

1997 TMS Fall Extraction  
& Processing Conference

# The Julian Szekely Memorial Symposium on Materials Processing

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October 5-8, 1997  
Massachusetts Institute of Technology  
Cambridge, Massachusetts

**FINAL  
PROGRAM**



Sponsored by:



**TMS**  
Minerals • Metals • Materials



# Symposium Schedule of Events

## Sunday, October 5, 1997

Registration ..... Royal Sonesta Hotel ..... 4:00PM-7:00PM  
Welcoming Reception ..... Royal Sonesta Hotel ..... 6:45PM-7:45PM

## Monday, October 6, 1997

Registration ..... Kresge Auditorium Lobby ..... 7:00AM-5:00PM  
Authors' Coffee ..... Kresge Auditorium ..... 7:00AM-8:00AM  
Slide Preview Area ..... Kresge Auditorium ..... 7:00AM-5:00PM  
Symposium Opening ..... Kresge Little Theater ..... 8:35AM  
Session 1: Gas-Solid Reactions ..... Kresge Little Theater ..... 8:45AM-12:00 PM  
Symposium Luncheon ..... Compton Center ..... 12:15PM-1:45PM  
Session 2: Ironmaking and Steelmaking ... Kresge Little Theater ..... 2:00PM-5:15PM  
Poster Session—Group #1 ..... Kresge Little Theater ..... 5:15PM-6:00PM

## Tuesday, October 7, 1997

Registration ..... Kresge Auditorium Lobby ..... 7:00AM-5:00PM  
Authors' Coffee ..... Kresge Auditorium ..... 7:00AM-8:00AM  
Slide Preview Area ..... Kresge Auditorium ..... 7:00AM-5:00PM  
Session 3: Molten Metal Processing ..... Kresge Little Theater ..... 8:45AM-12:00PM  
Poster Session—Group #2 ..... Kresge Little Theater ..... 12:00PM-1:50PM  
Session 4: Solidification ..... Kresge Little Theater ..... 1:50PM-5:00PM  
Symposium Dinner ..... Museum of Fine Arts ..... 6:00PM-9:00PM

## Wednesday, October 8, 1997

Registration ..... Kresge Auditorium Lobby ..... 7:00AM-5:00PM  
Authors' Coffee ..... Kresge Auditorium ..... 7:00AM-8:00AM  
Slide Preview Area ..... Kresge Auditorium ..... 7:00AM-1:00PM  
Session 5: Plasma Processing ..... Kresge Little Theater ..... 8:45AM-12:00PM  
Poster Session—Group #3 ..... Kresge Little Theater ..... 12:00PM-1:50PM  
Session 6: Economic Modeling  
and Industrial Ecology ..... Kresge Little Theater ..... 1:50PM-5:00PM

### THE JULIAN SZEKELY MEMORIAL SYMPOSIUM

## ATTENTION: TMS NON-MEMBER ATTENDEES

Welcome! If you attend The Julian Szekely Memorial Symposium as a non-member of TMS and pay the non-member registration fee, TMS will be pleased to offer you a complimentary one-year introductory associate membership for 1998 (including the remainder of 1997, as well)! Associate members receive the same benefits as members, including a subscription to *JOM*, discounts on TMS publications and meeting fees, inclusion in, and access to, the TMS Membership Directory on TMS OnLine via the World Wide Web, plus an array of other personalized membership benefits and services.

You will receive your membership card very shortly, along with a postal card asking for additional vital information for our records, such as birthdate, education, and work experience.

Your associate membership will be activated upon completion of your registration form and payment of the non-member registration fee. If you have any questions, please contact the TMS Member Services Department at 412/776-9000 Ext. 213 or 215.

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## GENERAL INFORMATION

### Dates and Location

The 1997 TMS Fall Extraction & Processing Conference, "The Julian Szekely Memorial Symposium on Materials Processing," will be held October 5-8, 1997 at the Royal Sonesta Hotel and Massachusetts Institute of Technology, Cambridge, Massachusetts.

### Scope

This symposium is being held to recognize Professor Szekely's many contributions to the field of materials processing and to provide an opportunity for specialists to present invited papers in the topic areas of solidification/crystal growth, gas-solid reactions, molten metal processing, plasma processing, iron and steel making, economic modeling, industrial ecology and other technologies impacted by the work of Professor Julian Szekely.

### Program

A complete at-meeting program with a listing of the technical program symposium schedule, will be distributed to all registrants on-site. All full conference registrants will also receive a copy of the proceedings.

### Technical Sessions

The technical program will commence on Monday October 6, 1997. Sessions will be held at the Massachusetts Institute of Technology. Session and paper titles are included in this brochure.

### POLICY ON AUDIO & VIDEO RECRDING OF TECHNICAL PAPER PRESENTATIONS/SESSIONS

The Minerals, Metals & Materials Society (TMS) reserves the right to any audio and video reproduction of all presentation at every TMS sponsored meeting. Recording of sessions (audio, video, still photography etc.) intended for personal use, distribution or copyright without the express

# GENERAL INFORMATION

Dates and Location

Scope

Program

Technical Sessions

Policy on AV

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written consent of TMS and the individual author is strictly prohibited. Contact the TMS Technical Program Department in advance to obtain a copy of the waiver release form.

#### **Conference Proceedings**

A proceedings volume, containing papers from oral presentations and abstracts from poster presentations, will be published and available at the meeting. One copy is included in the registration fee.

#### **Symposium Co-Sponsors**

Sponsored by the Extraction & Processing Division and Light Metals Division of the Minerals, Metals & Materials Society (TMS), the Massachusetts Institute of Technology (MIT), and the Iron & Steel Society (ISS).

#### **Symposium Registration**

Registration fee includes admission to all technical sessions, the Sunday Welcoming Reception, Monday Symposium Luncheon, Tuesday Reception & Banquet at the Museum of Fine Arts, coffee breaks and a bound copy of the symposium proceedings.

#### **Registration**

Sunday, Oct. 5 ..... 4:00PM-7:00PM/Royal Sonesta Hotel  
Monday, Oct. 6 ..... 7:00AM-5:00PM/MIT  
Tuesday, Oct. 7 ..... 7:00AM-5:00PM/MIT  
Wednesday, Oct. 8 ..... 7:00AM-12:00noon/MIT

#### **Authors Coffee**

Monday through Wednesday, authors and session chairmen will meet in the Kresge Auditorium from 7:00AM-8:00AM. All authors and session chairmen are strongly urged to attend **on the day of their presentation**. Please refer to the Symposium Schedule of Events for times and days of presentations.

#### **Slide Preview Area**

Authors are invited to preview their slides at the slide Preview Area located in the Kresge Auditorium during the following hours:

Monday, October 6      7:00AM-5:00PM  
Tuesday, October 7      7:00AM-5:00PM  
Wednesday, October 8    7:00AM-1:00PM

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**Cooperating Societies**

Academia Mexicana de Ciencia de Materiales  
The Australasian Institute of Mining & Metallurgy  
CIM/Canadian Institute of Mining & Metallurgy  
Hungarian Mining and Metallurgical Society (OMBKE)  
Institute of Mining & Metallurgy  
The Iron & Steel Institute of Japan  
Japan Institute of Metals  
The Korean Institute of Metals and Materials  
The Mining and Materials Processing Institute of Japan  
The Nonferrous Metals Society of China  
Societe Francaise de Metallurgie et de Materiaux  
The South African Institute of Mining & Metallurgy

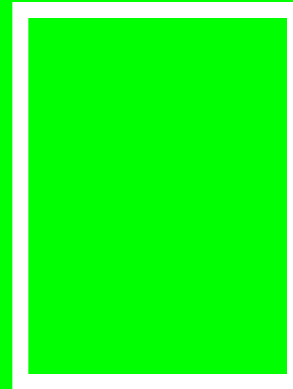
**General Meeting Chairmen**

Professor James W. Evans, Chancellor's Professor  
Department of Materials Science &  
Minerals Engineering  
University of California, Berkeley, CA 94720  
Telephone: (510) 642-3807  
Fax: (510) 642-9164  
e-mail: evans@socrates.berkeley.edu

Professor Diran Apelian  
Howmet Professor of Engineering  
Metal Processing Institute  
Worcester Polytechnic Institute  
Worcester, MA 01609-2280  
Telephone: (508) 831-5992  
Fax: (508) 831-5993  
e-mail: dapelian@wpi.edu

**Program Chairman**

Professor Hong Yong Sohn  
University of Utah Department  
of Metallurgical Engineering  
412 Browning Bldg.  
Salt Lake City, UT 84112-0114  
Telephone: (801) 581-5491  
Fax: (801) 581-4937  
e-mail: hysohn@mines.utah.edu



Conference  
Proceedings

Symposium  
Co-Sponsors

Cooperating Societies

General Meeting  
Chairmen

Program Chairman

Symposium  
Registration

Authors Coffee

Slide Preview Area

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**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 this act, we ask that those attendees requiring specific equipment or services indicate by checking the box on the enclosed housing form.

**Social Functions**

Various social functions have been planned to supplement the formal technical program.

These functions are included in the registration fee for full -conference registrants. Tickets for students and accompanying persons may be purchased at the conference registration desk. Welcoming Reception is complimentary to all attendees students and guest.

**Welcoming Reception**

All attendees, students and guests are invited to attend a hosted Welcoming Reception on Sunday, October 5, from 6:45PM-7:45PM at the Royal Sonesta Hotel.

**Symposium Luncheon**

For the convenience of attendees during the limited break time for lunch on Monday, October 6, a luncheon is included in the full conference registration fee. The cost of luncheon for students and guests is \$20 and may be purchased at the Registration desk.

**Symposium Dinner**

On Tuesday, October 7 MIT and the organizers of the conference will host a Reception/Dinner at the Museum of Fine Arts from 6:00PM - 9:00PM. The Koch Gallery, Upper and Lower Rotunda of the Museum have been reserved for the conference's exclusive use. Attendees will have access to Chinese Sculpture and Himalayan galleries as well as the entire European Paintings Collection. The Museum of Fine Arts is located at 465 Huntington Avenue, Boston, Massachusetts.

**Symposium Dinner Speaker**

Dr. William F. ("Gus") Porter  
President  
Connecticut Steel

*The organizers of the Symposium wish to acknowledge and thank the contributors to the Julian Szekely Memorial Symposium and Fellowship, they are:*

Texas Industries, Inc. TX1

Intel Foundation

Nucor Corporation

American Iron and Steel  
Institute

Kawasaki Steel Corporation

HYSLA Corporation

Allegheny Teledyne Inc.

Nippon Steel Corporation

DOFASCO (Canadian  
Company)

Department of Materials  
Science & Engineering  
MIT

Materials Processing  
Laboratory MIT

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**Monday, AM**

**Session 1: Gas-Solid Reactions**

*Organized by:* H.Y. Sohn, Dept of Metallurgical Engineering, University of Utah, Salt Lake City, Utah 84112, USA

*Session Chairmen:* H.Y. Sohn, Dept of Metallurgical Engineering, University of Utah, Salt Lake City, Utah 84112, USA; J.W. Evans, Dept. of Materials Science & Mineral Engineering, University of California, Berkeley, California 94720, USA

**8:45 am Opening Remarks**

**8:50 am**

**Developments in Gas-Solid Reaction Analysis:** *H.Y. Sohn*, Dept. of Metallurgical Engineering, University of Utah, 412 Browning Bldg., Salt Lake City, Utah 84112-0114, USA

**9:15 am**

**Kinetic Analyses on the Rate of Gaseous Reduction of Single Particles and Packed Beds of Iron Ore Agglomerates:** *T. Usui*, M. Ohmi, M. Naito, H. Kamiya, Y. Oshima, and Z.-I. Morita, Dept. of Materials Science & Processing, Osaka University, Osaka, 565, Japan

**9:40 am**

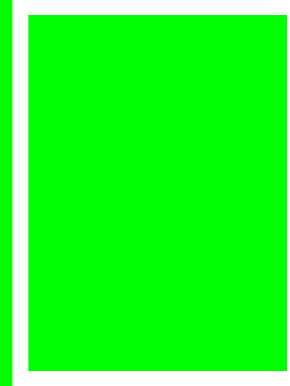
**Numerical Analysis of a Moving Bed Reactor for Iron Scrap Melting:** *J.-I. Yagi*, T. Akiyama, and X. Zhang, Institute for Advance Materials Processing, Tohoku University, Sendai, 980-77 Japan

**10:05 am**

**Kinetics of Chromite Reduction with Carbon:** *R.G. Reddy* and M.V. Klein, University of Alabama, Dept. of Metal and Materials Engineering, A-129 Beville Bldg., 126 7<sup>th</sup> St., P.O. Box 870202, Tuscaloosa, Alabama, 35487-0202, USA

**10:30 am Break**

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Americans with Disabilities Act

Social Functions

Welcoming Reception

Symposium Luncheon

Symposium Dinner

Technical Program  
**MONDAY AM**

**Session 1**

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**10:40 am**

**Gas-Solid Reactions in Thermal Plasma Environments: Synthesis of Non-Oxide Ceramic Powders:** *P.R. Taylor*, University of Idaho, Dept. of Metal Mining, McClure Hall #203B, Moscow, Idaho, 83844-3024, USA

**11:05 am**

**The Intrinsic Thermal Decomposition Kinetics of Some Alkaline-Earth Carbonates:** I. Arvanitidis, D. Sichen, H. Y. Sohn\*, and S. *Seetharaman*, Royal Institute of Technology, Dept. of Theoretical Metallurgy, Brinellv 23, Stockholm S-10044, Sweden; \*University of Utah, Dept. of Metallurgical Engineering, Salt Lake City, Utah, 84112, USA

**11:30 am**

**An Experimental Study of the Reaction of Sulfur Dioxide with Pyrrhotite Produced by Pyrolysis of Pyrite:** M. Dell'Amico, *W.J. Rankin*, and D.J. McCarthy, G.K. Williams Cooperative Research Centre for Extractive Metallurgy, CSIRO, Division of Minerals, PO Box 312, Clayton South, 3169 Australia

**12:00 pm-2:00 pm Luncheon Lectures**

**The Research of Professor Julian Szekely Prior to 1976:** *J.W. Evans*, Dept. of Materials Science & Mineral Engineering, University of California, Berkeley, California 94720, USA

**Professor Julian Szekely's Research: The MIT Years:** *E. Gutierrez-Miravete*, Rensselaer at Hartford, Dept. of Metallurgy, 275 Windsor St., Hartford, Connecticut 06120, USA

Session 2

MONDAY, PM

**Monday, PM**

**Session 2: Ironmaking and Steelmaking**

*Organized by:* J.K. Brimacombe, University of British Columbia, AMPEL, Room 112-2355 East Mall, Vancouver, B.C. Canada V6T 1Z4

*Session Chairmen:* J.K. Brimacombe, University of British Columbia, AMPEL, Room 112-2355 East Mall, Vancouver, B.C. Canada V6T 1Z4; T. Emi, Institute for Advanced Materials Processing, Tohoku University, 2-1-1 Katahira Aobaku, Sendai, 980-77, Japan

**2:00 pm Opening Remarks**

**2:05 pm**

**Infiltration of Coke and Other Carbons by Pyrolysis of Methane and the Effects on Microstructure and Reactivity:** Y. Shigeno, *J.W. Evans*, and I. Yoh, Dept. of Materials Science & Mineral Engineering, University of California, Berkeley, California 94720, USA

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**2:35 pm**

**Fundamental Issues in Steel Refining:** R.J. Fruehan and A.W. Cramb, Carnegie Mellon University, 5000 Forbes Ave., Pittsburgh, Pennsylvania 15213, USA

**3:05 pm**

**Alloying, Refining, and Metal Quality Issues in Ladle Steelmaking Operations:**

R.I.L. Guthrie, McGill Metals Processing, McGill University, 3610 University St., M.H. Wong Engineering Bldg., Rm 2M051, Montreal, Quebec, Canada H38 2B2; and G.A. Irons, McMaster University, Dept. of Materials Science, 1280 Main St., Hamilton, Ontario, L8S 4L7, Canada

**3:35 pm Break**

**3:45 pm**

**Some Kinetic Phenomena at the Surface of Liquid Steel:** T. Emi, Institute for Advanced Materials Processing, Tohoku University, 2-1-1 Katahira Aobaku, Sendai, 980-77, Japan; G.R. Belton, BHP Co., P.O. Box 188, Wallsend, New South Wales, 2287, Australia

**4:15 pm**

**Steel Transfer Operations — Blessings in Disguise:** A. McLean, University of Toronto, Dept. of Metal and Materials Science, Toronto, Ontario, Canada M5S 3E4

**4:45 pm**

**The Frontiers of Continuous Casting and Mathematical Modeling:** I. V.

Samarasekera and J.K. Brimacombe, University of British Columbia, 6350 Stores Rd. #309, Center for Met. Process Eng., Vancouver, B.C., V6T 1W5, Canada

**5:15-6:00 pm**

**Poster Session—Group #1**

**Thermodynamic Assessment of the Al and Mg Deoxidation Reactions in Liquid**

**Iron:** J.-D. Seo, S.-H Kim, Dept. of Materials Science and Engineering, POSTECH, Pohang 790-784, Korea

**Gas Inclusions Separation and Removal from Liquid Steels:** V.F. Chevrier, A.W.

Cramb, Department of Materials Science and Engineering, Carnegie Mellon University, Pittsburgh, Pennsylvania 15213

**Modeling Activities in Steelmaking at MEFOS:** Lage Jonsson<sup>1</sup>, Par Jonsson<sup>2</sup>, Henrik

Solhed<sup>1</sup>, Jonas Alexis<sup>1</sup>, <sup>1</sup>MEFOS, Lulca, Sweden; <sup>2</sup>Ovako Steel AB, Hofors, Sweden

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**Tuesday, AM****Session 3: Molten Metal Processing**

*Organized by:* N.H. El-Kaddah, Univ. of Alabama, Dept. of Metallurgical Eng., Box 870202, Tuscaloosa, Alabama 35487-0202, USA

*Session Chairmen:* N.H. El-Kaddah, Univ. of Alabama; Dept. of Metallurgical Eng., Box 870202, Tuscaloosa, Alabama 35487-0202; M.K. Choudhary, Owens Corning Science & Technology, Tech. Center 20-2, 2790 Columbus Rd., Granville, Ohio 43023-1200, USA

**8:45 am Openings Remarks****8:50 am**

**Actual and Future Developments of Electromagnetic Processing of Materials:** *M. Garnier*, EPM-CNRS, BP 95, Saint Martin d'Herès 38402 Cedex, France

**9:20 am**

**Mathematical Modeling of Flow and Heat Transfer Phenomena in Electric Glass Melting Furnaces:** *M. K. Choudhary*, Owens Corning Science & Technology, Owens Corning Science & Technology, Tech. Center 20-2, 2790 Columbus Rd., Granville, Ohio, 43023-1200, USA

**9:50 am**

**Recent Activities on Electromagnetic Processing of Materials:** *S. Asai*, Nagoya University, Dept. of Materials Proc. Engineering, Furo-Cho, Chikusa-Ku, Nagoya, Aichi 464-1, Japan

**10:20 am Break****10:30 am**

**Stirring and Mass Transfer in a Mercury Coreless Induction Furnace:** *Y. Fautrelle*, F. Debray\*, Ecole Nationale EPM-MADY INPG/ENSHD, BP95, 38402 St. Martin d'Herès, Cedex, France; \*LCMI-CNRS, 25 Av. De Martyrs, 38000 Grenoble, France

**11:00 am**

**Mathematical Modeling of Geometry, Composition, and Structure of Welds:** *T. DebRoy*, Pennsylvania State University, Dept. of Materials Science & Eng., 212 Steidle Bldg., University Park, Pennsylvania, 16802 USA

**11:30 am**

**Modeling of Electromagnetic, Fluid Flow, and Heat Transfer in Materials Processing:** *N. El-Kaddah*, Univ. of Alabama, Dept. of Metallurgical Eng., Box 870202, Tuscaloosa, Alabama 35487-0202, USA

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**12:00 pm-1:50 pm Lunch**  
**Poster Session—Group #2**

**An Improved Simulation of Internal Flow in Electromagnetically-Levitated Liquid Metal Droplets:** S. Berry<sup>1</sup>, R.W. Hyers<sup>2</sup>, L.M. Racz<sup>1</sup>, B. Abedian<sup>1</sup>, <sup>1</sup>Tufts University Department of Mechanical Engineering, Medford, Massachusetts;<sup>2</sup>M.I.T., Department of Materials Science and Engineering, Cambridge, Massachusetts 02139, USA

**Particle Image Velocimetry in the Physical Modeling of the Casting of Steel and Aluminum:** D. Xu, W.K. Jones, Jr., J.W. Evans, Dept. of Materials Science and Mineral Engineering, University of California, Berkeley, California 94720, USA

**Measurement of Bubbles in Aluminum by Means of a Capacitance Probe and the Removal of Magnesium by Gas Fluxing:** Q. Fu, J.W. Evans, Dept. of Materials Science and Mineral Engineering, University of California, Berkeley, California 94720, USA

**Transport Phenomena in Electron Beam Melting and Evaporation:** A.C. Powell, M.I.T., 77 Massachusetts Ave., Cambridge, Massachusetts 02139, USA

**Modelling Solder Joint Formation in Electronic Packaging:** C. Bailey, D. Wheeler, M. Cross, Centre for Numerical Modeling and Process Analysis, University of Greenwich, Wellington St., London SE18 6PF, England

**A Model of Magnetic Semi-Levitation of Liquid Metals:** V. Bojarevics, K. Pericleous, M. Cross, Centre for Numerical Modeling and Process Analysis, University of Greenwich, Wellington St., London SE18 6PF, England

**Comparison of Two Thermal Insulators for a Riser Using Numerical Simulation:** F. Kavicka and J. Brhel, B. Sekanina, Technical University of Brno, College of Mechanical Engineering, Technicka 2, 616 69 Brno, Czech Republic; J.M. Khodadadi, Dept. of Mechanical Engineering, Auburn University, 201 Ross Hall, Auburn, Alabama 36849-5341, USA

**Effect of Buoyancy-Driven Convection on Melting of a Liquid Metal Droplet:** Y. Zhang, J.M. Khodadadi, Dept. of Mechanical Engineering, Auburn University, 201 Ross Hall, Auburn, Alabama 36849-5341, USA; F. Kavicka, Technical University of Brno, College of Mechanical Engineering, Technicka 2, 616 69 Brno, Czech Republic

**Applications of Free Surface CFD Simulation in the Materials Processing Industries:** Gerald P. Backer, 24249 Tamarack Circle, Southfield, Michigan 48075, USA

**Modeling Free Surface Problems in Polymer Molding Operations:** V. Voller, Dept. Civil Engineering, University of Minnesota, 500 Pillsbury Dr., Minneapolis, Minnesota 55455, USA

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**Numerical Heat and Fluid Flow Analysis of Continuous Slag/Matte Separation in Mitsubishi Copper Process:** S. Okabe, A. Kaneda, Mitsubishi Materials Corporation, Materials Research Laboratories, Central Research Institute, 1-297 Kitabukuro-cho, Omiya, Saitama 330, Japan

Session 4

TUESDAY, PM

**Tuesday, PM**

**Session 4: Solidification**

*Organized by:* M.C. Flemings, MIT, Bldg. 8-407, 77 Massachusetts Ave., Cambridge, Massachusetts 02139-4307

*Session Chairmen:* M.C. Flemings, MIT, Bldg. 8-407, 77 Massachusetts Ave., Cambridge, Massachusetts 02139-4307; D. Apelian, Metal Processing Institute, WPI, 100 Institute Rd., Worcester, Massachusetts, 01609-2280

**1:50 pm Opening Remarks**

**1:55 pm**

**Microsegregation in Slabs Caused by Thickness Reduction during Solidification:** H. Eisermann, K. Schwerdtfeger, Institut für Allgemeine Metallurgie, Technical University Clausthal, Robert Koch Str. 42, D-38678, Clausthal-Zellerfeld, Germany

**2:25 pm**

**Simulation of Transport Phenomena in Directionally Solidified Castings:** *D.R. Poirier, J.C. Heinrich, and S.D. Felicelli\**, Dept. of Aerospace & Mechanical Engineering, University of Arizona, Tucson, Arizona 85721, USA; \*Centro Atomico Bariloche, Rio Negro, Argentina

**2:55 pm**

**Applications of Mathematical Models in Solidification:** *J.A. Dantzig*, University of Illinois, Dept. of Mechanical & Industrial Eng., 1206 W. Green St., Urbana, Illinois, 61801, USA

**3:25 pm Break**

**3:35 pm**

**Spray Forming Using a Linear Nozzle Microstructure Analysis and Deposit Thermal Modeling:** *M.G. Chu and S.J. Pien*, Alcoa Technical Center, Alcoa Center, 100 Technical Dr., Pennsylvania, 15069, USA

**4:05 pm**

**A Physical Model of Feeding during Solidification of Aluminum Casting Alloys:** *D. Apelian and A. Alexandrou*, WPI, Worcester, 100 Institute Rd., Worcester, Massachusetts, 01609-2280 USA

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**4:35 pm**

**Analysis of Fluid Flow and Solidification under Microgravity Conditions:** G. Trapaga, D.M. Matson, B.W. Hyers, and M.C. Flemings, MIT, Room 8-101, 77 Massachusetts Ave., Cambridge, Massachusetts 02139, USA

**Wednesday, AM**

**Session 5: Plasma Processing**

*Organized by:* P. Fauchais, Univ. de Limoges, 123 Ave. Albert-Thomas, Limoges 87060, France  
*Session Chairmen:* P. Fauchais, Univ. de Limoges, 123 Ave. Albert-Thomas, Limoges 87060, France; P.R. Taylor, University of Idaho, Dept. of Met. & Mining, McClure Hall #203B, Moscow, Idaho 83844-3024, USA

**TUESDAY, AM**

**Session 5**

**8:45 am Opening Remarks**

**8:50 am**

**Heat Transfer in Thermal Plasmas:** E. Pfender, Dept. of Mechanical Engineering, University of Minnesota, Minneapolis, Minnesota, 55455-0111 USA

**9:20 am**

**Mathematical Modelling of Plasma Systems:** M.I. Boulos, University of Sherbrooke, Dept. of Chemical Eng., Sherbrooke, Quebec J1K 2R1, Canada

**9:50 am**

**Measured and Simulated Particle Flow Field Characteristics in a High Swirl, Supersonic Plasma Spray:** J.R. Fincke, C.H. Chang, W. D. Swank, and D. C. Haggard, INEL, PO Box 1625, Idaho Falls, Idaho 83412-2211 USA

**10:20 am Break**

**10:30 am**

**The High Current D.C. Arc in Extractive Metallurgy:** T.R. Curr, MINTEK, Private Bag X3015, Randburg, 2125 South Africa

**11:00 am**

**Waste Treatment in Plasma Vitrification Reactor:** S.V. Dighe, D.L. Keairns, and D.F. McLaughlin, Westinghouse Electric Corp., 1310 Beulah Road, Pittsburgh, Pennsylvania 15235-5098 USA

**11:30 am**

**Plasma Spraying:** P. Fauchais, Universit, de Limoges, 123 Ave. Albert-Thomas, Limoges Cedex 87060, France

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12:00 pm-1:50 pm Lunch  
Poster Session—Group #3

**Modeling Penetration and Free Surface Depression During High Current Arc Welding:** P.F. Mendez, M.I.T., M.I.T. Room NV-412, Cambridge, Massachusetts, USA 02139

**Modeling of Nitrogen Dissolution in the Weld Pool:** T.A. Palmer, T. DebRoy, Dept. of Materials Science and Engineering, The Pennsylvania State University, University Park, Pennsylvania 16802, USA

**Low Alloy Steel Weld Microstructure Prediction from Fundamentals of Transport Phenomena and Phase Transformation Theory:** Z. Yang, Dept. of Materials Science and Engineering, The Pennsylvania State University, University Park, Pennsylvania 16802, USA

**Temperature Gyration during the Life Cycle of Oxide Inclusions in a Weld Pool:** T. Hong, T. DebRoy, Dept. of Materials Science and Engineering, The Pennsylvania State University, University Park, Pennsylvania 16802, USA

**The Simulation of Metal Cycles for Sustainable and Ecologically Friendly Metal Production:** M.A. Reuter, F. Severens, J.P. van Hall, E. Tempelman, J. Vileneauve\*, Faculty of Applied Earth Sciences, TU Delft, Mijnbouwstraat 120, 2628RX Delft, The Netherlands; \*BRGM, Avenue C. Guillemin, F-45060 Orleans Cedex 2, France

**Technical and Cost Analysis of a high Pressure Die Casting Operation for the Fabrication of Aluminum Automotive Parts:** F. Faura, J. Lopez, R. Zamora, Dpto. De Ingenieria de Materiales y Fabricacion, Escuela Technica Superior de Ingenieros Industriales, Universidad de Murcia, Alfonso XIII, 42. 30203 Cartagena, Spain

Session 6

WEDNESDAY, PM

**Wednesday, PM**

**Session 6: Economic Modeling and Industrial Ecology**  
*Organized by:* J.P. Clark, MIT, Dept. of Materials Science & Eng., 413 Bldg 8, Cambridge, Massachusetts, USA 02139

*Session Chairmen:* J.P. Clark, Dept. of Materials Science & Eng., MIT, 413 Bldg 8, Cambridge, Massachusetts, USA 02139; N.J. Themelis, Columbia University, Henry Krumb School of Mines, Mineral Eng., 500 W. 120<sup>th</sup> St., 1047 Mudd Bldg, New York, New York 10027, USA

1:50 pm Opening Remarks

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**1:55 pm**

**The Application of Quantitative Modeling Techniques to the Problems of New**

**Business Development:** *J. Busch*, Ravi Bhatkal, IBIS Associates, 55 Williams St., Suite 220, Wellesley, Massachusetts 02181, USA

**2:25 pm**

**Metal Production and Greenhouse Gases:** *N.J. Themelis*, I.K. Wernick\*, Columbia University, Henry Krumb School of Mines, Mineral Eng., 500 W. 120<sup>th</sup> St., 1047 Mudd Bldg, New York, New York 10027, USA; \*Columbia Earth Institute, 40E Low Library, Columbia University, New York, New York, 10027, USA

**2:55 pm**

**Economic Model of Recycling of Automobile Body Engineered Scrap:** *F.R. Tuler*, Cambridge Technology Center, 3 Cambridge Center, Cambridge, Massachusetts 02142-1613, USA

**3:25 pm Break**

**3:35 pm**

**Economic Analysis of Alternative Fabrication Approaches for Advanced Structural Silicon Nitride Ceramics:** *J.M. Schoenung*, H. Tuazon, M. Santos, R. Masseth, Dept. of Chemistry and Materials Engineering, California State Polytechnic University, 3801 W. Temple Avenue, Pomona, California 91768 USA; B. Draskovich, Allied Signal Ceramic Components, Torrance, California, USA; A. Mascarin, IBIS Associates, Inc., Wellesley, Massachusetts, USA

**4:05 pm**

**Manufacturing Cost Estimation of Large Processing Systems:** *R. Kirchain* and F. Field, MIT, Materials Systems Laboratory, CTTID Room E40-212, Cambridge, Massachusetts, 02139, USA

**4:35 pm**

**Effect of Vehicle Lightweighting on the Profitability of the Automobile Recycling Infrastructure:** *J.A. Isaacs* and S.M. Gupta, Dept of Mechanical, Industrial and Manufacturing Engineering, Northeastern University, 334 Snell Engineering Bldg., Boston, Massachusetts 02115 USA