded to γ-CD. The supramolecular assembly consists of cyclodextrin to which two ruthenium (II) or osmium (II) polypyridyl have been covalently linked these CDs then self-assemble with a fullerene moiety in 2:1 ratio to produce the tetramer, Figure 1. Here we describe the synthesis and characterization of the complexes and in particular their spectroscopic electrochemical and photophysical properties. We describe evidence for photoinduced processes and discuss the possibility of electron and energy transfers in these novel supramolecular assemblies.

Physical and Microstructural Properties of Ultra Dispersed Nano-Diamond Reinforced Copper Matrix Composites: *Hülya Kaftelen*[1]; Mustafa Öveçoglu[1]; [1]Istanbul Technical University

Ultra dispersed nanodiamond powders were used as a reinforcement material in copper matrix to improve thermal and physical properties of composites. High energy ball milling were performed under Ar atmosphere for four different milling times. The mechanical alloyed composite powders later consolidated and sintering under protective atmosphere at 1100-1200K. The microstructures of both sintered and mechanical alloyed powders were investigated using XRD, scanning electron microscope (SEM) and EDS analysis. Titanium was also incorparated to enhance interfacial bonding between the nano-diamond and the copper matrix phase.

Preparation of ZnO Nanoparticles, Nanorods and Nanoplatelets by Micro-Emulsion Template Method: *Teng Honghui*[1]; [1]Jilin Normal University

Nano-ZnO particles, nanorods and nanoplatelets were prepared by a micro-emulsion template method. The micro-emulsion consists of surfactant A/butanol/cyclohexane/water systems=5:1.2:1:X,X are certain specific values (1.0,1.5,2.0,2.5,3.0ml). The structures of microemulsions were studied from electric conductivities of the water in oil (W/O) microemulsions at different W/O rate, with the electric conductivities of that increasing, the structures of microemulsions change from spherical to double-continued-linear and layered structure. Then, each of zinc chloride and ammonia aqueous solutions instead of water systems, two micro-emulsion systems were established, as original reaction systems, mixed up, nano-ZnO particles, nanorods and nanoplatelets were prepared by the controlling of W/O rate. The particles were spherical or spherical-like with diameter about was 30 to 80nm. The nanorods were uniform in diameter and in length, their mean diameter was 70nm and mean length was 350nm. The mean thickness of nanoplatelets was 60nm.

Processing and Characterization of Ti_2AlC/Nanocrystalline Mg Matrix Composites: *Shahram Amini*[1]; Michel Barsoum[1]; [1]Drexel University

The MAX phases - of which Ti_2AlC is a member - are layered machinable, hexagonal ternary carbides and nitrides. Due to their high c/a ratios, the MAX phases deform primarily by the formation of kink bands and consequently are members – together with Mg - of a much larger class of solids labeled kinking nonlinear elastic, KNE. Herein we report on the fabrication and characterization of Ti_2AlC/nanocrystalline Mg matrix composites fabricated by hot pressing and pressureless melt infiltration. Hot-pressing of 50 vol. % Mg and Ti_2AlC powders at 750°C for 1 h at ~ 45 MPa resulted in fully dense composites. More importantly, fully dense samples were also made by pressureless infiltration of molten Mg into porous preforms of Ti_2AlC under vacuum. The Mg matrix existed in the form of ~ 35 and 50 nm diameter nanoparticles in hot pressed and infiltrated composites.

Size Dependent Elasticity of Nanowires: *Moneesh Upmanyu*[1]; [1]Colorado School of Mines

We employ a molecular statics approach based on embedded-atom-method (EAM) inter-atomic potentials to study the elasticity of metallic nanowires. Self-consistent comparison with the bulk response in copper clearly shows that the overall nanowire elasticity is primarily due to non-linear response of the nanowire core. While the surface stress induced surface elasticity modifies the behavior for ultra-thin nanowires, their contribution is always considerably smaller than that due to non-linear elasticity of the nanowire core. More importantly, for all three orientations, the surface is softer than an equivalently strained bulk, and the overall nanowire softening or stiffening is determined by orientation dependent core elasticity. Implications for heterostructured nanowires and nanotube bundles will be also discussed.

Structural Identification of Nanocrystals from High Resolution Transmission Electron Microscopy Images: *Peter Moeck*[1]; [1]Portland State University

A novel method for the structurally identification of nanocrystals from high resolution transmission electron microscopy images is described. Components of this method are demonstrated on both experimental and simulated images. There are several levels to this structural fingerprinting method that allow for increasingly discriminatory identifications of crystal structures out of a range of candidate structures from a database. With increasing identification power, these levels are extracting the projected reciprocal lattice geometry, plane symmetry group, structure factor amplitudes, and structure factor phases. If necessary for even higher levels of structural discrimination, the extracted structural information can be extended by direct methods and the errors that have been made by assuming kinematical scattering can be estimated and corrected for. The mainly inorganic subset of the Crystallography Open Database (http://nanocrystallography.research.pdx.edu/CIF-searchable/cod.php, with approximately 10,000 structure entries) and the Nano-Crystallography Database (http://nanocrystallography.research.pdx.edu/CIF-searchable/ncd.php) can be

employed to facilitate the structural identification by calculating lattice-fringe fingerprint plots.

Study on Nano-Alumina Prepared by Low-Temperature Combustion Synthesis: *Guo Rui*[1]; [1]Northeastern University

Al_2O_3 has fine physical and chemical properties. Nanometer α-Al_2O_3 powder was prepared by the method of Low-temperature Combustion Synthesis with aluminum nitrate Nona hydrate and urea as raw materials in the muffle furnace and microwave oven. By the means of XRD, TEM, TG-DTA, IR and Malvern Mastersizer measurements, the as-prepared powder was analyzed. The optimum technology process with muffle furnace was: the molar ratio of Al(NO3)3•9H2O/CO(NH2)2 was 1 to 2.5,the igniting temperature was 750°C. It was found that the a-Al_2O3 powders having an average gain size about 40-90nm were sheet structure in a great measure, others were the shape of approximate sphere. The optimum technology process with the microwave oven was: the molar ratio of Al(NO3)3•9H2O/CO(NH2)2 was 1 to 2.5; heat power was 900W. The product having an average gain size about 60-90nm was sheet in a grate measure.

Surface Modification of PPy Conducting Polymer Nanowires by Sputtered Noble Metals for Gas Sensing: *Jiajun Chen*[1]; Lianbin Xu[2]; Xiaojun Tang[1]; Yushan Yan[2]; Weilie Zhou[1]; [1]University of New Orleans; [2]University of California at Riverside

Polypyrrole (PPy) conducting polymer can works as the active materials for gas sensor, which has several advantages compared to commercial available metal oxide based sensors: high sensitivity and short response time at room temperature, low cost fabrication and compatible to flexible electronics. PPy nanowires are ideal materials for highly sensitive gas sensors due to their high surface-volume aspect ratio. PPy nanowires were fabricated by electrochemistry methods and multi-nanowire-based field effect transistors (FETs) were prepared by e-beam lithography. Sputtered noble metals were used to modify the PPy nanowire surfaces. The electrical and gas sensing properties of PPy nanowire based FETs were investigated. The role of noble metal modification was discussed.

Synthesis and Characterization of Nano-Spinel Lithium Manganate: *Xinghua Xie*[1]; Shilong Yan[1]; Hongbo Wu[1]; Weiguo Wang[1]; Meng Wang[1]; Xiaojie Li[2]; [1]Anhui University of Science and Technology; [2]Dalian University of Technology

The formation of metallic nanooxides via detonation reaction was investigated with respect to the presence of an energetic precursor, such as the metallic nitrate and the degree of confinement of the explosive charge. The detonation products were characterized by scanning electron microscopy. The thermal stability of the nanostructures has been examined by heating-treatment at different temperatures. Powder X-ray diffraction, transmission electron microscopy, scanning electron microscopy, thermogravimetric analysis and BET were used to characterize the products. Nano-metallic oxides with diameters from 10 to 50 nm and a variety of morphologies were found. The oxides produced by this cheap method affirmed the validity of detonation synthesis of nano-size powders.

Synthesis and Electrical Properties of Exotic Boron Carbide Nanowires: *Varun Gupta*[1]; Steve Miller[1]; Giovanni Fanchini[1]; Jafar Al-Sharab[1]; Manish Chhowalla[1]; [1]Rutgers University

Recently, synthesis of one dimensional nano-materials and quasi-one dimensional nanostructures such as nanotubes, nanopipes and nanowires (NWs) has gained a large impetus. Boron carbide NWs are particularly significant because of their use in thermoelectric devices and other electronic applications. In this study we explore the role of boron/carbon ratio, temperature, inert gas pressure and dopants (Si and Al) on the morphology, length and diameter of nanowires. Nanowire dimensions show a bimodal distribution with wire length varying from 100nm to 50μm and up to a few millimeters. The elemental composition, morphology and single crystalline nature of the nanowires were analyzed by SEM, EDS, TGA and HRTEM. The effect of Si and Al doping on the conductivity is further evaluated and compared to pure B_4C. This approach can be readily extended to the synthesis of other doped nanostructures, which can offer great opportunities for both fundamental research and technological applications.

Temperature, Thickness and High Energy Si Ions Bombardment Effects on the Thermoelectric Properties of $GdFe_4Sb_{6-y}Ge_y$ Thin Films: *Sadik Guner*[1]; Satilmis Budak[1]; Claudiu Muntele[1]; Daryush Ila[1]; [1]Alabama A&M University, Department of Physics, Center for Irradiation of Materials

We have grown three monolayer $GdFe_4Sb_{6-y}Ge_y$ (y = 2,4) thin films on silica substrates with varying thickness between 100-1000 nm using electron beam deposition. The high-energy (MeV) Si ion bombardments were performed on samples with varying fluencies ($1x10^{14}$-$5x10^{15}$). The thermopower, electrical and thermal conductivity measurements were carried out before and after the bombardment on samples to determine the dimensionless figure of merit, ZT. The Si ions bombardment caused changes on the thermoelectric properties of films. The fluence and temperature dependence of cross plane thermoelectric parameters were also reported. Rutherford Backscattering Spectrometry (RBS) was used to analyze the elemental composition of deposited materials and to determine the layer thickness of each film. Research sponsored by the Center for Irradiation of Materials, Alabama A&M University and by the AAMURI Center for Advanced Propulsion Materials under the contract number NNM06AA12A from NASA, and by National Science Foundation under Grant No. EPS-0447675.

The Fabrication Technique for Indium Tin Oxide Nanosized Composite Powder: *Huimin Lu*[1]; Xi Zhang[1]; [1]Beijing University of Aeronautics and Astronautics

Indium tin oxide (ITO) nanosized composite powder not only can improve sintering properties of target and afford material for big size and super density ITO target, but also can be made into electronic pastes which can be spurted on cathode ray tube as an effective seclusion screen of electromagnetic interfere. In this paper, conductive indium tin oxide(ITO) powder sin size of nanometer were prepared by the hydrolysis of corresponding metal salts following co-precipitation technique using indium metal ingots and SnCl4•5H2O as raw materials. On the purpose of manufacturing functional powders in a large amount and energy-conserving, the factors in whole course were considered, especially the influences of co-precipitation terminal pH value and heat treatment temperature under hydrogen gas on the particle size and power resistance were discussed. The characteristics of powers were investigated by DTA-TG, XRD, TEM.

The Influence of Nano Boehmite on Spinel Formation: *Hamid Zargar*[1]; Farhad Golestani Fard[1]; Hamidreza Rezaie[1]; [1]Iran University of Science and Technology

The effect of nano boehmite as an additive on the formation of spinel at low temperatures (T<1000°C) via solid-state procedure is investigated. In this regard, the homogeneity of prepared mixtures preciously studied by performing XRD, FTIR, SEM and MAP. Furthermore, in order to evaluate the morphology of synthesized spinel, SEM has applied. Results are implied that nano boehmite facilitate solid-state spinel formation on magnesia grain at temperatures as low as 700°C. In addition, prepared spinel is in nano scale (<80nm) and homogeniously distributed on, magnesia grains.

Thermoelectric Generator from Sequentially Deposited $SiO_2/GdFe_4Sb_{6-y}Ge_y$ Nanolayers Modified by MeV Si Ions Bombardment: *Sadik Guner*[1]; Satilmis Budak[2]; Claudiu Muntele[2]; Daryush Ila[2]; [1]Alabama A&M University, Department of Physics, Center for Irradiation of Materials; Fatih University, Department of Physics; [2]Alabama A&M University, Department of Physics, Center for Irradiation of Materials

We have grown 50-100 periodic nano-layers of $SiO_2/GdFe_4Sb_{6-y}Ge_y$ super-lattice electro-cooling system. The deposited multi-layer films have a periodic structure consisting of alternating layers, between 5-20 nm thick each. The super-lattices were then bombarded by 5 MeV Si ions at different fluences ranging from $1x10^{14}$ to $5x10^{15}$ ions/cm^2 to form nano-cluster structure. Rutherford Backscattering Spectrometry (RBS) specified the total deposit thickness and stoichiometry. We measured the thermoelectric efficiency of the fabricated device before and after MeV bombardments. To accomplish this we measured the cross plane thermal conductivity by 3rd harmonic method, cross plane Seebeck coefficient and cross plane electric conductivity. As predicted the electronic energy deposited due to ionization by MeV Si beam in its track produces nano-scale structures that disrupt and confine phonon transmission therefore reducing thermal conductivity, increasing electron density of state so as to increase Seebeck coefficient and

electric conductivity, thus increasing the figure of merit. Research sponsored by the Center for Irradiation of Materials, Alabama A&M University and by the AAMURI Center for Advanced Propulsion Materials under the contract number NNM06AA12A from NASA, and by National Science Foundation under Grant No. EPS-0447675.

Preparation of Nanosized Zinc Ferrite Particles: *Qing-hua Tian*[1]; Xueyi Guo[1]; Huang Kai[1]; [1]Central South University

Based on the review of technical literatures, the co-precipitation-drying-thermal decomposition was determined for the preparation of nanosized zinc-ferrite. The ammonium bicarbonate was chosen as the co-precipitation agent, and the thermodynamic analyses were done for the solution system of Fe(III)-Zn(II)-NH3-CO32—H2O. The double-jet precipitation process was proposed based on the thermodynamic analyses results. Considering the heavy aggregation among nano-sized particles, the measures were adopteed by addition of dispersant in the process of co-precipitation and washing by organic solvent or azeotropic distillation. By TG-DTA analysis, the suitable thermol-decomposition temperature of the zinc ferrite precursor was determined at about 450°C. Kept at this temperature for 2 hours, the pure and well crystalized $ZnFe_2O_4$ was obtained. SEM Photos of the obtained powder shows that the particles are uniform in size distribution (20nm-50nm) with good dispersivity.

Quantum Size Effect of Electron Density and Its Influence on Interlayer Relaxation of Ultra-Thin Metal Films: *Fei Ma*[1]; Shengli Ma[2]; Kewei Xu[2]; Paul Chu[1]; [1]City University of HongKong; [2]Xi'an Jiaotong University

Further minimization of electronic devices and microelectromechanical systems (MEMS) requires the feature sizes of relevant materials to be shrunk significantly. In such a case, boundary effects, such as interfaces and surfaces, become remarkable, especially in nanometer scale, which must affect their microstructures and properties. In this work, we have analyzed the distribution of electron charge density in Cu and Al ultra-thin films using free electron model. The results show that an electrostatic field may come into being due to quantum size effect, and the interlayer separations must relax to decrease the Coulomb energy, the thinner the films, the larger the relaxation. More interestingly, the different electron shell configurations result in two opposite deviating directions of the center of negative charges: inwards for Cu and outwards for Al, and thus two absolutely distinct interlayer relaxations.

Nano-Diamond Coatings for Machining Applications: Jianwen Hu[1]; *Kevin Chou*[1]; Raymond Thompson[2]; [1]University of Alabama; [2]Vista Engineering

Different from microcrystalline diamond (MCD) coatings, nanostructured diamond (nano-diamond) coatings, produced by microwave plasma-assisted chemical vapor deposition with nitrogen gas added, own several unique properties that enhance their machining performance in cutting tool applications. Characterized by nanoindentation, nano-diamond coatings have very high hardness (over 80 GPa vs. ~60 GPa of MCD) and lower elasticity (below 800 GPa vs. ~1100 GPa of MCD) which generates less residual stresses in the coating-substrate system. Moreover, nano-diamond coatings have much smoother topography than MCD coatings. Nano-diamond coatings consist of nanocrystalline diamond grains (average sizes from 5 to 30 nm) imbedded into an amorphous tetrahedral carbon matrix which offers cracking resistance. These distinct attributes jointly result in strong adhesion of nano-diamond coatings. Machining of high-strength Al alloys and composites using diamond tooling shows that nano-diamond coated tools significantly outperform conventional MCD tools, though both of them exhibiting delamination as the major tool failure mode.

The Anodic and Cathodic Processes in Direct Electrochemical Conversion of Solid Metal Chlorides to Metal Nanoparticles in Ionic Liquids: Linpo Yu[1]; Huijiao Sun[1]; Dihua Wang[1]; Xianbo Jin[1]; *George Chen*[2]; [1]Wuhan University; [2]University of Nottingham and Wuhan University

Solid metal chlorides have been attached to a metallic substrate in the form of either a thin coating or powder and successfully electrochemically reduced to metal nanoparticles in an ionic liquid, 1-butyl-3-methylimidazolium hexafluorophosphate. Particularly, the presentation compares the cyclic voltammograms of cuprous copper in aqueous and ionic liquid electrolyte, and the physicochemical characterisations of the potentiostatic electrolysis products on both cathode and anode. Preliminary findings are also presented for a few other metal chlorides. It is proposed that the formation of the metal nanoparticles is the result of a combined effect of the slow kinetics of the dissolution-deposition process in the ionic liquids, and also likely the ionic liquid being effective in preventing the metal particles to grow larger as compared with water.

Robust and High Current Cold Electron Source Based on Carbon Nanotube Field Emitters and Electron Multiplier Microchannel Plate: *Raghunandan Seelaboyina*[1]; Srinivas Rao Bodepalli[1]; Wonbong Choi[1]; [1]Florida International University

Vacuum microelectronics has been studied for decades to develop unique devices such as rf-generators, high efficiency flat panel displays, x-ray sources and so on. In recent years field emitters based on carbon nanotubes (CNTs) and other nano materials have demonstrated high emission current densities making them prime candidates for next generation vacuum microelectronic applications. However the emission efficiency and stability of these materials is hindered by non uniform emission and emitter destruction in high electric field conditions. To achieve higher and stable current we have designed and fabricated a unique ceramic microchannel plate (MCP) consisting of high secondary emission yield (SEY) materials. The MCP was fabricated utilizing the optimum design parameters, which include channel dimensions and material properties obtained from charged particle optics (CPO) simulation. In this presentation we will discuss the results on our new microchannel plate design (simulation), fabrication, and field emission current amplification from vertically aligned carbon nanotube tower structures and microchannel plate assembly.

Computational Thermodynamics and Kinetics: Poster Session

Sponsored by: The Minerals, Metals and Materials Society, TMS Electronic, Magnetic, and Photonic Materials Division, TMS Materials Processing and Manufacturing Division, ASM Materials Science Critical Technology Sector, TMS: Chemistry and Physics of Materials Committee, TMS/ASM: Computational Materials Science and Engineering Committee, TMS/ASM: Phase Transformations Committee
Program Organizers: Yunzhi Wang, Ohio State University; Long-Qing Chen, Pennsylvania State University; Jeffrey Hoyt, McMaster University; Yu Wang, Virginia Tech

Sunday PM — Room: Hall I 2
March 9, 2008 — Location: Ernest Morial Convention Center

Session Chairs: Yunzhi Wang, Ohio State University; Long Qing Chen, Pennsylvania State University; Jeffrey Hoyt, McMaster University; Yu Wang, Virginia Tech

Investigation of Atom Size Effects on Binary Alloys Phase Diagrams Using a Relaxed Monte Carlo Approach: *Mathieu Fevre*[1]; Alphonse Finel[1]; Yann Le Bouar[2]; [1]ONERA; [2]CNRS-ONERA

The precise determination of phase diagrams is essential to understand the microstructural evolution in metallic alloys. Theoretical predictions are difficult and usually rely on simplifying assumptions, such as interatomic potentials on a rigid lattice. In this study, we investigate a more realistic situation where atoms can move freely and interact through a position dependent potential. Using relaxed Monte Carlo simulations, we calculate the phase diagram of binary alloys exhibiting a phase separation (Cu-Ag type) or an order-disorder transformation (Cu-Au type). The whole composition range, from low temperature up to the liquid state is considered. By changing the parameters values of the potential, we have systematically studied the evolution of the phase diagram when the difference between the atomic radii of the two components is increased. The understanding of the phase stability in thin films and nanoparticles, where elastic relaxations play a major role is a natural extension of this work.

Prediction of the Thermodynamic Properties of Liquid Alloys by Molecular Interaction Volume Model: Hongwei Yang[1]; *Dongping Tao*[1]; [1]Kunming University of Science and Technology

The thermodynamic properties(for example:activities and mixing enthalpies) of ternary and quaternary liquid alloys are calculated by molecular interaction volume model (MIVM) which is a two-parameter model with the partial molar infinite dilute mixing enthalpies. The predicted values are in agreement with the

experimental data and then indicate that the model is reliable, convenient and economic.

First Principle Calculation of the Structural and Electronic Property of Zr Doped $B_{13}C_2$: *Yu Liang*[1]; Ru Hongqiang[1]; Jiang Yanli[1]; Zuo Liang[1]; Xue Xiangxin[1]; [1]Northeastern University

The first principle calculations based on density functional theory were carried out to study the stability and electronic properties of three structural unit models of Zr atom doped boron carbides ($B_{13}C_2$) crystal using CASTEP code which employed a plane wave-pseudo potential expansion technology. The calculations results show that Zr atom doped boron carbide is in preference to substituting C atom on the end of boron carbide chain, a representative structural unit containing Zr atom is [C-B-Zr] ε+-[B11C] ε-,while the structural unit without Zr is [C-B-C] ε—[B11C] ε+, The band and density of states(DOS) indicates that the coexistence of these two different structural units makes the electrical conductivity increased. As the covalent bond of Zr-B is weaker than those of B-B and B-C, and the thermal conductivity decreases when Zr doped $B_{13}C_2$, the thermoelectric property of Zr doped boron carbides will be improved.

Anharmonic Phonons in A15 V3X Compounds: *Oliver Delaire*[1]; Jorge Munoz[1]; Matthew Lucas[1]; Max Kresch[1]; Rebecca Stevens[1]; Brent Fultz[1]; [1]California Institute of Technology

Using inelastic neutron scattering, we investigated the temperature-dependence of the phonon density of states (DOS) in the A15 compounds V3Si, V3Ge and V3Co. Phonons in V3Si exhibit an anomalous stiffening up to temperatures T>500C, while V3Co and V3Ge exhibit the more common softening, expected from thermal expansion. We also measured the heat capacity of the compounds, which could be correlated to the trend observed in the phonons. To help interpret experimental results, we performed Density functional theory (DFT) calculations of these materials. The calculated phonon DOS was in good agreement with the low-T measurements. The electronic part of the heat capacity was also obtained from the DFT computations. V3Si and V3Ge are known to exhibit a fairly strong electron-phonon coupling, as evidenced by their rather high superconducting Tc (Tc=16K for V3Si). Anharmonic couplings arising from phonon-phonon or electron-phonon interactions are used to explain the departure from the quasiharmonic behavior.

Modeling of Dynamic Strain Aging in Solid Solutions: Part II: Multiple Strengthening Mechanisms: *Monica Soare*[1]; William Curtin[1]; [1]Brown University

Having previously shown that a full rate theory for thermally-activated dislocation motion involving a single rate-dependent dislocation strengthening mechanism is unable to predict a regime of negative strain rate sensitivity, here the analysis is extended to incorporate two concurrent mechanisms, solute strengthening and forest hardening, each of which is influenced by the same time-dependent solute diffusion. Explicitly, solute diffusion toward both (i) temporarily arrested but otherwise mobile dislocations and (ii) forest dislocations formed during the plastic deformation are considered simultaneously. Solute strengthening controls the overall rate dependence so that forest hardening enters the theory as a time, strain, and strain-rate dependent "backstress" acting on the mobile dislocations. The model includes the influence of plastic strain, strain rate, temperature, and solute concentration. Comparisons to experimental data on Al-Mg alloys show broad quantitative agreement, including non-intuitive features such as the non-additivity of solute strengthening and forest hardening at low strain rates.

Solute Drag Simulations in Grain Growth with Realistic Interaction Potential Input from Atomistic Simulations: *Michael Gao*[1]; Anthony Rollett[1]; Branden Kappes[1]; Moneesh Upmanyu[2]; [1]Carnegie Mellon University; [2]Colorado School of Mines

With the solute-grain boundary interaction potentials calculated from atomistic simulations, solute segregation and solute drag phenomena are reexamined using gradient weighted finite element package GRAIN3D coupled with solute diffusion field in 3-dimension grain growth. Specifically, the potential versus distance away from a grain boundary plane are computed using embedded atom method (EAM) for fcc Al with impurity of Mg for a flat tilt grain boundary with tilting angle of 0, 32, 35, 37 38 and 40 degrees. These measured potentials are then directly input into GRAIN3D to simulate Mg segregation and the corresponding drag effect during grain growth. Our simulation results are compared with analytical models reported in the literature.

Grain Growth Simulations with Langevin Noise: *Nele Moelans*[1]; Frans Spaepen[2]; [1]Katholieke Universiteit Leuven; [2]Harvard University

We have added, in a thermodynamically consistent way, Langevin noise to a diffuse interface (phase field) model for grain growth. With this model we simulated how thermal noise affects grain growth. The total energy content of the simulated system was measured as a function of time. Energy jumps were linked to special events in the grain growth process, for example the disappearance of a grain. Depending on the magnitude of the noise, certain events and processes are induced or accelerated. Furthermore, we studied the stability and occurrence of (local) metastable grain configurations as a function of the magnitude of the noise. Langevin noise is also successful in preventing artificial pinning and drag in simulations, for example as a result of low resolution of the numerical technique.

Phase Field Study of Precipitate Growth Kinetics: Effect of a Misfit Strain: Rajdip Mukherjee[1]; Thennathur Abinandanan[1]; *Mogadalai Gururajan*[2]; [1]Indian Institute of Science; [2]Northwest University

Laraia and Johnson presented a model for the kinetics of growth of an isolated, dilatationally misfitting precipitate. Our study - using a phase field model based on the Cahn-Hilliard equation - is aimed at validating their results through 'computer experiments', since those results are not amenable for direct experimental verification. We first establish the validity of phase field experiments by showing that the parabolic growth coefficient obtained from our phase field simulations is in very good agreement with that obtained through a numerical solution of the classical Zener problem with a variable diffusivity. We then show that the parabolic growth coefficient for a dilatationally misfitting precipitate is in agreement with that obtained from the sharp interface model (modified to account for composition-dependent diffusivity) of Laraia and Johnson. In more supersaturated alloys, since curvature effects are smaller, the agreement between phase field results and those from the sharp-interface model is better.

Microscopic Phase-Field Simulation of the Ni_3Al Phase Separation Process: *Yanli Lu*[1]; [1]Northwestern Polytechnical University, School of Materials Science and Engineering

The separation process of Ni_3Al phase in Ni-Al alloy containing 12.5at.%Al was simulated at the atomic scale using the microscopic phase-field model and microelasticity theory. The simulation results show that Ni_3Al phases firstly are formed from the disordered solid solution by the mechanism of non-classical nucleation growth, resulting in the appearance of single ordered domain separated by the antiphase domain boundaries (APBs). With the ordered domains isostrcutural decomposing and the Al-lean regions disordering spontaneously, the equilibrium state is formed finally. In the whole stage of precipitation, the shape of Ni_3Al phase becomes more regular and their orientation becomes more obvious, at the later stage, Ni_3Al phases present quadrate shape with round corner and align along the [10] and [01] directions.

Development and Calibration of Pseudo-Binary Phase Field Modeling for Microstructural Evolution in Multi-Component Alloys: *Billie Wang*[1]; James Lill[2]; Youhai Wen[3]; Jeff Simmons[4]; Yunzhi Wang[1]; [1]Ohio State University; [2]High Performance Technologies Inc.; [3]UES Inc.; [4]Air Force Research Laboratory

Alloy development time is under constant pressure to be reduced. Physics-based modeling promises to make the most efficient use of experimentalist time by identifying processing windows for the formation of desirable microstructures. In order to be incorporated into the development cycle, a model must be calibrated rapidly and accurately, and be computationally efficient. To this end, a pseudo-binary phase field methodology that captures the kinetics of microstructural evolution of a multi-component system was developed. The parameters for the pseudo-binary model were optimized using the simplex method to match experimental measurement on average particle size as function of time. A penalty function was defined to quantify deviation from target parameters and accounts for uncertainty in literature, database and experimental data. Preliminary results will be presented.

Model Study and Forecast on the Behavior of Rare Earth during Solidification Process of Heavy Rail Steel: *Liu Chengjun*[1]; [1]Northeastern University

A thermodynamic model was developed to describe quantificationally elements segregation and inclusions precipitation during solidification process of heavy rail steel. According to the SEM and energy spectrum analysis, the model could completely consist with experimental results. The state of RE and constituents of inclusions in heavy rail steel with different cleanliness were studied. The results as follows: (1) The increment of RE dissolved in heavy rail steel mainly has two stages: the first stage is before the RE second phases were not precipitated, the second stage is after the separation react of the RE second phases reached equilibrium. And the increment of the second stage is more obvious. (2) Under the conditions of the same RE addition, the content of solid lanthanum dissolved in heavy rail steel is more than that of cerium. Alloying function of lanthanum is better than that of cerium.

Numerical Simulation of Twin-Roll Strip Casting Process: *Jieyu Zhang*[1]; Bo Wang[2]; [1]Shanghai University; [2]Inner Mongolia University of Science and Technology

A three-dimensional mathematical model has been developed to simulate fluid flow, heat transfer, and solidification in twin-roll strip casting of steel. The two equation model is used to incorporate the turbulence in fluid flow. The effect of the casting speed, superheat, and roll gap on the flow and temperature field was predicted. The simulation results showed that it was desirable for the wedge metal delivery system to not only gain the uniform of flow and temperature in the pool, but also improve strip quality and ensure casing process.

Thermodynamics of Liquid Phase Sintering of SiC Using Al_2O_3 and Y_2O_3 as Sintering Additives: *Hans Seifert*[1]; Damian Cupid[2]; Olga Fabrichnaya[1]; [1]Technische University Bergakademie; [2]University of Florida

A thermodynamic dataset for the Al–C–O–Si–Y system was used for calculations of multicomponent, multiphase reactions. Some aspects of the liquid phase sintering of silicon carbide using alumina and yttria sintering additives were analyzed. The phase relations in the SiC–Al_2O_3, SiC–Al_2O_3–SiO_2 and SiC-Y_2O_3–SiO_2 systems were calculated. Phase fraction diagrams, isopleths, isothermal sections, and potential phase diagrams are presented to illustrate the reactions between silicon carbide and sintering additives. The effect of Ar inert gas as an additional component and the related volume change of the gas phase were considered. In addition, the influence of surface silica on silicon carbide powder is taken into account.

Modeling of Oxygen Kinetics in a Ag/MgO Composite: *Nilindu Muthubandara*[1]; Irina Belova[1]; Andreas Oechsner[2]; Graeme Murch[1]; [1]University of Newcastle; [2]Technical University of Malaysia

The presence of atomic oxygen at metal/oxide interfaces can significantly affect the physical properties of interfaces and hence the properties of the bulk material. We modeled oxygen diffusion in Ag-MgO composites with a Lattice Monte Carlo method and the finite element method. First, we considered oxygen in-diffusion from a constant surface source solely into a Ag metal matrix: oxygen depth profiles were in excellent agreement with exact results. Next, we simulated oxygen in-diffusion/segregation in the composite permitting and restricting the mobility of oxygen in different scenarios involving the Ag-MgO interface. The (higher temperature) out-diffusion of oxygen from the composite was also simulated and corresponding results obtained for the oxygen depth profiles. In both cases, very good agreement was found between the Lattice Monte Carlo method and the finite element method.

Kinetic Study on Chromium Ore Dissolution in CaO-SiO_2-MgO-Al_2O_3 Melts: *Jiang Maofa*[1]; [1]Northeastern University

To reveal the smelting reduction mechanism of chromium ore for producing stainless steel in converter, the dissolution behavior of chromium ore in CaO-SiO_2-MgO-Al2O_3 slag system was studied by laboratory experiments, and the effect of different temperature and slag composition on the dissolution rate of chromium ore in slag was investigated. The dissolution mechanism of chromium ore in slag was discussed. A kinetic model for dissolution process of chromium ore was developed on macrokinetics theory for the first time. According to the data of dissolution experiments, the regression expression between the dissolution rate constant and the temperature and slag composition was obtained. It was found that the dissolution process of chromium ore is controlled by the surface dissolution reaction on conditions of the present experiments, where the temperature has significant effect on the reaction rate constant of chromium ore dissolution. The calculated value of dissolution activation energy is 524.50kJ·mol-1.

Study on Dynamic Mathematical Model of Ion Exchange Process: *Changren Tong*[1]; Fengli Yang[1]; Xiaoxue Zhou[1]; [1]Jiangxi University of Science and Technology

Based on the mechanism analysis of fixed-bed ion exchange process, the relationship among solution flow in column, external diffusion, inner diffusion and ion exchange reaction was given an overall consideration, with the aid of thermodynamics, Fick's law of diffusion and flow solution micro-layers idea, dynamic mathematical model on fixed-bed ion exchange process was developed. In the paper, simulation verification based on an example of tungsten ion exchange process was carried out. The results show the dynamic mathematical model was in agreement with ion exchange practical process, and it would provide guidance and reference for ion exchange process.

General Poster Session

Sponsored by: The Minerals, Metals and Materials Society

Sunday PM Room: Hall I 2
March 9, 2008 Location: Ernest Morial Convention Center

On the Phase Diagram and Thermodynamics of the Al-Ca-Cu System: A Combined Approach of Experiments, CALPHAD and First-Principles Calculations: *Michael Gao*[1]; Gary Shiflet[1]; Marek Mihalkovic[2]; Michael Widom[2]; [1]University of Virginia; [2]Carnegie Mellon University

This study combines critical experiments, CALPHAD modeling and first principles calculations to determine the Al-Ca-Cu ternary phase diagram and the quantitative thermodynamics. Using electron microprobe analysis, nine ternary compounds are experimentally identified. Four ternary compounds and three binary compounds are found to have extended Al/Cu solubility. The compound crystal structures are proposed according to first principles calculations. The observed Al/Cu homogeneity ranges are in good agreement with theoretical predictions. Based on current first principles calculations and experimental results, the complete phase diagram of Al-Ca-Cu is updated and the thermodynamic descriptions are determined via CALPHAD modeling.

Microstructure Evolution and Mechanical Properties of In-Situ Fe-Zr-Nb Ultrafine Eutectic Composites: *Tae Eung Kim*[1]; Jin Man Park[1]; Ka Ram Lim[1]; Won Tae Kim[2]; Do Hyang Kim[1]; [1]Yonsei University; [2]Chongju University

Recently, there have been considerable interests in the development of nano/ultrafine grained materials for structural applications. However, applications of these materials are restricted by various reasons such as complex processing route, limited size and low ductility at room temperature. To overcome the limited ductility of these materials, a new concept for the design of composite microstructure with different length scale has been proposed.[1] In this study, we investigated the development of in-situ nano/ultrafine eutectic composites in Fe-Zr-Nb alloy system by tailoring the microstructure during solidification processing. The morphology and distribution of primary phases (α-Fe or Fe_2Zr) and the scale of α-Fe/Fe_2Zr eutectic have been significantly changed depending on the alloy composition. To improve strength and ductility, Cr and C have been added as strengthening elements in ternary Fe-Zr-Nb alloy system. [1]E. Ma *et al*., "High tensile ductility in a nanostructured metal" NATURE VOL 419, p912-915.

Nano Eutectic Al-Ag_2Al Composites with High Strength and Ductility: *Sung Woo Sohn*[1]; Jin Man Park[1]; Tae Eung Kim[1]; Ka Ram Lim[1]; Won Tae Kim[2]; Do Hyang Kim[1]; [1]Yonsei University; [2]Chongju University

Recently, extensive investigations have been carried out on nano/ultrafine structured materials due to outstanding mechanical properties. Nano/ultrafine grained alloys exhibit high strength but lack of ductility, which restricts their application. The Al-Ag system, which contains a eutectic between the Al solid solution and the Ag_2Al compound, has been selected since the slopes of liquidus, solidus and solvus are very different for the two sides.The alloy compositions studied in the present study are Al-xAg (x= 65, 67 and 69 at%). In-situ eutectic

structure has been obtained under the conditions of various cooling rate such as melt spinning, injection casting, and conventional mold casting. Each sample has been carefully observed using secondary electron microscopy (SEM) and transmission electron microscopy (TEM). The cylindrical samples with 1 mm diameter have been tested in compression mode at room temperature, showing the strength of over 800MPa with a notable strain of 25%.

Microstructural Characterization in Cast AlMg Alloy-SiCp Composites: *S. Valdez*[1]; B. Campillo[1]; R. Perez[1]; L. Martínez[1]; A. García H.[2]; [1]Instituto de Ciencias Físicas-Universidad Nacional Autóoma de México; [2]Facultad de Química-Universidad Nacional Autóoma de México

On the present investigation, microstructural behavior of 10 vol% SiCp reinforced composites was investigated. The composites used were produced by vortex technique. In the vortex process, an Al-8.7 wt% Mg as-cast alloy added with SiC particulates were mixed into the steel tubes at 1500 rpm. The metal-matrix composites was characterized with the purpose of knowing and quantifying the present phases, distribution of stiffener and the interaction of SiC particulates with the metal-matrix. Material characterization was made by means of X-ray diffraction (DRX) and scanning electron microscopy (MEB). Composite microstructure is influenced by solidification parameters and processing conditions. Hence, mechanical properties are highly sensible to the microstructure and these are indirectly related to the preparation route, so processing parameters involved have a great importance. Vórtex technique generates a composite with non secondary chemical reactions, minimum porosity aprox. 5%, and uniform particles distribution in the Aluminum matrix.

Mean Width Evaluation on Regular Grids: *Seth Wilson*[1]; A.D. Rollett[1]; [1]Carnegie Mellon University

We develop and compare several methods to compute the mean width (first-order Minkowski functional) of grains represented on regular grids. Error analysis is presented for a variety of shapes with cusps, creases, facets, and curved surfaces whose mean widths are known exactly. We use our mean width measurements to test the 3D generalization of the vonNeumann-Mullins relation conjectured by MacPherson and Srolovitz (Nature 2007), in the context of multi-phase field and Monte Carlo models of isotropic normal grain growth. Results are presented for single grains as well as large networks of grains.

Microstructural Studies of Heteroepitaxial Silicon-on-Sapphire by TEM: *Titas Dutta*[1]; Gopinath Trichy[1]; Jagdish Narayan[1]; [1]North Carolina State University

Silicon on sapphire (SOS) based devices have extremely small parasitic junction capacitance and hence are suitable for high speed-low power applications. The performance of SOS devices depend on the film-substrate interface and defects that arise due to the high misfit (14%) strain. We report on the detailed investigation of misfit defects in the heteroepitaxial Si(100)/r-plane of sapphire system by cross sectional transmission electron microscopy (TEM). The SAED pattern with the zone axis, <100> Si| <01-11> Sap, revealed the following epitaxial relationship: (040) Si| (-4-220) Sap. Epitaxial growth in this high misfit system is interpreted and explained by domain matching epitaxy, where integral multiples of lattice planes match across the film-substrate interface. HRTEM revealed a sharp interface with no interfacial reaction. The Si film showed extensive twinning, the linear twin density was estimated to be 2x105/cm. Evidence of ion-channeling within the twinned region has also been demonstrated.

The Change of Microstructure and Hydrogen Permeation of Nb-TiNi Alloys with Various Ti/Ni Ratios: *Tetsuya Kato*[1]; Kazuhiro Ishikawa[1]; Kiyoshi Aoki[1]; [1]Kitami Institute of Technology

High purity hydrogen is mainly produced by purification of steam reformed gas by using the Pd-based hydrogen permeation alloy membrane. However, Pd is too expensive and rare in resources, so that non-Pd alloys are strongly desired. We have demonstrated that the Nb-TiNi alloys having the Ti/Ni ratio =1.0 show high hydrogen permeability and large resistance against the hydrogen embrittlement. However, their performance is insufficient for industrial applications. The value of permeability increases with increasing Nb content in the Nb-TiNi alloys with Ti/Ni ratio=1.0, but the higher Nb content alloys suffer from the hydrogen embrittlement. In the present work, the effect of Ti/Ni ratio on the microstructures, crystal structures and permeability of Nb-TiNi alloys is investigated and discussed on the basis of the experimental data.

Synthesis and Hydrogen Absorption of Li-Doped Titanate Nanotube by Hydrothermal Ion Exchange Processing: *Yi-Hun Jung*[1]; Dong Hyun Kim[1]; Sun-Jae Kim[2]; Kyung Sub Lee[1]; [1]Hanyang University; [2]Sejong University

Titanate nanotubes have been studied for hydrogen storage due to its unique shape of interlayers. However, absorbing reaction occurred only at a high temperature and/or low temperature (at -196°C and over 250°C). In order to improve the hydrogen capacity of titanate nanotubes at RT, Li-doped titanate nanotubes were synthesized by hydrothermal lithium ion exchange processing from titanate nanotube precursor. To prepare the Li-doped TNT, titanate nanotubes powder was mixed with LiOH aqueous solution and the resulting suspension placed in a Ni-lined stainless-steel autoclave at 120°C for 24 hrs. And Li-doped TNT were fired at 100-500°C in vacuum to remove the hydrate in the nanotube. The sorption of hydrogen of the titanate nanotubes was studied by the conventional volumetric pressure-composition isothermal method at RT, 10 to 40atm. Systematic studies of effect of Li dopant in the nanotube and the relationship between interlayer spacing and hydrogen capacity with firing temperature were presented.

The Effect of Addition of Sn, Zr and B on the Microstructure Evolution in Zn-Al Alloy: *Ka Ram Lim*[1]; Jin Man Park[1]; Tae Eung Kim[1]; Sung Woo Sohn[1]; Hee Tae Jeong[2]; Won Tae Kim[1]; Do Hyang Kim[1]; [1]Center for Noncrystalline Materials; [2]BK21

Zn-Al alloys are well-known to have excellent damping properties when they are quenched from above the eutectoid temperature of 550K. The reduction of the lamella spacing in Zn-22 wt.% Al eutectoid alloy can lead to the increase of damping capacity. In the present study, Zn-22 wt.% Al alloy has been prepared by casting into a copper mold followed by rolling with reduction of ~ 50 %. Almost fully lamella structure has been obtained in Zn-22 wt.% Al alloy by heat treatment under the eutectoid temperature. The lamella spacing is about 200~300 nm. The orientation relationship between lamellae is $[11\text{-}20]_{\beta}||[110]_{\alpha}$, $(0001)_{\beta}||(\text{-}111)_{\alpha}$, which corresponds to the previous result. The effects of replacement of Zn by Sn, Zr and B on the spacing of lamella have been investigated. In addition, the effect of processing methods such as rolling and reciprocating extrusion on the microstructure and mechanical property has also been investigated.

Plasticity Size Effects: A Mechanism-Based Discrete Dislocation Analysis of Micro-Crystals: *P. Guruprasad*[1]; Amine Benzerga[1]; [1]Texas A&M University

Mechanism-based discrete dislocation plasticity (M-DDP) is used to study the effect of dimensional constraint on micro-crystals. The M-DDP frame work involves key dislocation mechanisms including junction formation, dynamic source and dynamic obstacle formation, in addition to dislocation nucleation, annihilation and dislocation escape near the surface. Initially high dislocation source density specimens oriented for double-slip are subjected to macroscopically homogeneous deformation with applied strain rate varied between 10^4 - 10/s. In general all the specimens showed stress strain response typical of bulk crystals highlighted by strong size affected stage II hardening rate (Θ_{II}). A slight decrease in the flowstress values were observed with decrease in strain rate, nevertheless Θ_{II} remained significant. The observed strengthening was attributed to the emergence of a net GND density locally. As a consequence of the net GND build-up we observe: (a) Taylor hardening law breaks down (b) strong Bauschinger effect in the specimens below micron scale.

Synthesis and Mechanical Properties of Al2O3/Ti50Cu28Ni15Sn7 Bulk Metallic Glass Composite: *Pee-Yew Lee*[1]; Chih-Feng Hsu[1]; [1]National Taiwan Ocean University

In the present study, the preparation of Ti50Cu28Ni15Sn7 metallic glass composite powders was successfully synthesized by the mechanical alloying of powder mixtures of pure Ti, Cu, Ni, Sn and Al2O3 after a 6h milling. In the ball-milled composites, the initial Al2O3 particles were homogeneously dispersed in the Ti-based alloy glassy matrix. The metallic glass composite powders were found to exhibit a large supercooled liquid region before crystallization. Bulk metallic glass (BMG) composite compact discs were obtained by consolidating the 6h as-milled composite powders by vacuum hot pressing process. The microstructure of the Ti50Cu28Ni15Sn7 BMG with 8 vol. % Al2O3 additions exhibited an amorphous matrix embedded with Al2O3 nanoparticles ranging from 20 to 300 nm. A significant hardness increase with the Al2O3 additions can be achieved for the Ti50Cu28Ni15Sn7 BMG composites. These BMG composites exhibit good mechanical properties of 1880~2190 MPa for compressive strength and 2.0~2.27 for compressive elastic strain.

The Role of Carbide Morphology in High Temperature Deformation of a Modified Single Crytal Nickel-Base Superalloy: *Andrew Wasson*[1]; Gerhard Fuchs[1]; Elyssa Cutler[1]; [1]University of Florida

Carbon additions to single crystal Ni-base superalloys are known to reduce casting defects, surface scale, and oxide inclusions in large blade castings such as those in industrial gas turbines. In this study, the effect of carbon, carbon and boron, and carbon and nitrogen additions on the microstructure, high temperature tensile, creep, and high cycle fatigue behavior of CMSX-4 was examined. All tests were conducted at 850°C. The analysis focused on how the different additions altered the carbide morphology and how this carbide morphology affected the different modes of deformation and failure. The carbon and nitrogen additions produced carbides that were primarily blocky while the other alloys exhibited more script morphology carbides. Fracture surfaces and post-test microstructures were used to show how the carbides affected the various deformation mechanisms.

Thermal Stability of Cu-Sn Metal-Metal Interconnects: *Jemima Fernandez*[1]; Megan Frary[1]; Amy Moll[1]; [1]Boise State University

Cu-Sn is currently being investigated as an alternative to Pb-Sn solders. It is especially interesting for small scale solder bumps and fine pitches. With the appropriate bonding conditions, the preferred phase of Cu-Sn (Cu_3Sn) can be formed at the interface of two bond pads. This phase should be thermodynamically stable (for up to 350°C) and withstand multiple reflow cycles encountered during the assembly process of a multilayer interconnect stack. This paper investigates the thermal stability and reliability of Cu-Sn bonded die with different Sn thicknesses and bonding pressures. The samples are isothermally aged at 125°C ± 10°C and also subjected to thermal cycling from 125°C to -55°C. The samples are analyzed before and after experiments to track any changes in inter-metallic growth, grain-structure, die cracking, package cracking, and bond lifting with analytical tools including Transmission Electron Microscopy (TEM), Scanning Electron Microscopy (SEM) and Electron Back Scattered Diffraction (EBSD).

Phase Transformation into α Phase Enhanced by Substrate Surface Defects in an Alumina Thin Film Grown on Si(001): Sung Bo Lee[1]; *Eun Kyu Her*[1]; Kyu Hwan Oh[1]; [1]School of Materials Science and Engineering, Seoul National University

A 250-nm-thick Al2O3 film was deposited on a Si(100) 4-inch wafer by a radio-frequency (rf) magnetron sputtering and annealed at 1050°C for various times in air. In the matrix composed of fine grains of about 50 nm in diameter, large α-Al2O3 grains of about 2-5 μm in diameter were formed, arranging themselves in rows. The thermal expansion coefficient of alumina is higher than that of silicon, which develops compressive stresses in the film. The observed, enhanced phase-transformation into α-Al2O3 is suggested to start at surface steps in the Si wafer which may bring the highest strain energy to the interface between Al2O3 film and Si substrate. This phenomenon was analyzed using Electron Backscattered Diffraction (EBSD), Focused Ion Beam (FIB) and Transmission Electron Microscope (TEM).

Slag Detection Technology: *Prasad Goundla*[1]; Rizwan Abdul Rahman Rashid[1]; Gouni Rajkiran[1]; Siva Jyoth Reddy[1]; [1]Mahatma Gandhi Institute of Technology

The occurrence of slag during the production of steel is inevitable with the result that the steel loses its quality thereby imposing severe financial losses on producers. Hence Slag Kills Profits. Now thanks to FLIR's advanced Infrared imaging technology, slag can be detected during casting of crude steel. The highly user-friendly, hand-held A20M state-of-the-art tool detects & records the presence of slag and emits a control signal enabling the operator to interrupt the process. The system also comes integrated with software for remote shutdown possibilities. In this paper, we discuss the properties of this technology, its proper usage techniques and its advantages to the steel industry fraternity.

The Study of the Destabilized Effect in NaAlH4 Using TiN and BN: Tabbetha Dobbins[1]; *Whitney Fisher*[1]; [1]Louisiana Technical University

Destabilized metal hydride systems are gaining increased attention due to their ability to undergo a lowered hydrogen desorption reaction temperature (moving toward targeted temperatures set by the Dept. of Energy). LiBH4 has been destabilized using MgH2 (Vajo, Skeith, and Mertens) with a demonstrated lowering of the hydrogen desorption reaction temperature by 90 C (compared to LiBH4 alone). This research reports on the potential for destabilization of NaAlH4 using TiN and BN as destabilizer phases. The samples prepared were NaAlH4 with varying concentrations of TiN or BN (specifically, 25 mol%, 50 mol%, and 75 mol% concentrations were used). The destabilizer was introduced to the hydride powder system using high energy ball milling (SPEX 8000M mill in WC mill media). After high energy milling, the formation of TiAl (using the TiN destabilizer) was determined by x-ray diffraction. Alternatively, there was no formation of Al-B phases.

Synthesis and Characterization of Bulk Amorphous/Amorphous Composite Alloys through Powder Metallurgy Route: *Pee-Yew Lee*[1]; [1]National Taiwan Ocean University

Recently dual-amorphous phases bulk metallic glasses (DAPBMG) consisting of two metallic glassy phases has attracted increasing R&D interests. Similar to the concept of composite material, DAPBMG can be expected to exhibit dual properties of its original ones. In this study, we attempt to prepare the DAPBMG through powder metallurgy route. The amorphous Ni60Nb20Zr20 and Ti50Cu28Ni15Sn7 alloy powders were synthesized separately by mechanical alloying technique. The dual-phase powders were prepared by mixing corresponding amorphous powders. The amorphous dual-phase powders were then consolidated into DAPBMG discs. The microstructure of DAPBMG discs showed that the Ni60Nb20Zr20 phase is distributed homogeneously within the Ti50Cu28Ni15Sn7 matrix. The mechanical behavior of the DAPBMG was investigated by hardness test. The measured hardness values follow the rule-of-mixture equation for describing the hardness of the composite materials. The relative density and Vickers microhardness of DAPBMG increase as the amount of Ni60Nb20Zr20 of the bulk samples increases.

Morphological Changes after H2 Desorption from Ti3+-Catalyzed NaAlH4: *Nicholas Dailey*[1]; Tabbetha Dobbins[2]; [1]Grambling State University; [2]Louisiana Technical University

With the continuing problem with global warming, a way to properly store hydrogen in cars needs to be established in order to institute environmentally "clean" energy technologies. Our research addresses issues in hydrogen storage materials by studying powder morphology changes. Specifically, Ti3+-catalyzed NaAlH4 is demonstrated to experience morphological changes upon hydrogen desorption at 150C and 200C. After desorption at 150C for 5 minutes, the NaAlH4 powder appeared to have melted (as indicated by both the powder morphology and the loss in intensity in the x-ray diffraction peaks). Melting occurred prior to any transformation to the product phases. Alternatively, experiments performed at 200C for 5 minutes showed that the powders partially transformed to Na3AlH6 and Al product phases. Those powders appear to have also melted and show an increased quantity of spherical porosity (relative to powders which did not undergo desorption).

Metals Industry Air Metals Emissions and Hazard Rankings: *John Heinze*[1]; Karen Hagelstein[2]; [1]Environmental Health Research Foundation; [2]TIMES Limited

Total releases of metal air emissions (18 metals) from the metals manufacturing industry (SIC33XX) were over 3400 tons in 2005, according to the latest US EPA Toxic Release Inventory data. These emissions represent the largest source of metal air emissions of any industry sector in the US. Because metals have well recognized human health and the environmental hazard properties, metal air emissions can be prioritized not only by the amount of metal compounds released, but also by their hazard properties, also called "toxicity weighting." For example, the five most toxic metals according to EPA's Toxicity Characteristic Leaching Procedure (TCLP) for hazardous waste metal compounds are: mercury, followed by cadmium and selenium, and then arsenic and lead. The Indiana Relative Chemical Hazard Score (IRCHS) and other methods of hazard ranking will be evaluated and compared as methods for prioritizing hazard impacts and environmental management practices in metals manufacturing.

The Influence of Heterogeneity in Grain Boundary Sliding Resistance on the Constitutive Behavior of AA5083: *David Cipoletti*[1]; Allan Bower[1]; Yue Qi[2]; Paul Krajewski[2]; [1]Brown University; [2]General Motors R&D Center

Continuum finite element simulations are used to investigate the influence of heterogeneity in grain boundary sliding resistance on the creep response of the aluminum alloy AA5083 when deformed at 450°C. Previous simulations and experiments have demonstrated that under these conditions, grain boundary sliding (GBS) is the dominant deformation mechanism at strain rates below 0.001, and dislocation creep (DC) is the dominant mechanism for higher strain

rates. However, these simulations assumed a uniform resistance to sliding on all grain boundaries. Molecular dynamic simulations indicate that sliding resistance is strongly sensitive to the character of the boundary: high angle boundaries have resistance up to an order of magnitude lower than low angle boundaries. Finite element simulations are used to investigate the influence of the fraction of high angle boundaries *f* in a polycrystal on its creep response and operative deformation mechanisms. Computation results showed that GBS heterogeneity greatly influenced the constitutive response.

Nanoscale Electrical Properties of NiO Thin Films: *Cheol-Hwan Kim*[1]; Hak-Beom Moon[1]; Seong-Sik Min[1]; Yun-Hyung Jang[1]; Jin-Hyung Cho[1]; [1]Pusan National University

The electrical properties of NiO thin films have been studied extensively to exploit their resistance change effect to nonvolatile memory devices. To understand the mechanism of the resistance change, we have studied nanoscale electrical properties of NiO thin films grown by RF magnetron sputtering method. The nanoscale electrical properties were measured using the conducting atomic force microscopy (CAFM) and the electric force microscopy (EFM) and the data indicate that the transition of resistance states results from filamentary conducting paths in the NiO thin films. We will discuss the experimental results of the resistance change of NiO thin films in terms of mechanism of filamentary conducting path.

Microstructural Evolution and Mechanical Properties with Addition of Sn in Mg-MM(Misch-Metal) Alloy: *JoonSeok Kyeong*[1]; Hyun Kyu Lim[1]; Won Tae Kim[2]; Do Hyang Kim[1]; [1]Yonsei University, Department of Metallurgy/NSM Laboratory; [2]Cheongju University

Considering the beneficial effect of MM (misch metal) and Sn addition in Mg-based alloys, it is strongly required to investigate Mg-MM-Sn system for casting products as well as wrought products. Therefore, the present study aims to identify the phases in Mg-RE-Sn system, and to evaluate the mechanical properties of Mg-MM-Sn rolled sheets. The Sn addition into the Mg-MM alloy results in the formation of the feather-shaped phase mainly in the interdendritic region when the ratio of Sn to MM is close to 1 in wt%. Although the strength of alloy is decreased with addition of Sn in Mg-MM alloys, the rollability and ductility are improved when the feather-shaped phase is formed in Mg-rich Mg-MM-Sn alloy due to the sound interface without forming any void at the boundary of the feather-shaped phase during tensile loading.

Laser Synthesis of Porous and Textured Ca-P Bio-Ceramic Coating on Ti-6Al-4V: *Sameer Paital*[1]; Narendra Dahotre[1]; [1]University of Tennessee

In the present work the feasibility of depositing a porous and geometrically textured Calcium Phosphate (CaP) bio-ceramic coating using a continuous wave Nd:YAG laser on a Ti-6Al-4V substrate has been demonstrated. Advantages offered by such porous bio-ceramic coating is its inertness combined with the mechanical stability of the highly convoluted interface that develops when bone grows into the pores of ceramic. Non-destructive phase analysis of the laser processed samples were carried out using XRD. Quantitative estimation of the crystallite size and relative amounts of Ti, TiO2 and a-tricalcium phosphate (α-TCP) was obtained. Surface porosity measurements indicated a decreasing trend with increasing laser fluence. In the preliminary studies, the bioactivity of the coatings were further proved by the formation of an apatite like layer on the surface of the sample after being immersed in a simulated bio fluid.

Hydrogen Permeability of Pure Nb and NbTi Solid Solution Alloys: *Naoyoshi Ota*[1]; Kazuhiro Ishikawa[1]; Kiyoshi Aoki[1]; [1]Kitami Institute of Technology

In recent years, non-palladium based hydrogen permeation alloys have actively been investigated by several research groups. Group 5 metals such as V, Nb and Ta showing large hydrogen solubility and high hydrogen diffusivity are promising for hydrogen permeation membranes, because hydrogen permeability is the product of hydrogen solubility and hydrogen diffusivity. However, it is recognized that these metals suffer severe hydrogen brittleness and are pulverized spontaneously during hydrogenation. Then, they are unusable as a hydrogen permeation alloy. However, it is still uncertain why they are easily broken in a hydrogen atmosphere. In the present work, hydrogen permeability of as-cast pure Nb and the NbTi alloys prepared by arc melting were successfully measured using a conventional gas permeation method. We discuss why hydrogen permeability of the as-cast pure Nb and the NbTi alloys is measurable on the basis of the microstructural observation.

Layer by Layer Nanoarchitectures Assembled Using Al2O3 and ZrO2 Systems: *Kristan Moore*[1]; Tabbetha Dobbins[2]; [1]Grambling State University; [2]Louisiana Technical University

For controlling the content and spatial distribution of interphase boundaries in materials, we have used a technique known as layer-by-layer (LbL) nanoassembly. The principle behind electrostatic self-assembly is the use of polyelectrolytes (for example, polyallylamine hydrochloride as polycation and polystyrene sulfonate as polyanion) to provide a coulombic 'glue' between ceramic particulate layers. The inherent surface charge (zeta-potential) on the particulate systems leads to their attraction to the polyelectrolytes. The self-assembly technique has been used to deposit multilayered ceramic films and also been used to provide nm-particle coverage over µm-scale colloidal particles. Using LbL nanoassemlby, we have prepared various Al2O3 and ZrO2. The concentration of the nanoparticles in suspension and deposition time was studied to affect the degree of microstructure control during self-assembly.

Inoculation of Aluminum Alloys with Nanosized Borides and Microstructure Analysis: *Hermes Calderón*[1]; Cicily Smith[2]; Olga Menéndez[1]; O. Marcelo Suárez[1]; [1]University of Puerto Rico; [2]Austing College

The effect of MgB_2, AlB_2, HfB_2, and NbB_2 nanosized particles on the grain structure and microhardness of AA6061 and AA7075 aluminum alloys was studied. The metal boride powders were processed with a vario-planetary ball milling unit to be afterwards mixed with pure aluminum pellets. The resulting mechanical mixture was added as inoculant to the aforementioned alloys. For comparison the alloys were separately treated with a commercial grain refiner. Changes in grain size were observed: while boride-treated AA7075 presented a dendritic structure, the boride-inoculated AA6061 alloy exhibited equiaxed grain structure. Vickers microhardness tests showed that MgB_2 and HfB_2 were most effective in improving mechanical strength of these aluminum alloys. Additionally, Charpy impact test were performed to identify the effect of inoculation on the treated alloys toughness.

Deformation Behavior of Magnesium Alloys with the Low c/a Ratio: *Beomsoo Shin*[1]; Donghyun Bae[1]; [1]Yonsei University

Deformation behavior of Mg-Re-Zn-Sn alloy sheets has been investigated. The sheets are produced by the conventional thermomechanical processes. Tensile tests were performed at a strain rate of 1x10-3s-1 at room and elevated temperatures. The alloys exhibit superior tensile elongation higher than 25% at room temperature. The deformed microstructure shows that the contribution of deformation twinning to total elongation is not so significant, and non-basal dislocations are frequently observed. The non-basal slips can be activated not by the presence of refined grains, but by the low c/a ratio of alpha magnesium phase. The c/a ratio of the phase is measured to be below 1.6. The details of deformation behavior of the alloys will be presented.

Deformation Behavior of Zr-Based Bulk Metallic Glasses Showing No Catastrophic Failure at Room Temperature: *Jaehyuck Shin*[1]; Donghyun Bae[1]; [1]Yonsei University

Plastic deformation of bulk metallic glasses (BMGs) at room temperature occurs within the highly localized shear bands in which generated excess free volume is spontaneously coalesced, leading to a catastrophic failure of the BMGs even under compression. Therefore, to prevent the catastrophic failure, atomic clustering kinetics should be retarded. Zr-Al-Cu-Ni BMGs with high thermal activation energy have shown a highly deformable behavior without global failure under compression. In addition, further plastic homogeneity in the macroscopic appearance can be achieved with the addition of minor elements in the Zr-based BMGs due to the formation of abundant nano-scale ordered sites which initiate multiple shear bands. With the consideration of structural thermal stability, together with free volume, deformation behavior of Zr-based bulk metallic glasses which show no catastrophic failure at room temperature will be discussed.

Effect of Cr on the Oxidation Behavior of Ti-46Al-2V Alloy: *Daniela Pilone*[1]; Ferdinando Felli[1]; [1]Sapienza Università di Roma

Titanium aluminide alloys are already used because of excellent mechanical properties, but are limited to low temperature applications due to insufficient oxidation resistance. When these alloys are subjected to oxidation in air the scale is not a protective Al2O3 layer, but a mixture of Al2O3 and TiO2. The oxidation resistance of TiAl intermetallics is known to be significantly affected

by the addition of alloying elements. The oxidation behavior of Ti-46Al-2V was studied and compared with the ones of the same alloy alloyed respectively with 7, 10 and 14 at.% Cr. Isothermal tests were conducted in air at 850 and 950°C. The scale's morphology and composition were studied by means of SEM/EDS and X-ray diffraction. From weight gain curves and cross-sectional microscopy after oxidation exposure it was found that more than 7 at.% of Cr improves the oxidation resistance of the alloy, although it simultaneously reduces its toughness.

Effects of Initial Texture on the Deformation Behaviors of Strip Cast AZ31 Mg Alloy: *Byoung Ho Lee*[1]; Sung Hyuk Park[1]; Chong Lee[1]; Wonkyu Bang[2]; Sangho Ahn[2]; [1]Pohang University of Science and Technology; [2]Research Institute of Industrial Science and Technology

The effect of initial texture on the deformation behavior of AZ31 Mg alloy was (manufactured by strip casting method) investigated in this work. XRD experiments showed that a strong basal texture (implying that the basal planes of HCP lattice in grains were located parallel to the rolling direction) was formed in the rolled plate, while a weak and random basal texture was formed in a strip cast sheet and cast ingots, respectively. Compressive specimens were obtained in two different directions, ND (normal direction) and RD (rolling direction). Microstructure observations and stress-strain curves showed that twin formation in strip-cast AZ31 Mg alloy was strongly affected by initial textures. Constitutive modeling of materials having different initial textures was also conducted in this work through physically-based modeling.

Effect of Prior Deformation on the Sliding Wear Characteristics of the Ultra-Fine Grained (UFG) Dual Phase Steel: *Yong-suk Kim*[1]; H. Yu[1]; D. Shin[2]; [1]Kookmin University; [2]Hanyang University

Effect of prior deformation on the sliding wear of the ultra-fine grained (UFG) ferrite-martensite dual phase (DP) steel was investigated. The UFG DP steel was fabricated by the ECAP and subsequent intercritical annealing. The steel was cold rolled before the wear test, and the effect of the prior deformation on the wear was examined. The wear tests were carried out at various loads against a bearing steel ball. The wear rate of the UFG DP steel that did not experience the prior deformation was higher than that of the coarse-grained (CG) DP steel, because of more severe surface shear deformation. The wear rate of the specimens with prior deformation was much higher than that of the specimen without prior deformation. The deformed CG DP specimen showed higher rate than the deformed UFG DP specimen, and the rate-variation of the CG DP steel was much bigger under the same test condition.

Chemical Composition Effects on the Microstructure of Functionally-Graded Aluminum Matrix Composites: *Lilia Olaya-Luengas*[1]; Marcelo Suarez[1]; [1]University of Puerto Rico, Mayagüez

Aluminum matrix composites reinforced with boride dispersoids redefine the limits of aluminum-based materials due to their unique mechanical properties, low density and low-cost processing methods. In addition, by centrifugal casting a functionally-graded composite can be fabricated. The redistribution of the denser dispersoids in the aluminum matrix is further affected by changes in the levels of boron, magnesium, copper and calcium. The present research has been focused on studying the functionalized composite microstructure and the resulting graded mechanical properties. The final goal has been to determine the optimal reinforcement distribution as a function of the chemical composition of the material.

Co-Doping (Ti3+, Fe3+, and Zr4+) in NaAlH4 Powders Studied by Ultra-Small-Angle X-Ray Scattering (USAXS): *Ejiroghene Oteri*[1]; Tabbetha Dobbins[1]; [1]Louisiana Tech University

This study uses ultrasmall angle x-ray scattering (USAXS) to elucidate differences in NaAlH4 particle morphology as dopant type and mill time is varied after co-doping using FeCl3-TiCl3, FeCl3-ZrCl4, and TiCl3-ZrCl4. In these co-doped systems, USAXS was used to track changes in powder surface area using measured particle sizes and volume fractions. The variation in desorption rates in those co-doped systems correlated well with changes in powder surface area—indicating surface reaction rates are the limiting factor in hydrogen desorption kinetics for these systems.

Application of Amide–Impregnated Fiber to Separation of Precious Metals: *Hirokazu Narita*[1]; Mikiya Tanaka[1]; Kazuko Morisaku[1]; Ken Tamura[2]; Daisuke Sakamoto[3]; Masashi Suzuki[3]; Tomomi Nadano[3]; [1]National Institute of Advanced Industrial Science and Technology; [2]Chiba Institute of Technology; [3]Saitama Industrial Technology Center

The separation of precious metals in a hydrochloric acid solution using a solvent impregnated fiber (SIF) was investigated. N-disubstituted amide compounds and kapok fibers were used as the separation reagents and the impregnation support, respectively. We synthesized N,N-di-n-octyl-lauramide (DOLA), N,N'-dimethyl-N,N'-di-n-octyl-thiodiglycolamide (MOTDGA) and N,N'-dimethyl-N,N'-di-n-octyl-diglycolamide (MODGA) and prepared the amide-impregnated fibers (amide–IF). The adsorption of some precious and base metals (Au(III), Pd(II), Pt(IV), Rh(III), Fe(III), Cu(II), Ni(II) and Zn(II)) in HCl solutions was carried out batchwise using the DOLA–IF, MODGA–IF and MODGA–IF. The results of the metal adsorption showed that the selective separation of Au(III), Pd(II) and Pt(IV) can be performed using successively the DOLA–IF, MOTDGA–IF and MODGA–IF.

Changes in Hydrogen Permeability and Microstructure of Melt-Spun $Nb_{40}Ti_{30}Ni_{30}$ Alloy Ribbons by Annealed: *Yuta Seki*[1]; Koichi Kita[2]; Kazuhiro Ishikawa[1]; Kiyoshi Aoki[1]; [1]Kitami Institute of Technology; [2]Mitsubishi Materials Corporation

Pd-Ag based hydrogen permeation alloys are mainly used for separation and purification of hydrogen gas. However, since Pd is too expensive and a rare metal, it is strongly desired to develop non-Pd based alloys. The Nb-TiNi alloys consisting of the bcc-(Nb, Ti) and the B2-TiNi phase show high hydrogen permeability equivalent to that of pure Pd. However, its membrane is prepared by means of complex processes such as cold rolling and intermediate annealing. On the other hand, it is well known that alloy ribbons can at a stroke be obtained by a melt-spinning technique. In the present work, hydrogen permeability, crystal structures and microstructures of melt spun Nb-TiNi alloy ribbons before and after annealing treatments are investigated in order to develop the preparation method of alloy membrane, and it was concluded that melt-spinning technique is effective for the preparation of the Nb-TiNi hydrogen permeation alloy membrane.

Characterization and Research of Nano-Meter ZnO by X-Ray Diffraction: *Cheng Guofeng*[1]; [1]Shanghai Institute of Ceramics

The microstructures (average crystallite size and stacking faults probability) and the doped effects of the nano-meter ZnO have been characterized and researched using separating multip-broadening effects method improved by author. The results are following: (1) The crystallite size of studied two group samples are a few huandreds and several nano-meter respectively. The crystallite shape of the two groups ZnO samples nearly are the same polohedron,but the difference among them can be characterized by. (2) The method for separating two-fold and three-fold broadening effects of closed packing hexagonal is not used to the nano-meter ZnO samples, because the seletive broadening effects is also not obviously. (3) The selective broadening effects of stacking faults may be ignored, because the stacking faults probability of the two groups ZnO samples is very small.

Measuring Enhanced Elevated Temperature Deformation Using Spark Plasma Sintering Equipment: *Dustin Hulbert*[1]; Dongtao Jiang[1]; Amiya Mukherjee[1]; [1]University of California

A fully dense nanocrystalline ceramic consisting of ZrO2, Al2O3 and MgAl2O4 was deformed at 1150ºC at a strain rate on the order of 10-2 s-1. Spark plasma sintering was used in this study as a means of consolidation as well as for measuring elevated temperature deformation. By using the constitutive equation for elevated temperature plasticity in conjunction with previously measured strain rate sensitivities and activation energies a strain rate on the order of 10-6 s-1 is predicted at 1150ºC. This strain rate is four orders of magnitude slower than that measured using the spark plasma sintering equipment. This suggests some significant enhancement of the kinetics of deformation garnered by the pulsing electric field found inside the SPS chamber.

Elastic-Plastic Stress and Deformation Analysis of Annular Plates under Prescribed Radial Loading: *Ahmed Elkholy*[1]; Abdulazim Falah[1]; [1]Kuwait University

A modified from of constitutive equation for an isotropic elastic-plastic deformation of circular plates subjected to radial tensile loading on the inner surface is introduced. The form takes into consideration the effect of rotation of various principal axes and material hardening during the process of continued deformation. Plastic instability analysis of plates is carried out to determine stresses at the onset of cavity formation. Both symmetric and antisymmetric modes of deformation are determined. It was found out that the modified form which is derived in this study leads to deformation stresses which are lower than those obtained when classical plasticity relations are used, and therefore, are comparable with the results obtained experimentally. It is found also that deformation is asymmetric with respect to the plate axis and depends not only on the stress in the current state but also on the prescribed incremental traction ratio and material properties.

Hael Mughrabi Honorary Symposium: Plasticity, Failure and Fatigue in Structural Materials - from Macro to Nano: Poster Session

Sponsored by: The Minerals, Metals and Materials Society, TMS Structural Materials Division, TMS Materials Processing and Manufacturing Division, TMS: High Temperature Alloys Committee, TMS/ASM: Mechanical Behavior of Materials Committee, TMS: Nanomechanical Materials Behavior Committee
Program Organizers: K. Jimmy Hsia, University of Illinois, Urbana-Champaign; Mathias Göken, Universitaet Erlangen-Nuernberg; Tresa Pollock, University of Michigan - Ann Arbor; Pedro Dolabella Portella, Federal Institute for Materials Research and Testing; Neville Moody, Sandia National Laboratories

Sunday PM Room: Hall I 2
March 9, 2008 Location: Ernest Morial Convention Center

Modeling the Influence of Microstructure on Multi-Site Fatigue Damage Evolution in AA7075: *Stephen Sintay*[1]; Joe Fridy[2]; John Brockenbrough[2]; Anthony Rollett[1]; Hasso Weiland[2]; [1]Carnegie Mellon University; [2]Alcoa, Inc.

Fatigue crack nucleation and growth in AA7075 is observed to be directly correlated with constituent particles. Given the relatively high volume fraction of such particles, and the spectrum fatigue loading experienced by in service aerospace components, it becomes increasingly difficult to answer questions such as; Where and when will fatigue cracks initiate? What is the distribution of cycles required to grow a crack of a certain size? What is the distribution of cracks at a certain number of cycles? and What role does microstructure play the in incubation, nucleation, and growth of fatigue cracks? The goal of this presentation is to outline the progress and strategy of a set of modeling tools designed to explore the influence of microstructure on fatigue damage evolution.

Crack Initiation in AA7050 Due to Cyclic Fatigue: *Jonathan LeDonne*[1]; [1]Carnegie Mellon University

The fatigue life of aerospace aluminum alloys is governed primarily by crack initiation, which is accelerated by the presence particles in the microstructure. Although much is known qualitatively about the relationships between fatigue life and the size of microstructural features, quantitative models suffer because of the lack of detailed microstructural data. Characteristics of coarse constituent particles are investigated for AA7050. Size distributions of second phase particles are characterized. The sizes and positions of particles are analyzed for 2-dimensional orthogonal sections, which are then used for reconstruction of a 3-dimensional microstructure of particles. The conversion assumes that the particles can be approximated as ellipsoids. Fracture surfaces are also investigated to establish a defined fatigue crack-initiating feature. The results are compared to previous results on AA7075.

Multiscale Characterization of Subsurfaces Produced by Dry Sliding Wear: *Wenjun Cai*[1]; Jung Singh[1]; Pascal Bellon[1]; [1]University of Illinois

Frictional wear resulting from the dry sliding of two metallic bodies under applied load leads to the formation of complex microstructures. Using a high performance Cu-Ni-Sn bronze as a test material, we combine pin-on-disc wear measurements with SEM and TEM characterization of subsurface microstructures. The sustained plastic deformation produces layers ranging from severely plastically deformed to nanocrystalline layer in the top few microns. SEM and SEM-EBSD are employed to identify these layers, to quantify the strain and strain-rate, and to analyze the crystallographic texture of these layers. Twinning is found to be a significant deformation mode near the surface. Comprehensive TEM analysis combining imaging, nanodiffraction, EDS, EELS, HAADF provides further information at the nanoscale on the structure and chemistry of these layers. A Taylor model is applied to simulate the evolution of the subsurface textures under sliding. Consequences on the design of materials with optimized wear resistance are discussed.

Fatigue Crack Propagation in E319 Cast Aluminum Alloy at Ultrasonic and Conventional Frequencies: *Xiaoxia Zhu*[1]; J. Wayne Jones[1]; John Allison[2]; [1]University of Michigan; [2]Ford Motor Company

The fatigue crack propagation behavior of E319 cast aluminum alloy was studied by using both ultrasonic and conventional fatigue techniques in order to understand the potential effect of frequency on fatigue behavior of cast aluminum alloys. Fatigue cracks grew faster at 30 Hz than at 20 kHz in air at both 20 and 250°C. The effect of frequency on the fatigue crack growth rates at all temperatures can be attributed to an environmental effect, particularly the effect of water vapor. For E319, fatigue crack growth rates at a given ΔK increased with increasing water exposure, *P/f*, until saturation the environment effect occurred. This behavior was characterized by an environmental superposition model for fatigue crack growth. Based on this model, fatigue crack growth rates over the entire range of Δ,K in various environments with different water exposure can be predicted and the predictions generally agreed well with the experimental observations.

Using Marked and Unmarked Correlations to Investigate Interactions of Microstructure Attributes in Fatigue of Titanium Alloys and Nickel Superalloys: *Craig Przybyla*[1]; David McDowell[1]; [1]Georgia Institute of Technology

Much work has gone into identifying various mechanisms of fatigue crack initiation, but it is still not well known how interactions of microstructure attributes (e.g., grain/phase morphology, orientation/misorientation, etc.) either inhibit or promote fatigue damage. We explore how correlations of various microstructure attributes differ between larger microstructure "representative" volumes and "marked" volumes from fatigue initiation sites identified in physical fatigue specimens of Ti6246 and Rene 88. In addition, new variants of previously described marked correlation functions are employed to explore probabilities of correlations between certain microstructure attributes marked by the magnitudes of the Fatemi-Socie fatigue indicator parameter (which can indicate localized susceptibility to fatigue crack initiation due to microplasticity) calculated using finite element simulations in a microstructure-sensitive constitutive formulation. Linking correlations of microstructure attributes and a fatigue response parameter in this way provides a potentially effective framework to identify the interactions between attributes that either promote or inhibit fatigue damage.

Atomistic Simulations of Dislocation Nucleation in Copper Grain Boundaries under Uniaxial Tension and Compression: *Garritt Tucker*[1]; Mark Tschopp[2]; David McDowell[1]; [1]Georgia Institute of Technology; [2]Air Force Research Laboratories/Universal Technology Corporation

Atomistic simulations are used to investigate how grain boundary structure influences dislocation nucleation under uniaxial tension and compression for a specific class of symmetric tilt grain boundaries that contain the E structural unit. After obtaining the minimum energy grain boundary structure, molecular dynamics was employed based on an embedded-atom method potential for Cu at 10 K. Simulation results show that higher nucleation stresses are required in uniaxial compression than in tension. Additionally, analysis of the dislocation nucleation mechanisms show several differences between tension and compression. For instance, partial dislocations are nucleated in tension and full dislocations are nucleated in compression. The tension-compression asymmetry in mechanisms and responses can be partially explained by the resolved stress components on the slip plane on which the dislocation nucleates.

Effect of Interfacial Dislocation Structure on Yield Strength of Nanostructured Metallic Multilayer Thin Films: *Qizhen Li*[1]; [1]University of Nevada, Reno

Metallic multilayer thin films with the nanoscale layer thickness attract great research interest due to their high hardness and strength. The multilayer system studied here is composed of alternating A and B phases with FCC structure and cube-on-cube orientation relationship. A and B have the same layer thickness. A three dimensional cellular automaton dislocation model is used to study the yield strength of this multilayer system. Different interfacial dislocation structures are investigated in the model for the metallic multilayer thin films with different layer thicknesses ranging from several nanometers to hundreds of nanometers. The result will illustrate the influence of interfacial dislocation structure on yield strength of multilayer systems with different layer thickness.

Damage Mechanisms of High Chromium Iron Used in Work Rolls of Hot Rolling Mills: *Christian Krempaszky*[1]; Wenge Zhang[1]; Ewald Werner[1]; [1]Technical University-Munich

Hot-rolled steel sheets used in automotive applications have to meet high surface quality demands and therefore rolled-in scale often cannot be tolerated. Rolled-in scale is correlated to the deterioration of the work-roll's surface in the first stands of the finishing train. It is established that this deterioration is a result of discontinuous wear, a phenomenon called banding, caused by the thermomechnical loads and the tribochemical environment. By characterization of the complex thermomechanical loads acting on hot rolling mill work-rolls, a special cyclic loading path with mixed load/displacement control modes is employed to simulate the thermomechanical behavior of the work-roll material via a series of laboratory low cycle fatigue (LCF) tests. With increasing load level the cyclic maximum residual tensile stress increases during cyclic deformation, while the fatigue lifetime decreases. These laboratory tests are useful to explain the mechanisms and conditions responsible for surface deterioration and to optimumize the process.

Fatigue Life Prediction under Ranking of Heterogeneity Scales in Ni-Base Superalloys: *Sushant Jha*[1]; Michael Caton[2]; James Larsen[2]; [1]Universal Technology Corporation; [2]US Air Force Research Laboratory

A probabilistic life-prediction approach for powder-processed Ni-Base superalloys is presented. Integral to this approach is the premise that several levels of heterogeneous deformation can develop for any given microstructure and fatigue loading. In the present Ni-Base superalloys, these levels are related to randomly occurring microstructural features such as the non-metallic particle, the void, and certain local configurations of the γ grains. The probability of failure from a heterogeneity scale and the associated lifetime decrease in the order of the increasing scale. The lower-tail response is limited by crack growth due to the probability of instant crack initiation from a suitably higher heterogeneity level. This appears to produce a separation, with a decrease in the stress level, of the mean-lifetime behavior which tends to be controlled by the smaller (and more prevalent) heterogeneity scale and the crack-growth-controlled lower-tail which is governed by a larger (and less frequent) scale.

Microscopic Material Units Governing the Macroscopic Fatigue Behaviour of Cold Drawn Eutectoid Steel: *Jesús Toribio*[1]; Beatriz González[1]; Juan Carlos Matos[1]; [1]University of Salamanca

This paper analyzes how the cold drawing process influences the fatigue behaviour of eutectoid steel. Macroscopically, the analysis is focussed on the region II (Paris) of the fatigue behaviour in which $da/dN=C(\Delta K)m$, measuring the constants (C and m) for the different degrees of drawing. From the engineering point of view, the manufacturing process by cold drawing improves the fatigue behaviour of the steels, since the fatigue crack growth rate decreases as the strain hardening level in the material increases. From the microscopical viewpoint, fatigue cracks are transcollonial and exhibit a preference for fracturing pearlitic lamellae, with non-uniform crack opening displacement values, micro-discontinuities, branchings, bifurcations and frequent local deflections that create microstructural roughness. The net fatigue surface increases with cold drawing due to the higher angle of crack deflections.

Damage of APS-TBCs in Thermomechanical Fatigue Tests: Tilmann Beck[1]; *Olena Trunova*[1]; Rolf Willi Steinbrech[1]; Roland Herzog[2]; Lorenz Singheiser[1]; [1]Research Center Juelich; [2]MAN Turbo AG

Thermal barrier coatings (TBCs) are applied to gas turbine blades to increase maximum service temperature. The performance of TBCs under thermomechanical fatigue (TMF) is governed by the TMF cycle, the thermal mismatch between TBC and substrate, and microstructural changes (e.g. sintering of the TBC, oxide scale growth, interdiffusion processes). In the present work a TBC system comprising air plasma sprayed ZrO_2/8wt.-% Y_2O_3 with NiCoCrAlY bond coat on CMSX-4 substrate was subjected to out-of-phase TMF with different high temperature dwell times and mechanical load amplitudes. Some specimens were pre-oxidised before TMF testing.TMF without dwell time resulted in fatigue failure of the base material. Pre-oxidation before TMF testing with the same cycle did not significantly change the failure behaviour. However, sufficient long dwell times lead to TBC spallation before fatigue cracking of the base material. The oxidation and fatigue related processes of crack formation and propagation under TMF loading are discussed.

Effect of Plastic Strain on NiTi-Based Shape Memory Alloys: *Qizhen Li*[1]; [1]University of Nevada, Reno

NiTi-based shape memory alloys (SMAs) attract great research interest and have broad applications including actuators, electric switches, pipe couplings, mobile phone antennas, eyeglass frames, dental braces, etc, due to their good mechanical properties. Like human muscles, the SMAs will endure overloading and be deformed plastically in service. It is important to understand how the plastically deformed SMAs will behave subsequently. Mechanical and shape memory properties will be studied for the SMAs with different plastic strains. The results will provide the knowledge about the amount of plastic strain the SMAs can bear.

Surface Stress-Induced Phase Transformations and Shape Memory Effect in Pd Nanowires: *Jijun Lao*[1]; Dorel Moldovan[1]; [1]Louisiana State University

Recent experimental and atomistic simulation studies have demonstrated the existence of structural reorientations and shape memory effect (SME) in various metallic face-centered-cubic (fcc) nanowires. Here we use molecular dynamics simulations to investigate the surface-stress-induced phase transformations in Pd crystalline nanowires. For a <100> initial crystal orientation and wire cross section areas below 4 nm2 we show that the surface stress can cause Pd nanowires to undergo a structural reorientation from an initial fcc structure to a body-centered-tetragonal (bct) structure. The simulations also indicate the existence of SME in Pd nanowires which is associated with the existence of a reversible fcc to bct phase transformation. Under tensile loading and unloading the Pd nanowires exhibit recoverable strains of up to 50%; value that is well beyond the typical recoverable strain for most bulk shape memory alloys.

Ultrafine-Grained Materials: Fifth International Symposium: Poster Session

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Sunday PM — Room: Hall I 2
March 9, 2008 — Location: Ernest Morial Convention Center

Contribution of Texture and Grain Size to Hall-Petch Relation of a Wrought Magnesium Alloy AZ31: Jun Tao[1]; *Jingtao Wang*[1]; Deliang Yin[1]; Jinqiang Liu[1]; [1]Nanjing University of Science and Technology, Department of Materials Science and Engineering

Because of the mixed contribution from both texture and grain size to mechanical properties of wrought Mg alloys, there was a confusion on the slope of Hall-Petch relation of wrought magnesium alloys, especially in

those processed by equal channel angular pressing (ECAP). The experiment is designed in this investigation so that the effect of texture and grain size on yield strength of an AZ31 alloy could be clearly separated. It is concluded that Hall-Petch relation holds valid for the effect of grain size on yield strength in the experimental alloy, as long as no significant difference in the texture of the samples with different grain size. The effect of crystallographic texture on yield strength manifests itself by the different interception on stress axis of Hall-Petch lines with significant difference in texture intensity.

Corrosion and Fretting Wear Behaviour on UFG Ti-13Nb-13Zr Alloy in Ringer's Solution: Anbarasan Viswanathan[1]; *Geetha Manivasagam*[1]; C. Richard[2]; Sathyam Suwas[3]; R. Asokamani[1]; C. Kowandy[2]; J. Landoulsi[2]; [1]Vellore Institute of Technology-University; [2]Université de Technologie de Compiègne; [3]Indian Institute of Science

Corrosion and wear are the prime consideration for a biomaterial that is to be used in the human body, because metal ion released mainly associated with toxicity of surgical implants and can adversely affect the biocompatibility and mechanical integrity. Earlier works clearly indicate that refinement of grain size may enhance the corrosion and mechanical properties in comparison with coarse grain (CG) counterparts. Hence in this work we have attempted to study the corrosion and fretting wear behavior of ultra fine grain (UFG) Ti-13Nb-13Zr developed by Equal channel angular pressing (ECAP) process in simulated body fluid (Ringer's solution). Potentiodynamic anodic polarization and open circuit potential were used to evaluate the corrosion behavior of UFG Ti-13Nb-13Zr in simulated body fluid at 37ºC. In addition, fretting wear behavior of UFG Ti-13Nb-13Zr alloys against bearing steel is also evaluated. The results of the corrosion and fretting wear studies will be presented in this paper.

Deformation and Fracture of AZ31 Magnesium Alloy during Equal Channel Angular Pressing: Feng Kang[1]; *Jing Tao Wang*[1]; Yong Peng[1]; [1]Nanjing University of Science and Technology

The deformation and fracture characteristics of AZ31 magnesium alloy during equal channel angular pressing (ECAP) were established. The isothermal behavior of AZ31 magnesium alloy was determined at temperatures between 150 and 250°C and ram speeds producing average effective strain rates between 0.001 and 0.25s-1. AZ31 magnesium alloy was particularly susceptible to shear localization during ECAP, uniform flow occurred only at high temperatures and low strain rates. Observations of shear banding and shear fracture were interpreted in terms of the tendency for strain concentration as quantified by the flow localization parameter, or the ratio of the normalized flow softening rate to the strain-rate sensitivity. These understandings of the effect of material properties on flow localization tendency are helpful for the selection of processing parameters with uniform flow during ECAP.

Deformation Behavior of Nanocrystalline Metals and Alloys Investigated by Mini-Tensile Test: *Lilia Kurmanaeva*[1]; Yulia Ivanisenko[1]; Jörg Weismüller[1]; Jürgen Markmann[2]; Ruslan Valiev[3]; Hans-Jörg Fecht[4]; [1]Forschungszentrum Karlsruhe GmbH; [2]Universität des Saarlandes; [3]Ufa State Aviation Technical University; [4]University of Ulm

The recent past has seen an increasing interest in studies of mechanical properties of nanocrystalline materials (nc). NC materials offer wide application as structural materials thanks to their outstanding mechanical properties. A novel method for the preparation of bulk nanocrystalline materials with a grain size <30 nm using the combination of inert gas condensation and subsequent high pressure torsion was developed. Here, we present results on a comprehensive investigation of the microstructure and mechanical properties of nanocrystalline metals and alloys, namely Pd and Pd-Au, with a mean grain size of 15 nm. Microstructure was investigated by Transmission Electron Microscope (TEM). Mechanical properties of the obtained specimens were studied in tensile test using a dedicated tensile machine for miniature specimens. It was shown that nanocrystalline Pd and Pd-Au alloy exhibits a very high yield stress and a microhardness with sufficient ductility. The obtained results of mechanical properties and microstructure are discussed.

Microstructure and Mechanical Properties of Nanostructured Metal Matrix Composites: *Timothy Lin*[1]; Fei Zhou[1]; Quan Yan[1]; Chunfu Tan[1]; Bob Liu[1]; Adolphus McDonald[2]; [1]Aegis Technology Inc.; [2]U.S. Army Aviation and Missile Command

Over last few years Al-based nanostructured metal matrix composites (NMMCs) has attracted increasing interests because of their great potentials in strength enhancement. Presently Aegis Technology is developing a novel class of NMMCs funded by U.S. Army Small Business Innovative Research (SBIR) project, "Light-weight Material for Ballistic Armor". This class of NMMCs, which is based on submicron SiC particulates reinforced nanostructured Al alloy matrix, can be used for not only lightweight armors but also lightweight structures (e.g. anti-wear engine components). Aegis has successfully developed a cost-effective, scalable processing route for the fabrication of NMMCs plates, billets and near-net-shape components. In this poster, Aegis will report its detailed investigations on the characterization of the NMMCS, including (1) Microstructures using TEM, SEM and X-Ray, and (2) Mechanical properties (Tensile, compression, fatigue, fracture toughness, creep and ballistic penetration). These investigations will provide a solid foundation for the further development of this class of NMMCs for a variety of potential applications.

Flow Properties of an Aluminum Alloy Processed by Equal Channel Angular Pressing: *Sivaraman Arjunan*[1]; Uday Chakkingal[1]; [1]Indian Institute of Technology Madras

Equal Channel Angular Pressing (ECAP) process is an important process for producing ultra fine grained microstructures in bulk metals and alloys. The microstructures developed after ECAP represent high energy configurations; hence they are inherently unstable and susceptible to flow softening depending upon strain paths employed in subsequent deformation. In the present work aluminum alloy AA 6063 samples were subjected to ECA pressing for up to three passes with a die angle of 105 degree. Compression testing was used to determine the subsequent flow behaviour. Two types of compression test specimen orientations; one parallel to the axis of pressed sample and the other at 45 degree to the axis of the pressed sample were used for the study. The flow curves were plotted and comparative flow properties, flow softening and anisotropic behavior have been studied with respect to number of passes and processing routes. These are correlated to the observed microstructures.

Forging Parameter Effects on the Mechanical Behavior of Cryomilled Al 5083: *Troy Topping*[1]; Byungmin Ahn[2]; A. Newbery[3]; Enrique Lavernia[1]; [1]University of California, Davis; [2]University of Southern California; [3]MillStrong Ultra, LLC

Aluminum alloys with nanocrystalline (NC) and ultra-fine grain (UFG) size are of immense interest because of their high strength – typically 30% stronger than conventionally processed alloys of the same composition. For this study, the microstructure and mechanical behavior of UFG Al 5083 plate, produced by the quasi-isostatic forging of cryomilled powder, has been investigated and compared to course-grained Al 5083 - in particular, the ability to strengthen the UFG material further by tuning the forging parameters. Experimental forging parameters were used on six plates with approximate dimensions of 10" in diameter and 0.75" in thickness. The effort focuses on increasing strength through reduced grain growth during processing, while maintaining ductility by breaking up prior particle boundaries (PPBs) with high forging pressures. Mechanical tests reveal increased strength in proportion to decreased grain growth, while ductility is maintained at the level of conventional alloys.

Improvement in Both Strength and Ductility in Nanostructured Carbon Steel Produced by High Pressure Torsion and Annealing: Shaohua Xia[1]; Lilia Vichikganina[2]; *Jingtao Wang*[1]; Igor Alexandrov[2]; Ruslan Valiev[2]; [1]Nanjing University of Science and Technology; [2]Ufa State Aviation Technology University

Nanostructured carbon steels of Fe-0.45%C and Fe-0.65%C were obtained by high pressure torsion and annealing. Combination of high strength and improved uniform elongation was achieved in Fe-0.45%C resulted from formation of bimodal distribution in grain size. By comparing the microstructures and mechanical properties between nanostructured Fe-0.45%C and Fe-0.65%C, we can conclude that in-situ formed micro-meter sized grains in ferrite phase during annealing provide extra strain hardening ability to sustain the uniform elongation as their coarse-grained counterpart. Estimation of the relationship

between volume fraction of micro-meter sized grains and mechanical properties in bimodal steel was also made by associated analysis of results from previous investigations in low carbon steel processed by equal channel angular pressing and annealing.

Improving the Superplastic Properties of an AZ31 Magnesium Alloy by Equal-Channel Angular Pressing: *Roberto Figueiredo*[1]; Terence Langdon[1]; [1]University of Southern California

The interest in improving the properties of magnesium alloys has led to the development of technology to refine the grain structure especially through the use of severe plastic deformation. In the present paper, extruded billets of a commercial alloy, AZ31, were processed by Equal-Channel Angular Pressing (ECAP). Optical microscopy and tensile tests were used to evaluate the grain structure and high temperature mechanical properties in order to determine the effect of processing by ECAP. An analysis of grain structure shows that ECAP effectively reduces the average grain size to the range of a few micrometers. High temperature tensile tests demonstrate that ECAP reduces the flow stress of the AZ31 alloy and improves the strain rate sensitivity and the elongation to failure. Superplastic elongations up to more than 1000% were achieved after ECAP with low flow stresses and high strain rate sensitivity.

In-Situ Observation of Deformation of Nanocrystalline Al-Mg Alloy with Bimodal Grain Structure: *Byungmin Ahn*[1]; Enrique Lavernia[2]; Steven Nutt[1]; [1]University of Southern California; [2]University of California, Davis

The tensile properties and deformation response of nanocrystalline Al-Mg alloy (Al 5083) were investigated using a micro-straining unit. Atomized Al 5083 powder was ball-milled in liquid N2 to obtain a nanocrystalline structure, and blended with 15% unmilled coarse-grained powder to achieve bimodal structure. The blended powder was hot vacuum degassed to remove residual contaminants, consolidated by either cold (CIP) or hot isostatic pressing (HIP), and then forged. The microstructure was observed using an optical microscope. The investigation of tensile and fracture of bimodal structure suggests unusual deformation mechanisms and interactions between ductile coarse-grain bands and nanocrystalline regions.

Mechanical Properties of Ultra Fine Grained Aluminum and Iron Produced by Accumulative Roll Bonding Method: *Saeed Tamimi*[1]; Mostafa Ketabchi[1]; Nader Parvin[1]; [1]Tehran Polytechnic University

This work aims to investigate whether accumulative roll bonding (ARB) is an effective grain refinement technique for ultra-low-carbon steel strips containing 0.002% C and pour aluminum. For this purpose, a number of ARB processes were performed at 500°C for IF and 200°C for pour aluminum, with 50% reduction of each rolling pass. The mechanical properties after rolling were obtained. Aluminum and iron's yield and tensile strengths increased by 200–300%. Variations of hardness along the thickness of the samples were obtained using micro hardness tests. It was found that both the grain size achieved, as well as the degree of bonding, depend on number of rolling pass and reduction of area as a whole. In IF steel, mean grain size was obtained about 300nm. The rolling process was stopped in 7th cycle for pour aluminum and 10th cycle for IF steel, when cracking of the edges became pronounced.

Microstructure and Mechanical Properties of ECAE Processed Two-Phase Zinc-Aluminum (Zn-8%Al) Alloy: *Majid Al-Maharbi*[1]; Mohammed Haouaoui[1]; Ibrahim Karaman[1]; Gencaga Purcek[2]; [1]Texas A&M University; [2]Karadeniz Technical University

A two-phase zinc-aluminum alloy (Zn-8%Al) has been subjected to severe plastic deformation by equal channel angular extrusion (ECAE). The alloy was successfully extruded at homologous temperatures of 0.52 to 0.55 through different strain paths. The as-cast dendritic structure was eliminated and the α-phase particles were fragmented and dispersed more uniformly into the η-matrix leading to a more homogeneous microstructure. TEM micrographs show that grain sizes were significantly reduced to the ultrafine grain (UFG) sizes. An average increase in strength and elongation of about 53% and 1420% of as-cast values was achieved. Noticeable softening was observed after the first pass, and was attributed to chemical composition homogenization occurring with increasing strain level. The homogenization is assisted by the simultaneous long range diffusion and the refinement of the two phases as revealed by EDS and microhardness measurements which show considerable changes in composition and properties of the individual phases after ECAE.

OIM Study of Microstructure and Texture Heterogeneity during ECAP of Copper: *Alexander Zhilyaev*[1]; Azat Gimazov[2]; Shrinivasan Swaminathan[3]; Terry McNelley[3]; [1]Centro National de Investigaciones Metallurgicas (CENIM), CSIC; [2]Russian Academy of Sciences, Institute for Metals Superplasticity Problems; [3]Naval Postgraduate School

The heterogeneous deformation of annealed copper subjected to equal channel angular pressing (ECAP) was studied by Orientation Imaging Microscopy. The microstructure and microtexture of a partially pressed Cu billet has been analyzed at the inner and outer corners in the region of the die channel intersection as well as in the middle of the shear zone. Distinctly inhomogeneous deformation of prior annealing twins by interpenetrating slip bands was observed, and some twin-matrix interfaces displayed stair-like offsets. The intense local deformation within the annealing twins is characteristic of dislocation slip and not deformation twinning.

On the Texture Analysis of High Pressure Torsion - Deformed Mg and Cu: *Bartlomiej Bonarski*[1]; Erhard Schafler[1]; Michael Zehetbauer[1]; Borys Mikulowski[2]; [1]University of Vienna; [2]AGH-University of Science and Technology

Polycrystalline pure magnesium (99.8%) and copper (99.99%) have been subjected to High-Pressure Torsion (HPT) at room temperature. A special technique was developed in order to enable the HPT of Mg up to very high shear strains $\gamma \leq 120$ and different hydrostatic pressures (1–8 GPa). The texture development has been analyzed as a function of strain and hydrostatic pressure by systematic X-ray macrotexture investigations and compared with corresponding microhardness measurements. The texture evolution could be described in terms of volume fractions of the following components: (i) {0001}-, {10-11}- and {10-12}- fibres for the case of Mg; (ii) the typical components of shear textures for the case of Cu. From the textures observed, there is evidence for the occurrence of dynamic and static recovery, which turns out to depend not only on the strain but also on the hydrostatic pressure of HPT.

Stored Energy and Recrystallization Temperature of High Purity Copper after Equal Channel Angular Pressing: Yue Zhang[1]; *Jingtao Wang*[1]; [1]Nanjing University of Science and Technology

Equal channel angular pressing (ECAP) was conducted at room temperature to impose high strain into high purity copper. Differential Scanning Calorimeter (DSC) was used to estimate the store energy from ECAP and recrystallization temperature. It was found that the stored energy increases upon ECAP processing until a peak reached at 12 passes, and a slight decrease in stored energy was observed at higher ECAP passes. The recrystallization temperature decreases upon the increase of stored energy up to ~50 J/mol, and reaches a stable valve of ~210°C. Partial annealing of an ECAP processed (8 passes) sample by heating to ~185°pC at a heating rate of 20°C /min released the stored energy from ~55J/mol to ~18J/mol, without substantial change on the recrystallization temperature of the sample. A model was proposed to help understanding the recrystallization mechanism of ultrafine-grained copper and the observations above.

Tailoring the Microstructures of Ultrafine Grained Aluminum through a Two-Step Annealing Process: Naoya Kamikawa[1]; *Xiaoxu Huang*[1]; Niels Hansen[1]; [1]Riso National Laboratory

Due to microstructural and textural heterogeneities, annealing of nanostructured metals is difficult to control in order to avoid non-uniform coarsening and recrystallization. The present research demonstrates a method to delay such process by annealing at low temperature before annealing at high temperatures. By this two-step process the structure is homogenized and the stored energy is reduced significantly during the first annealing step. As an example high purity aluminum has been deformed to a total reduction of 98.4% by accumulative roll-bonding at room temperature. Isochronal annealing for 0.5 h of the deformed sample shows initiation of recrystallization at about 200°C. However, when introducing an annealing step for 6 h at 175°C the initiation of non-uniform coarsening and recrystallization is significantly delayed. To underpin these observations the structural evolution has been characterized by TEM, showing that extensive annihilation of low-angle dislocation boundaries characterizes the low-temperature annealing step.

TEM Studies on the Effect of Nature of Precipitates in Al-Li Alloy on Microstructural Evolution during Severe Plastic Deformation: *S. Giribaskar*[1]; Gouthama[1]; [1]Indian Institute of Technology, Kanpur, Department of Materials and Metallurgical Engineering

Fundamental research in the area of severe plastic deformation (SPD) focuses on the mechanisms that reduce grain size effectively down to nanometer range in metallic materials. Evolution of microstructure of Al-Li alloy processed by equal channel angular extrusion (ECAE), using redundant strain route B_C is analyzed using transmission electron microscopy (TEM). At initial stages of deformation, layers of elongated subgrains with alternating arrays of equiaxed subgrains are formed. Observations on the effect of precipitates/second phase particles in the sample on the deformation characteristics and their role on the increased degree of grain fragmentation process is highlighted. The nature of the precipitates on the evolution of the microstructure is elucidated. For this purpose, the Al-Li is solutionized, quenched and aged at different temperatures before subjecting to ECAE. It was observed that optimal thermal treatment leads to most effective grain refinement and consequent ultrafine grained material.

The Effect of Deformation History on the Microstructure and Texture of Annealed ECAE Processed Copper: *Ana Erb*[1]; Daudi Waryoba[1]; Peter Kalu[1]; [1]Florida A&M University-Florida State University College of Engineering

Grain refinement by equal channel angular extrusion (ECAE) has recently attracted attention due to its effectiveness of producing ultrafine-grained structures in bulk materials. In the present investigation, OFHC Copper ECAE processed at room temperature via route B_C (where the billet is rotated 90° in the same direction between consecutive passes) has shown refinement of the grain size to about 1µm at 4 passes. On the other hand, a billet swaged first to a 30% reduction and ECAE processed to 4 passes shows a lower grain size refinement to about 3µm. Both deformation history, however, show a similar grain boundary structure, consisting of about 25% high angle grain boundaries (HAGBs) and 75% low angle grain boundaries (LAGBs). The effect of deformation history on the microstructure and texture of these materials is discussed.

Transmission Electron Microscopy (TEM) Study of the Effect of Machining Parameters on Grain Refinement in Aluminum Alloy Machine Chips: *Lei Dong*[1]; Judy Schneider[1]; [1]Mississippi State University

The resulting microstructure of machined chips of AA 2195 and AA 2219 were characterized by Transmission Electron Microscopy(TEM). By varying the specimen diameter and rotation and feed speed, different strains and strain rates were imposed on the metal during the cutting process. Dependant on the metal cutting conditions, the resulting microstructure was found to contain either elongated or ultra-fine grains. These observations suggest that the grain refinement mechanisms were influenced by the metal cutting or hot working conditions. The use of metal cutting theory is being explored as a basis of quantifying the optimal conditions for grain refinement during the friction stir welding process.

Effect of Strain Rate, and Deformation Temperature on the Microstructure of an Equal Channel Angular Extrusion (ECAE) Processed Ti-6Al-4V Alloy: *Rabindra Mahapatra*[1]; Shankar Sastry[2]; [1]Naval Air Systems Command; [2]Washington University

The Ti-6Al-4V alloy was ECAE processed to produce ultra-fine grains of 1-2µm. The uni-axial compression experiments to simulate forging parameters subsequent to ECAE processing were carried out to elucidate whether, the ultra-fine grained microstructure of the alloy can be sustained after the deformation. The ECAE processed Ti-6Al-4V alloy showed no significant grain growth when deformed at 750°C, at a strain rate of 0.1"/sec., where as when deformed at same temperature, a strain rate of 0.001"/sec., both the recovery and grain growth were observed.

Microstructural Characteristics of Leadframe Cu Alloys after Accumulative Roll Bonding Process: *Chayong Lim*[1]; Seungzeon Han[1]; Seonghee Lee[2]; [1]Korea Institute of Materials Science; [2]Mokpo National University

Mechanical properties and formation of nano-sized grains in Cu and Cu-Fe-P alloys by accumulative roll bonding (ARB) process were investigated. Nano-sized grains were successfully obtained in OFC and PMC-90 alloys by ARB process after third cycle. Once the 200 nm grains formed, further reduction in the grain size was not observed up to the 8 ARB process cycles. For both alloys, the tensile strength values increased drastically in the initial stage of ARB process. The tensile strength values of both alloys tended to saturate after the third ARB process cycle. The tensile elongation value greatly decreased by 1 cycle of ARB process due to the strain hardening. After the third cycle of ARB process, each alloy showed a gradual increase in tensile elongation due to the dynamic recovery. For PMC-90 alloy, the strength value is higher than that of OFC due to addition of the alloying elements.

Synthesis of Al-$Al_{85}Ni_{10}La_5$ Nanocomposites by Mechanical Milling: *Zhihui Zhang*[1]; Yizhang Zhou[1]; Enrique Lavernia[1]; [1]University of California, Davis

Mechanical milling has been widely used to fabricate metal matrix composites and dispersion-strengthened alloys with the advantage of improved dispersion, enhanced interfacial bonding and refined microstructure. This study reports on the synthesis of an Al-$Al_{85}Ni_{10}La_5$ nanocomposite by milling a mixture of Al (mean particle size ~60 µm) and amorphous $Al_{85}Ni_{10}La_5$ powder (particle size 10~25 µm) at a cryogenic temperature. The microstructural evolution during the milling process was investigated using XRD, DSC, SEM and TEM. The results show that nanocrystaline Al matrix with a grain size about 26 nm was obtained and the amorphous powder was fractured and homogeneously distributed in the Al matrix with a whisker shape (1~2 µm thick with an aspect ratio of 1~5). The mechanical behavior of the powder and consolidated bulk composite was also discussed.

Texture Analysis of Materials Subjected to Equal Channel Angular Pressing: Katrina Houston[1]; Srinivasan Swaminathan[1]; Jianqing Su[1]; *Terry McNelley*[1]; [1]Naval Postgraduate School

The correlation between the microstructure and texture for aluminum alloys processed by equal channel angular pressing (ECAP) has been studied. The microstructure was characterized using optical microscopy, scanning electron microscopy (SEM) and transmission electron microscopy (TEM). The local textures were discerned using orientation imaging microscopy (OIM) and compared to macro-texture measurements made by X-ray diffraction. Specific emphasis has been given to understanding the long-range arrangement of texture variants in the microstructure. The interfaces between texture variants are pre-cursors to high angle boundaries in repetitive ECAP. The microstructure-mechanical property relations were also examined.

The Relationship between Work Hardening and Grain Size Distribution in Ultrafine Grained Materials: *Babak Raeisinia*[1]; Warren Poole[1]; Chad Sinclair[1]; [1]University of British Columbia

One anticipates the mechanical response of ultrafine grained materials to be sensitive to heterogeneity arising from a grain size distribution. In the limit of bimodal distributions, experiments appear to support this assertion. For a given strength level, experiments have shown that improvements in uniform elongation can be obtained via manipulating the size distribution. The conclusion is that the grain size distribution can affect both the yielding and the work hardening behaviour. In this work, the role of grain size distribution on the macroscopic properties of ultrafine grained materials has been examined. This is interpreted based on the partitioning of stress and strain between grains within the framework of a self-consistent approach. This approach extends recent efforts focused on yielding to look at the fully plastic work hardening response of polycrystals. The results of this approach are compared with the experimental tensile response of example materials exhibiting heterogeneous microstructures.

Three Pass Twist Extrusion of Pure Aluminum 1100: Experimental Approach: *Amir Reza Shahab*[1]; S. Akbari Mousavi[1]; [1]University of Tehran, University College of Engineering, School of Metallurgy and Materials Engineering

Equal channel angular press (ECAP) and Twist extrusion (TE) are two promising types of Severe Plastic Deformation (SPD) methods in order to produce bulk nano-structured materials. TE process has its own profits in comparison to ECAP such as achieving to nanostructure in less number of passes. In this study, three simultaneous counterclockwise twists were performed on the annealed pure Al of type 1100 samples at room temperature and without any inter pass annealing. In order to evaluate the effects of TE, mechanical and metallurgical properties of the nano-Al produced by the twist extrusion process were examined. The results show that the ultimate tensile strength of the nano Al is almost three times greater than that of the original one. In addition, the ductility of the nano Al reduced 58% and the hardness increased 85% approximately. Moreover, the metallographic inspection of the sample is carried out. The study shows the grain

size non uniformity across the cross section of the sample in longitudinal and transversal directions. This matter may be attributed to the difference of mode of deformation from pure shear to simple shear in cross section.

Three Pass Twist Extrusion of Pure Aluminum 1100: Numerical Simulation Approach: *S. Akbari Mousavi*[1]; Amir Reza Shahab[1]; [1]University of Tehran, University College of Engineering, School of Metallurgy and Materials Engineering

Reviewing lots of articles, it has been approved that Finite Element Method (FEM) is a powerful mean in order to predict and optimize metal forming techniques include more modern ones such as Severe Plastic Deformation (SPD) methods. Equal channel angular press (ECAP) and Twist extrusion (TE) are two promising types in order to produce bulk nano-structured materials. FEM has addressed well for ECAP but its ability for TE process is not so definite yet. In TE process the cubic bulk of material goes through a 90 degree clock or anticlockwise twisted channel die for a couple of turns. In this study, the simulation of three consecutive anticlockwise passes is presented using an explicit finite element method with ABAQUS software. Suitable constitutive relations are used to describe the behavior of Al 1100 during deformation at room temperature. The flow of three simultaneous clockwise twists is presented using von Mises stress and effective plastic strain contours. The positions of the maximum and minimum values of effective strain and von Mises stress are determined and their profile histories are obtained. The average values of equivalent plastic strains at the end of first, second and third simultaneous passes are found to be 1.5, 2.5 and 3, approximately. The mode of deformation also changes from center to corner of the cross section from pure shear to simple shear.

Continuous Equal-Channel Angular Pressing for Producing Long Nanostructured Ti Semi-Products: *Georgy Raab*[1]; Yuntian Zhu[2]; Terry Lowe[2]; Ruslan Valiev[1]; [1]Ufa State Aviation Technical University; [2]Los Alamos National Laboratory

We have analysized major factors that influence the formation of ultrafine-grained structure and evaluated the effectiveness of a continuous equal-channel angular pressing (ECAP) method, ECAP-Conform, for producing nanostructured CP-Ti long rods. In this work we have built a pilot ECAP-Conform machine to process rods with length up to 3 m and diameter up to 7.5 mm. The nanostructured Ti rods produced here have superior strength and fatigue properties, which is of great interest to advanced medical applications in stomatology and traumatology.

Mechanisms of Deformation and Refinement of Grains in Metals by Severe Plastic Deformation: *Georgy Raab*[1]; Farid Utyashev[2]; [1]Ufa State Aviation Technical University; [2]Russian Academy of Sciences, Institute for Metals Superplasticity Problems

Grains refinement is considered as an effect of mechanisms of fragments boundaries and bands formation as a result of crystallographic and non-crystallographic shears at bending and/or torsion of a sample. During ECAP and HPT the sample's bending-torsion in a localized deformation center grows and that leads to a non-monotonic deformation and an increase in the angular misorientations of boundaries of the formed bands and fragments. It was shown that the depth of structure refinement depends on the contributions of the required mechanisms in total strain that depend, in their turn, on a scale factor – the dimensions of the deformation center and sample.

Microstructure Refinement of Ti-6Al-4V Titanium Alloy during Warm Deformation: *Sergey Zherebtsov*[1]; Maria Murzinova[1]; Sergey Mironov[1]; Alexander Pshenichnuk[1]; Gennady Salishchev[1]; Lee Semiatin[2]; [1]Institute for Metals Superplasticity Problems; [2]Air Force Research Laboratory, Materials and Manufacturing Directorate, Wright-Patterson Air Force Base

Microstructure evolution and mechanical behaviour of Ti-6Al-4V titanium alloy during uniaxial compression at 600°C to a height strain of 70% has been investigated. Initially the alloy has a lamellar microsrtucture. During deformation lamellar microstructure transforms into globular one with a grain size of around 0.4 micrometers. Mechanical behavior of the material is described by the deformation curve with strengthening, softening and steady state flow stage. The microstructure evolution with emphasis on grain boundaries misorientation and mutual turn of alpha and beta phases has been studied. The orientation of phases was determined by means of the EBSD-technique and so-called "single-reflex" method which based on computation of microdiffraction patterns. It have been revealed that transformation of lamellar microstructure into globular one is associated with loss of coherence of interphase boundaries. As soon as the coherence is lost the deformation localizes within each phase intensifying division of the lamellae into equiaxial fragments.

Room Temperature Relaxation in Copper under High Pressure Torsion Detected by In-Situ Synchrotron Diffraction: *Askar Kilmametov*[1]; Gavin Vaughan[2]; Alain Yavari[3]; Ruslan Valiev[1]; [1]Ufa State Aviation Technical University; [2]European Synchrotron Radiation Facilities; [3]Institut National Polytechnique de Grenoble

Structural relaxation in severely deformed Cu has been investigated in real time diffraction experiments at room temperature during in situ high pressure torsion (HPT) in high energy synchrotron light. Simultaneous relative changes in Bragg peak's broadening and crystal lattice expansion were under study in loading-unloading regime of torsion straining. Experimental results are consistent with the attribution of the annihilation of crystalline defects generated during HPT. Relaxation kinetics assumed to be controlled by diffusion; therefore the enhanced diffusivity has been estimated due to extremely high excess vacancy concentration, which is typical for those at thermal equilibrium near the melting point.

Superplastic Ultrafine-Grained Sheet Produced out of the Al-Li-Mg-Sc Alloy with Enhanced Mechanical Properties Introduced by ECAP and Rolling: *Nina Yunusova*[1]; Rinat Islamgaliev[1]; Nikolay Krasilnikov[2]; Gulnaz Nurislamova; Ruslan Valiev[1]; [1]Ufa State Aviation Technical University; [2]Ulyanovsk State University

ECAP at elevated temperatures was applied to produce bulk textureless billets with equiaxed grains with a size less than 1 μm in size out of Al-Li-Mg-Sc alloy. The billets demonstrated the effect of high-strain-rate (10^{-1} s^{-1}) superplasticity (780%) at a relatively low (400°C) temperature. The sheet fabricated out of the billet by warm rolling retained its equiaxed structure with minor grain refinement and exhibited superplasticity with elongation 530% at the same temperature and the strain rate equal to 10^{-2} s^{-1}, when compared to the ductility (80%) of a sheet fabricated out of a coarse-grained billet. Short-time annealing of the superplastic sheet at a temperature of solid solution treatment with subsequent aging allowed to use potential of UFG structure and dispersion hardening to achieve very high UTS (690 MPa) retaining the initial ductility.

The Influence of Impurities on Structure and Mechanical Properties of Nanostructured Titanium: *Rinat Islamgaliev*[1]; Vil Kazyhanov[1]; Askar Kilmametov[1]; Alfred Sharafutdinov[1]; Ruslan Valiev[1]; [1]Ufa State Aviation Technical University

High pressure torsion (HPT) is a well established severe plastic deformation technique for producing nanostructured metallic materials. Using new HPT installation we have investigated the microstructure (grain size, content of omega-phase) and mechanical properties of commercially pure titanium with different content of impurities (VT1-00, VT1-0, Grade 4) processed at various HPT regimes. It was found that content of high pressure omega-phase depends strongly on purity of initial material influencing on strength, ductility and thermal stability of grain structure. Special attention has been paid to investigation of the influence of thermomechanical treatments on nanostructure and mechanical properties.

Influence of Phase Separation on the Mechanical Properties of Pre-Oxidized PM 2000 Alloy: *Carlos Capdevila-Montes*[1]; Michael Miller[2]; Jesus Chao[1]; Jose Gonzalez-Carrasco[1]; [1]Centro Nacional de Investigacines Metalurgicas (CENIM-CSIC); [2]Oak Ridge National Laboratory

In the last few years, the ultrafine-grained Fe-based oxide dispersion strengthened (ODS) PM 2000 alloy has been shown to be a viable biomaterial as result of its outstanding combination of mechanical properties and corrosion resistance. After pre-oxidation at 1100°C and phase separation upon aging at 475°C, the room temperature tensile and fatigue properties are suitable for achieving the required biofunctionality for load-bearing implants. Atom probe tomography has revealed that phase separation into Fe-rich alpha and Cr-enriched alpha-prime phases is responsible for the increases in the yield and ultimate tensile strength. However, despite the loss of some ductility, PM 2000 shows ductile behaviour in the necked zone of tensile specimens. This ductility contrasts with the brittle failure observed during the so-called "475°C embrittlement" of other

ferritic alloys. Moreover, PM 2000 aged at 475°C exhibits a higher fatigue limit than that of unaged pre-oxidised material.

Microstructure and Mechanical Properties of Nanocrystalline Fe-C Alloys Processed by Mechanical Milling and Spark Plasma Sintering: *Keiichiro Ohishi*[1]; Bonta Rao[2]; Kazuhiro Hono[1]; [1]National Institute for Materials Science; [2]University of Tsukuba

Bulk nanocrystalline Fe-C alloys containing different carbon contents were fabricated by mechanical milling and spark plasma sintering (SPS). The samples consolidated by SPS at temperatures in the range of 650-675°C exhibited a good combination of strength and plastic strain in compression. The values of yield and maximum compressive strengths increased with carbon content, while the plastic strains decreased. The microstructure has been characterized using transmission electron microscopy (TEM) and a three-dimensional atom probe (3DAP) to understand the origin of the unusually high yield strength and plastic strain. A bimodal grain structure consisting of fine and coarse grains was observed for all the samples showing high strength and plastic strain. The fine grained region was found to be a duplex phase structure comprised of ferrite and cementite grains. From TEM and 3DAP analyses, the presence of fine oxide particles containing chromium was confirmed.

Microstructure and Mechanical Properties of Ultra Fine Grained Cu-Al and Cu-Zn Alloys: *Martin Heilmaier*[1]; V. Subramanya Sarma[2]; [1]Otto Von Guericke University; [2]Indian Institute of Technology Madras

Recent studies on ultrafine grained (ufg) electro-deposited Cu containing controlled densities of nanoscale twins revealed a unique combination of very high yield strength (≈850 MPa) and good tensile ductility (≈14%). Here we aim at producing bulk Cu-5wt.%Zn and Cu-5wt.%Al alloys with ufg matrix and controlled densities of nano/sub-micron twins through varying (i) alloying additions (reducing the stacking fault energy SFE compared to pure Cu), (ii) deformation (rolling) temperatures and (iii) annealing treatments. Grain sizes were found in the range of 0.6 to 1.2 µm (including twin boundaries in the evaluation). The Cu-Al alloy shows significantly improved strength in comparison to the Cu-Zn alloy at tensile comparable ductilities >30%. This is attributed to the much stronger contribution of Al to solid solution strengthening. Contrary, the yield stress dependence on grain size is much stronger for Cu-Zn. Possible reasons will be discussed incorporating strain rate sensitivity tests to understand the deformation mechanisms.

Microstructure of a FeCoV Alloy after Equal Channel Angular Pressing and Tempering: Zhongze Du[1]; *Jingtao Wang*[2]; Qingjuan Wang[1]; [1]Xi'an University of Architecture and Technology; [2]Nanjing University of Science and Technology

Equal channel angular pressing (ECAP) of a FeCoV alloy was carried out at room temperature via route A up to 4 passes. The microstructure of the FeCoV alloy after ECAP and subsequent tempering were characterized by transmission electron microscopy (TEM). The FeCoV alloy transformed into a fine lath structure with the width of lath decreasing obviously with ECAP passes. The average width of lathes was 90nm after four passes of ECAP, with dislocation tangles inside the lath. These lath structure would breaks and transforms into a fine lath, when increasing ECAP passes. Although tempering after four passes ECAP had little effect on its lath shape of the microstructure, carbide particles and nanometer precipitates appeared inside the lathes after tempering, indicating the decomposition of the microstructure.

Direct Metal Particulate Production Using Modulation-Assisted Machining: *James Mann*[1]; Chris Saldana[1]; Srinivasan Chandrasekar[1]; W. Compton[1]; Kevin Trumble[1]; [1]Purdue University

Continuous production of Al 6061-T6 particulate using modulation-assisted machining (MAM) is demonstrated. Superimposition of a controlled, low-frequency modulation in conventional machining causes chips to form as discrete particles. By adjusting the conditions, equiaxed, platelet, and fiber shaped particles having narrow size distributions can be produced. Large-strain deformation leads to microstructure refinement and enhanced hardness. The process is applicable to a wide range of alloys and appears to be intrinsically scalable for large-volume production.

Effect of Initial Microstructure on Strain Hardening Behavior of Ultrafine Grain Dual-Phase Steel Produced by Severe Plastic Deformation: *Young Gun Ko*[1]; Dong Hyuk Shin[2]; [1]Massachusetts Institute of Technology; [2]Hanyang University

Strain hardening behavior of ultrafine grained (UFG) dual phase (DP) steels via equal channel angular (ECA) pressing and subsequent intercritical annealing followed by water quenching was investigated at ambient temperature. A series of tensile tests were carried out for three distinct DP steels, i.e., CG-DP, UFG-DP and UFG-DPV steels. In contrast to conventional UFG steels with a lack of strain hardening, UFG-DPV steel showed significant strain hardening rate, resulting from uniform distribution of island-typed martensite as well as grain refinement of each constituent phase throughout the microstructure. Also, UFG-DPV steel containing 0.06% of vanadium exhibited the good combination of high strength and sufficient strain hardening, because initial microstructure of that was consisted of the fine martensite through equal channel angular pressing. Strain hardening behavior of these steels was discussed in relation to modified C-Janalysis based on Swift relationship.

Effect of Subsequent Annealing Treatment on Dynamic Deformation Behavior of Ultrafine Grain Al-Mg Alloy: *Young Gun Ko*[1]; Yang Gon Kim[2]; Dong Hyuk Shin[3]; Sunghak Lee[2]; Chong Soo Lee[2]; [1]Massachusetts Institute of Technology; [2]Pohang University of Science and Technology; [3]Hanyang University

A study was made to investigate the dynamic deformation behavior of ultrafine grain Al-Mg alloy with subsequent annealing treatments at ambient temperature. By imposing an effective strain up to 8 via equal-channel angular pressing (ECAP), most grains were refined from to 300 nm with a non-equilibrium nature of grain boundaries. Upon several subsequent annealing treatments, the ultrafine microstructure was stable at temperature up to 473 K, whist normal grain growth was found to take place above 523 K. In order to understand the effect of annealed microstructure (ultrafine grain with unstable grain boundary vs. fine grain with stable grain boundary) on dynamic deformation behavior, torsional tests were carried out for four samples i.e., as-ECAPed and 473, 523 and 573 K after ECAP process, using a Kolsky bar. Such mechanical response was discussed in relation to microstructure, tensile property and fracture mode associated with the occurrence of adiabatic shear bands.

Polymer Bonding Ultrafine Grained Al 6061-T6 Particulate Produced by Machining: Boum-seock Kim[1]; James Mann[1]; Srinivasan Chandrasekar[1]; *Kevin Trumble*[1]; [1]Purdue University

Plane-strain machining has been used to produce 20 to 200 µm size Al6061-T6 particulate having grain sizes less than 100 nm and 50% higher hardness than the bulk Al6061-T6. Several routes for low-temperature (~100°C) densification and bonding the particles using epoxy resins will be presented. Metal fractions greater than 90 vol % have been achieved with no loss of hardness (in the particulate) during the epoxy cure. Microstructure based modeling of composite hardness will be presented and tensile test results will be discussed. Potential structural applications for these composite materials will be elaborated.

Novel Microstructures from Severely Deformed Al-Ti Alloys Created by Chip Formation in Machining: Jiazhao Cai[1]; Andreas Kulovits[1]; *M. Ravi Shankar*[1]; Jörg Wiezorek[1]; [1]University of Pittsburgh

We present some consequences of Severe Plastic Deformation (SPD) of Al-Ti alloys by chip formation in machining that can enable novel opportunities for creating materials with unprecedented properties. Chips cut from Al-6wt%Ti are composed of a refined dispersion of the fragmented remains of a hitherto coarse Al_3Ti embedded in a nanostructured matrix. This multi-phase nanostructured chip material demonstrates considerable resistance to coarsening owing to the thermally-stable dispersion of ultra-fine Al_3Ti precipitates and thus has promise in structural alloy applications. Furthermore, the Al-Ti machining chips are shown to possess excellent grain-refining characteristics, leading to microstructurally refined and homogeneous Al castings. This realization enables a low-cost route for enhancing the efficiency of the grain refiner Al(Ti) master alloy systems by exploiting SPD during chip formation.

Strain-Assisted Grain Refinement of Co-Fe Alloys upon Room-Temperature Compression: Lai-Chang Zhang[1]; Mariana Calin[1]; Flora Paturaud[2]; *Jürgen Eckert*[1]; [1]Leibniz Institute for Solid State and Materials Research (IFW) Dresden; [2]W.C. Heraeus GmbH

It is well-known that severe plastic deformation methods, including equal channel angular pressing and high-pressure torsion, have been widely used to produce bulk ultrafine- and/or nanoscale-grained metals and alloys. However, the mechanism of the deformation-induced grain refinement is strongly related to the crystal structure of the investigated metallic materials. In this work, instead of applying severe plastic deformation, pronounced grain refinement to ultrafine or nanoscale has been achieved upon the room-temperature conventional compression of initially coarse-grained single-phase bcc Co-xFe (x=25 and 35 wt%) alloys. These alloys exhibit large plasticity over 140% without fracture at room temperature. The grains refine with increasing of the deformation strains during compression. The possible mechanism for the strain-induced grain refinement under compression is a consequence of the shear deformation and dramatic deformation-enhanced atomic diffusion during deformation.

Thermal Stability of Ultrafine Grains Size of Pure Copper Obtained by Equal-Channel Angular Pressing: *Nayar Lugo*[1]; Nuria Llorca[2]; Joan Suñol[3]; Jose Cabrera[1]; [1]Universidad Politecnica de Catalunya; [2]Universitat de Barcelona; [3]Universitat de Girona

Ultrafine grains size of pure copper 99.98% have been obtained by severe plastic deformation using the Equal-Channel Angular Pressing (ECAP) method. Copper samples were ECAPped from 1 to 8 passes developing a finer microstructure showing grain sizes of 250 nm after the 8th pass through the die. Important enhancement in the mechanical strength properties was obtained in the material processed by this technique. Subsequent heat treatments were carried out to evaluate the grain size thermal stability of the ECAPped samples. Microstructure and mechanical properties together with Differential Scanning Calorimetric (DSC) tests were carried out in order to evaluate thermal recovery and recrystallization temperature as well as activation energy. Good correlation was obtained with the microstructure and the mechanical properties. Heat treatment produced significant changes in the behaviour of the material.

XRD Characterisation of Ultrafine Grained (UFG) Al-Mg Alloys: *Markus Dinkel*[1]; Florian Pyczak[1]; Mathias Göken[1]; [1]University Erlangen - Nürnberg

The characterisation of ultrafine grained materials by X-ray diffraction (XRD) is a suitable and convenient method to acquire information about this material class. In this work examples from different areas of interest are covered. The effect of impurities on the crystallite sizes and dislocation densities of ECAP – processed AlMg alloys is studied. It can be shown that with increasing Magnesium content the achievable reduction in crystallite size with ECAP eventually reaches a saturation state and a further reduction of the structural size seems unlikely. Simultaneously the dislocation density increases to a plateau level with increasing Mg content. In annealing experiments the microstructural stability of AlMg0.5 and the resulting changes are determined by XRD. As a result it becomes evident that the annealing leads to a moderate increase in crystallite size up to a temperature where accelerated crystallite growth begins. Also XRD results prior and after fatigue testing are presented.

Solid State Amorphization of Cu+Zr Multi-Stacks by ARB and HPT Technique: *Yufeng Sun*[1]; Yoshikazau Todaka[2]; Minoru Umemoto[2]; Nobuhiro Tsuji[1]; [1]Osaka University; [2]Toyohashi University of Technology

A series of CuZr binary alloys with wide composition range were fabricated through ARB and HPT technique using pure Cu and Zr metals as the starting materials. Bulk alloy sheets with thickness of about 0.8 mm after ARB process and alloy disks with 0.35mm in diameter and 10 mm in diameter after HPT process can be obtained respectively. The structures of all the alloys were found to be gradually refined with the increasing of ARB cycles or HPT rotations. As a result, nanoscale multiple-layered structure was formed for the 10 cycled ARBed specimens, which could partially transform into amorphous phase after low temperature annealing. While for the as-HPTed sample, the alloy will be completely amorphrized after 20 rotations without any heat treatment. The thermal stabilities of the amorphous alloys were studied. The deformation behavior and the amorphization mechanism during the ARB and HPT process were put forward and discussed.

Creep Response and Deformation Processes in Nanocluster Strengthened Ferritic Steels: Taisuke Hayashi[1]; *Peter Sarosi*[1]; Joachim Schneibel[2]; Michael Mills[1]; [1]Ohio State University; [2]Oak Ridge National Laboratory

Mechanically alloyed Oxide Dispersion Strengthened (MA/ODS) ferritic alloys are considered as candidate structural materials for fission and fusion power plants applications because of their excellent creep strength at high temperature and good resistance to irradiation-induced swelling. An alloy designated 14YWT containing 100nm sized grains and nanometer sized clusters (Y and Ti containing oxides) was subjected to high temperature annealing followed by creep at 800°C. Microstructural characterization using scanning and transmission electron microscopy to understand the microstructure stability during annealing as well as the deformation processes during creep of the MA/ODS steel was performed. A detailed examination of the grain growth, nanocluster distribution and dislocation analysis will be discussed.

Evolution of Microstructure and Property of a Pure Iron during Equal Channel Angular Pressing: Yue Zhang[1]; Jingtao Wang[1]; *Songming Wang*[1]; [1]Nanjing University of Science and Technology

Equal channel angular pressing (ECAP) was conducted on a pure iron up to 8 passes via route A and Bc. Evolution of microstructure and mechanical property during ECAP were characterized by tensile testing and TEM observation. While strong thin lamellae structure with an average thickness of 0.2~0.4 micrometer were observed after 8 pass of ECAP via route A, as one expected; similar structure is also observed, mixed with equiaxed fine grain structures in the sample after 8 pass of ECAP via route Bc. Immediate necking after yielding is observed in tensile test of all the samples after ECAP, although an obvious plastic deformation is observed before failure. A high tensile strength of ~880MPa could be achieved through ECAP by both route A and Bc.

Influence of Rolling Direction on Strength and Ductility of Aluminium and Aluminium Alloys Produced by Accumulative Roll Bonding: *Irena Topic*[1]; Heinz Werner Höppel[1]; Mathias Göken[1]; [1]Friedrich-Alexander University of Erlangen Nürnberg

The accumulative roll bonding (ARB) process has been recognised as a successful severe plastic deformation method for production of ultrafine-grained (UFG) materials with superior mechanical properties compared to their conventionally grained counterparts. The biggest advantage of this process is that it can be easily adapted in industry to produce large scale UFG sheets, especially interesting for light weight construction in automotive industry due to high potential of cost reduction and energy savings. In this work, accumulative roll bonded AA1050 and AA6016 showed significantly increased specific strength paired with high ductility. Despite a strongly elongated grain structure, tensile testing of samples oriented 45° to the rolling direction (RD) revealed considerable improvement in elongation to failure compared to the samples parallel to RD. Hydraulic bulge testing showed a tendency to higher achievable burst pressures and strains indicating good formability. Friction stir welding proved to be a successful method for UFG sheet material.

Influence of SPD on the Magnetic Properties of Soft Magnetic Materials: *Stephan Scheriau*[1]; Klemens Rumpf[2]; Siegfried Kleber[3]; Heinz Krenn[2]; Reinhard Pippan[1]; [1]Erich Schmid Institute of Material Science; [2]Karl-Franzens-University Graz; [3]Böhler Edelstahl GmbH

Industrial available FeSi, FeCo and FeNi alloys with an initial grain size of 20-50µm were subjected to Severe Plastic Deformation (SPD) by high pressure torsion at both ambient temperature (293 K) and liquid nitrogen temperature (77 K). The strain levels were chosen in that way where a saturation of the microstructural refinement is observed. The microstructure of the severely deformed states is analysed by Back Scattered Electrons (BSE) micrographs captured in a SEM. Additionally samples that were deformed at 77 K are examined in a Transmission Electron Microscope (TEM). The magnetic properties were characterised by means of SQUID-magnetography providing information of the magnetic behaviour of the material in the as processed state. Depending on the deformation temperature the mean microstructural sizes in the SPD-state are about 120nm and 50nm at 293 K and 77 K, respectively. The microstructural size influences significantly the magnetic properties of these materials. The initial soft-magnetic behaviour of the coarse grained state shifts towards a hard-magnetic with decreasing crystallite size. By dropping below a crystallite size of ~50nm the magnetic properties become again soft-magnetic.

Microstructure Development Ultrafine Grained Tantalum Produced by Machining: *Mert Efe*[1]; Hyun Jun Kim[1]; Wilfredo Moscoso[1]; W. Dale Compton[1]; Srinivasan Chandrasekar[1]; Kevin Trumble[1]; [1]Purdue University

Severe plastic deformation (SPD) of pure tantalum and subsequent microstructure development in annealing has been studied. Bulk plates of 1- to 6-mm thickness with plastic strains of 1 to 4 have been achieved in a new process called Large Strain Extrusion Machining (LSEM), in which the imposed plastic strain and plate thickness can be controlled controlled independently in a single stage deformation process. Significant grain refinement and corresponding hardening of the tantalum has been measured. High vacuum annealing with and without zirconium gettering, and metallographic analysis were used to characterize the recrystallization and grain growth behavior of the UFG tantalum. The results are discussed relative to the corresponding behavior in conventional ingot Ta.

Nano-Grained Copper Strip Produced by Accumulative Roll Bonding Process: *Mohammad Reza Toroghinejad*[1]; Mahnoosh Shaarbaf[1]; [1]Isfahan University of Technology

Accumulative roll bonding (ARB) process is a severe plastic deformation process that has been used for pure copper (99.9%). The ARB process up to 8 cycles was performed at ambient temperature under unlubricated conditions. Microstructural characterizations were done by transmition electron microscopy and electron backscattered diffraction. It was found that continuous recrystallization resulted in microstructure covered with small recrystallized grains with an average diameter below 100 nm. The tensile strength and hardness of the ARB processed copper has become two times higher than initial value. On the other hand, the elongation dropped abruptly at the first cycle and then increased slightly. Strengthening in ARB processed copper may be attributed to strain hardening and grain refinement. In order to clarify the failure mode, fracture surfaces after tensile tests were observed by scanning electron microscopy. Observations revealed that failure mode in ARB processed copper is shear ductile rupture with elongated small dimples.

Precipitation Hardening and Grain Refinement in an Al-4.3wt%Mg-1.2wt%Cu Alloy Processed by ECAE: *Vanessa Vidal*[1]; Zheng-Rong Zhang[2]; Bert Verlinden[1]; [1]KULeuven; [2]University of Electro-Communications

In this study the influence of severe plastic deformation on the microstructure and the properties of a precipitation hardenable Al-4.3wt%Mg-1.2wt%Cu alloy was investigated by room temperature compression tests, EBSD and TEM. Samples in under aged, peak aged and over aged condition were deformed in an ECAE die at 180°C. After four ECAE passes fine equiaxed grains with an average size of approximately 200 nm with some traces of remnant elongated grains were obtained. It was observed that peak aged and over aged samples lose much of their strength during ECAE due to fragmentation of the precipitates. The highest strength after four ECAE passes (route Bc) was obtained with samples in under-aged condition, although in this case dissolution of precipitates into the matrix occurred. Formation of new round precipitates with small size were detected during post-ECAE annealing at 180°C. However, this re-precipitation resulted in a softening of the severely deformed samples.

Cold and Hot Severe Plastic Deformation of an Al-3wt%.Mg Alloy: *Martin Hafok*[1]; Reinhard Pippan[1]; [1]Erich Schmid Institute of Materials Science

In order to examine the effect of deformation temperature on materials processed by high pressure torsion, an Al-3wt.%Mg alloy was chosen to analyse the evolution of microstructure and microtexture. By using a single phase aluminium alloy instead of pure aluminium the static recrystallization and recovery, which may occur in pure aluminium even at room temperature, is suppressed after quenching the sample from elevated temperatures or after heating the sample to room temperature from cryogenic temperatures. The characteristic development of microstructure and microtexture of the alloy deformed in a temperature range between -196°C and 450°C were investigated by SEM, EBSD and TEM technique in order to reveal the transition between cold working, dynamic recovery and dynamic recrystallization during HPT. In the experiments a characteristic microtexture and microstructure was found which is associated with the torsion deformation, the dynamic recovery and the dynamic recrystallization.

Crack Growth in Ultrafine-Grained AA6063T6 Produced by Equal Channel Angular Pressing: Lothar W. Meyer[1]; *Kristin Sommer*[1]; Thorsten Halle[1]; Matthias Hockauf[1]; [1]Chemnitz University of Technology

Crack growth behaviour of ultrafine-grained AA6063T6, processed by equal channel angular pressing (ECAP) via route E at room temperature, were evaluated with special emphasis on the effect of grainsize distribution and work hardening. A bimodal, two times ECAPed state and a monomodal ultrafine-grained state after eight ECA-extrusions are compared with the coarse grained initial T6 state. Crack growth behaviour is investigated by using SE(N)B-specimens and described by a Paris-Erdogan-Ratwani-equation, covering crack growth behaviour from the threshold region up to the high rate region approaching the critical stress intensity. Depending on the number of ECA-extrusions, the ECAPed material shows significantly lower threshold values (ΔK_{th}) and higher crack growth rates (da/dN) than its coarse grained counterpart. SEM micrographs of crack propagation surfaces reveal reduced grain size as major key to increased crack growth rates of the ECAPed material, as it influences roughness-induced crack closure and crack deflections.

Grain Growth in Ultrafinegrained Aluminium Processed by Hydrostatic Extrusion: *Malgorzata Lewandowska*[1]; Tomasz Wejrzanowski[1]; Krzysztof Kurzydlowski[1]; [1]Warsaw University of Technology

Ultrafinegrained materials may be produced by a number of techniques involving severe plastic deformation. These materials are generally thermally unstable and undergo grain growth at elevated temperature driven by a large surface area of grain boundaries. The kinetics of growth at early stage of the process (in fine grain size range) depends on microstructural features, such as a high fraction of high angle grain boundaries and grain size uniformity. This implies a correlation between the SPD technique used for grain refinement and thermal stability of processed materials. In the present work, the changes in grain size and grain boundary characteristics during annealing at various temperatures were evaluated quantitatively for technically pure aluminium processed by hydrostatic extrusion. The experimental kinetics of grain growth have been analyzed in terms of the influence of initial fraction of high angle grain boundaries and grain size homogeneity and by simulation based on Monte Carlo method.

Mechanical Properties and Corrosion Behavior of Ultrafine-Grained AA6082 Produced by Equal Channel Angular Pressing: *Matthias Hockauf*[1]; Lothar W. Meyer[1]; Daniela Nickel[1]; Gert Alisch[1]; Thomas Lampke[1]; Bernhard Wielage[1]; Lutz Krüger[2]; [1]Chemnitz University of Technology; [2]Technische Universität Bergakademie Freiberg

The mechanical properties and corrosion behaviour of AA6082 with ultrafine-grained (UFG) microstructure are investigated and compared with the coarse grained (CG) AA6056 with much higher Cu-content that has been increasingly used for automotive applications. The AA6082 was processed by equal channel angular pressing (ECAP) up to eight extrusions at room temperature in a die with an internal angle of 90° following Route E with active backpressure. Besides the peak-aged temper, which gave maximum strengths and strongly reduced ductility, the solution heat treated condition was considered as well. Combined with post-ECAP ageing, an optimum of high strength, ductility and toughness was achieved. Polarisation tests showed a slightly more positive corrosion potential for the UFG-conditions compared to the CG counterparts. The results indicate that UFG low-Cu Al-alloys like AA6082 are capable to replace Cu-containing Al-alloys like AA6056 for applications in automotive industry, for example in high strength screws.

Low Temperature Mechanical Properties of the Ultra-Fine Grained Zirconium: *Elena Tabachnikova*[1]; Aleksey Podolskiy[1]; Vladimir Bengus[1]; Sergey Smirnov[1]; Vladimir Azhazha[2]; Mikhail Tikhonovsky[2]; A. Velikodniy[2]; Natalia Andrievskaya[2]; [1]B.Verkin Institute for Low Temperature Physics and Engineering of the National Academy of Sciences of Ukraine; [2]National Science Center Kharkov Institute of Physics and Technology

Mechanical behavior of the ultra-fine grained zirconium has been investigated in uniaxial compression at temperatures 300, 170, 77, and 4.2 K. Mechanical characteristics have been compared for the different structural states of Zr: initial coarse-grained state (CG) with grain size 20 μm; ultra-fine grained state (UFG) with grain size 0.5 μm, produced by extrusion, thermal treatment and wire drawing; and another ultra-fine grained state (UFG+Term), produced

analogously to state UFG, but with additional annealing (grain size 0.5 μm). It has been established that values of yield stress of ultra-fine grained Zr (UFG state) are 4-6 times larger at all temperatures in comparison with initial coarse-grained structural state. Additional annealing (UFG+Term state) leads to small decrease of strength values (3–20%) due to reduction of internal stresses in ultra-fine grained Zr. All structural states of Zr have rather large plasticity (10-20%).

Microstructural Refinement of Bismuth-Antimony Alloy by Severe Plastic Deformation Processing: K. Hartwig[1]; *Jae-Taek Im*[1]; Jeff Sharp[2]; [1]Texas A&M University; [2]Marlow Industries, Inc.

Cast bismuth (Bi) antimony (Sb) alloy was deformed by equal channel angular extrusion (ECAE) to refine the microstructure. The material under study is used in thermoelectric cooling applications, and the objective of the study was to improve the thermoelectric figure of merit and mechanical properties by grain refinement. In the work reported, twelve millimeter diameter bars of Bi10Sb were encapsulated in square cross section aluminum 6061 alloy containers and heated to the processing temperature. The composite bars were then placed in a warm tool and extruded through a 90 degree angle die isothermally. Processing variables included punch speed, extrusion temperature, multipass route and exit channel area reduction ratio. Post extrusion material characterizations included optical microscopy, x-ray diffraction, energy dispersive spectroscopy, wavelength dispersive spectroscopy and scanning electron microscopy. Texture evolution was analyzed using the {006} reflection plane to identify the orientation of the basal poles. The cast microstructure was equiaxed, had a nominal grain size of one to three millimeters, and showed substantial microsegregation. Severe plastic deformation above the recrystallization temperature is shown to break down the cast grains into a bimodal microstructure consisting of fine-grained (5-30 micron) and coarse-grained (50-300 micron) regions. It is noteworthy that further grain refinement and the elimination of the bimodal microstructure do not progress rapidly beyond the first pass. Texture results show that route C processing gives a stronger texture than route A processing, and that in both cases, the basal-plane poles become aligned with the shear direction. Reducing the exit channel area is seen to encourage a much stronger texture than ECAE processing alone.

Processing and Ballistic Performances of Lightweight Armors Based on Ultra-Fine-Grain Aluminum Composites: *Timothy Lin*[1]; Fei Zhou[1]; Quan Yan[1]; Chufu Tan[1]; Bob Liu[1]; Adolphus McDonald[2]; [1]Aegis Technology Inc.; [2]U.S. Army Aviation and Missile Command

Over last few decades Al-based metal matrix composites (MMCs) have become a promising material of choice for lightweight armors in vehicles. Recent development in ultra-fine-grain (UFG) and nanostructured material technology provides a new opportunity for the substantial strength enhancement of MMCs unattainable with the conventional microstructure of microscale, leading to significant weight reduction in armor packages. In this paper, Aegis Technology will present its latest development of a novel class of nanostructured metal Matrix composites (NMMCs) based on submicron SiC particulates reinforced nanocrystalline Al alloys, which is sponsored through an U.S. Army Small Business Innovative Research (SBIR) project. In this project, Aegis has successfully demonstrated the fabrication of large-dimension NMMCs plates by using a cost-effective synthesis and consolidation process that can be scaled up for the mass production. In this presentation, Aegis will report the microstructure, processing, mechanical properties and their correlations of this class of NMMCs. Particularly Aegis will present a detail investigation of the ballistic behaviors of the NMMCs under high-speed bullets of rifle and machine guns, in which a physical model and the associated simulation have been also developed to predict the penetration depth and identify the key influential parameters.

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