

**Sohn
International
Symposium**

**ADVANCED PROCESSING OF
METALS AND MATERIALS**

**Thermo and
Physicochemical
Principles:
Iron and Steel
Making**

Volume 2

**Edited by
Florian Kongoli
Ramana G. Reddy**

TMS

Sohn International Symposium
ADVANCED PROCESSING OF METALS AND MATERIALS

Proceedings of the International Symposium
August 27-31, 2006
San Diego, California, USA

VOLUME 2

**THERMO AND PHYSICOCHEMICAL PRINCIPLES:
IRON AND STEEL MAKING**

Edited by

Florian KONGOLI
Ramana G. REDDY

Cover designed by **LEOGEN® Technologies Inc.**

A Publication of
TMS

A Publication of **TMS (The Minerals, Metals & Materials Society)**

184 Thorn Hill Road
Warrendale, Pennsylvania 15086-7528
(724) 776-9000

Visit the TMS web site at

<http://www.tms.org>

Statements of fact and opinion are the responsibility of the authors alone and do not imply an opinion on the part of the officers, staff, or members of TMS, The Minerals, Metals, and Materials Society. TMS assumes no responsibility for the statements and opinions advanced by the contributors to its publications or by the speakers at its programs. Registered names and trademarks, etc., used in this publication, even without specific indication thereof, are not to be considered unprotected by the law.

No part of this book may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, microfilming, recording, or otherwise, without written permission from the publisher.

Library of Congress 2006929284
ISBN Volume 2: 978-0-87339-635-6
ISBN Set: 978-0-87339-633-2

Authorization to photocopy for internal or personal use beyond the limits of Sections 107 and 108 of the U.S. Copyright Law is granted by TMS, provided that the base fee of \$7.00 per copy is paid directly to the Copyright Clearance Center, Inc., 222 Rosewood Drive, Danvers, MA 01923 USA, www.copyright.com. Prior to photocopying items for educational classroom use, please contact the Copyright Clearance Center, Inc.

For those organizations that have been granted a photocopy license by the Copyright Clearance Center, a separate system of payment has been arranged.

This consent does not extend to copying items for general distribution or for advertising or promotional purposes or to republishing items whole or in part in any work in any format.

Please direct republication or special copying permission requests to the Copyright Clearance Center, Inc., 222 Rosewood Drive, Danvers, MA 01923 USA; (978) 750-8400; www.copyright.com.

TMS

Copyright 2006, The Minerals, Metals, and
Materials Society. All rights reserved.

If you are interested in purchasing a copy of this book, or if you would like to receive the latest TMS publications catalog, please telephone (800) 759-4867 (U.S. only) or (724) 776-9000, EXT. 270.

Sohn International Symposium

ADVANCED PROCESSING OF METALS AND MATERIALS

VOLUME 2

**THERMO AND PHYSICOCHEMICAL PRINCIPLES:
IRON AND STEEL MAKING**

Sohn International Symposium
ADVANCED PROCESSING OF METALS AND MATERIALS
VOLUME 2: THERMO AND PHYSICOCHEMICAL PRINCIPLES:
IRON AND STEEL MAKING

Volume 2 Pricing:

TMS Member Price: \$147 TMS Student Member Price: \$116 List Price: \$209

9 Volume Set Pricing:

TMS Member Price: \$1,200 TMS Student Member Price: \$950 List Price: \$1,700

Related Titles

- **EPD Congress 2005 including Arsenic Metallurgy and Converter and Fire Refining Practices**
Edited by M. Schlesinger, R.G. Reddy, V. Ramachandran, A. Ross, T. Warner, and K. Scholey
- **EPD Congress 2006**
Edited by S. Howard, R.L. Stephens, C.J. Newman, J-Y.J. Hwang, A.M. Gokhale, T.T. Chen, T.P. Battle, M.L. Free, B.R. Davis, C.L. Harris, H. Henein, P.N. Anyalebechi, A.C. Powell, G.K. Krumdick, and C.K. Belt
- **Metallurgical and Materials Processing Principles and Technologies (Yazawa International Symposium)**
Edited by F. Kongoli, K. Itagaki, C. Yamauchi, and H.Y. Sohn
- **Flash Smelting: Analysis, Control, and Optimization (2nd Edition)**
Authored by W.G. Davenport, D.M. Jones, M.J. King, and E.H. Partelpoeg

HOW TO ORDER PUBLICATIONS

For a complete listing of TMS publication offerings, contact TMS for a free copy of the Publications@TMS catalog or visit the on-line TMS Document Center (<http://doc.tms.org>). Through the TMS Document Center, customers will find:

- An easy and convenient way to purchase publications
- Access to TMS member resources, such as the on-line version of *JOM* and *TMS Letters*
- In-depth publications information, including complete descriptions, tables of contents, and sample pages
- Award-winning landmark papers and re-issued out-of-print titles
- A vast selection of resources from which to compile customized publications that meet the customer's unique needs

MEMBER DISCOUNTS

Members of TMS (The Minerals, Metals & Materials Society) receive a 30% discount off list prices for all TMS publications. In addition, TMS members also receive free monthly subscriptions to the journals *JOM* (both in print and on-line formats) and *TMS Letters* (published exclusively in on-line format), discounts on meeting registrations, and more. To begin immediate savings on TMS publications and to receive additional member benefits, become a TMS member today. Fill out a membership application when placing a publication order at the on-line TMS Document Center (<http://doc.tms.org>) or contact TMS for more information:

- Phone: 1 (800) 759-4867 (within the U.S.) or (724) 776-9000 (elsewhere)
 - Fax: (724) 776-3770
 - E-mail: membership@tms.org or publications@tms.org
- Web: www.tms.org

FOREWORD

This international symposium is organized to honor the very distinguished work and lifetime achievements of Prof. H.Y. Sohn. Prof. Sohn is renowned for his impact in various fields such as non-ferrous, ferrous and nano-scale materials processing; in many processing routes including pyrometallurgy, hydrometallurgy, chemical vapor synthesis and processing and recycling; and in several investigation techniques such as experimental measurements and physical modeling and simulation. This symposium reflects this rich activity and covers the three equally important topical areas of **principles, technologies and industrial practice**.

The symposium was cosponsored by a record number of 104 Professional Organizations, Independent Publishers including 9 financial corporate cosponsors. It drew an overwhelming response from the international professional community. The 517 contributions received from all over the world made this symposium the biggest ever held in its class. Papers were sent by authors representing the following 52 countries: USA, Japan, China, Russia, Korea South, Australia, Canada, Turkey, Chile, India, Georgia, Mexico, Brazil, France, South Africa, Finland, Belgium, Germany, Argentina, Austria, Sweden, Great Britain, Norway, Albania, Egypt, Ukraine, Iran, Peru, Poland, Portugal, Czech Republic, England, Israel, Italy, Malaysia, Netherlands, Taiwan, Armenia, Bangladesh, Belarus, Bulgaria, Holland, Hungary, Indonesia, Nigeria, Serbia, Slovakia Republic, Slovenia, Spain, Switzerland, Venezuela, Zambia. (The order is according to the number of papers received). This record number of papers left us no option but to prepare 9 separate volumes totaling about 5,000 pages, classified according to the topical areas mentioned above although it should be noted that there is not a clear-cut classification. We believe that these volumes will be a useful contribution to the professional community worldwide.

We would like to express our appreciation to TMS successive Presidents Gregory Hildeman and Brajendra Mishra and successive TMS Executive Directors Alex Scott and Warren H. Hunt Jr. for their support and TMS staff for their help and dedication. In particular we would like to thank Christina Raabe, Michael Packard and Stephen J. Kendall for their continuous professional help as well as D. Steighner, B. Makowski, T. M. Osman, G. Miller, M. Boots, D. Prize, T. Dunlap, N. Commella, J. DeLuca, C. Wilson. We would also like to thank Professor Sohn's wife Mrs. Victoria (Bee Tuan Ngo) and their sons Berkeley Jihoon and Edward Jihyun for the cooperation.

Dr. Florian Kongoli would like to thank the Directors and staff of FLOGEN Technologies Inc. that not only sponsored financially the symposium but did the majority of the work. He wants to thank all the co-chairs of the symposium and especially Dr. Reddy for closer collaboration as well as all members of the international committees and authors. On a special note he wants to thank his wife Me. Migen Dibra for organizing a very interesting legal session and for graciously supporting him at a time when she was herself extremely busy working as a lawyer for a judge of the Quebec Court of Appeal. He also wants to thank his 6-year old son, Mr. Davis Kongoli, for forgiving the time that daddy was not staying with him as usual and his grand mother Madam Dibra for the help given during the extra hours of work dedicated to this symposium and proceedings.

Dr. Ramana G. Reddy wants to particularly thank the Chair of the symposium Dr. Florian Kongoli, whose leadership made this symposium in honor of Prof. Sohn such a big success. He also wants to thank both his wife, Mrs. Ramadevi Reddy, and his son, Mr. Bharat Reddy, for their continuous help and support.



Dr. Florian Kongoli
Executive President
(CEO)
FLOGEN® Technologies Inc.
Montreal QC, Canada
Wilmington, DE, USA



Dr. Ramana G. Reddy
ACIPCO Professor and Associate Director
Center for Green Manufacturing
Dept. of Metallurgical and Materials Engineering
The University of Alabama
Tuscaloosa, Alabama, USA

EDITORS' BIOGRAPHIES

Dr. Florian Kongoli

Dr. Florian Kongoli, [BSc (Honors), MScA (Canada), PhD (Japan)/ MTMS, MCIM, MSME, MAIST, MSigmaXi, MIFAC, MACS] is **CEO** of FLOGEN Technologies Inc., a new technology product company, independently incorporated in Canada and USA, specialized among others in the process and furnace control, optimization and automation as well as in developing low cost technologies for metallurgical, chemical and environmental industries through original physical modeling and simulation and experimental measurements.

He has **about 18 years** of research and development and academic (lecturer) experience spread in many long time invited engagements in several continents, such as in **Australia, Europe, North America, South America and Asia**. He has a rich research background in both **pure and industry sponsored research** dealing with the control, optimization and automation of furnaces, processes and flowsheets; physical and thermochemical modeling; physicochemical properties of mattes, slags, metals, gases, oxysulfides etc. He has worked and successfully carried out many industrial projects for more than 47 well-known metallurgical and chemical companies such as **Mitsubishi Materials Corporation and Sumitomo Metal Mining (Japan), Falconbridge (Canada), Western Mining Corporation (Australia)**, to mention just a few. In his pure research work he has worked and cooperated with several well-known universities around the world such as **Tohoku University (Japan), Curtin University (Australia), University of Montreal (Canada)**, etc. His work is oriented among others in developing new low cost technologies for process and furnace control through physical and physicochemical modeling, simulation and laboratory experimental studies applicable in various metallurgical, chemical and environmental processes in both non-ferrous (Ni, Cu, Zn, Pb, Fe-Ni, Fe-Cr, PGMs, etc.) extraction and processing as well as in iron and steel making and processing.

Dr. Kongoli has published **4 books** and about **50 scientific articles** in the last 5 years in peer review journals and other publications dealing with furnace control, optimization and automation, novel technological applications, modeling of various properties of industrial mattes, slags, metals, liquidus temperature, phase diagrams, effect of minor components, fluxing strategies, etc. He has delivered in 19 countries around the world about **130 plenary, keynote and invited presentations as well as articles, technical reports and research presentations**. The results of his work and some of his databases have been used by several companies around the world. He has also taught several continuing education/short courses including **"Sulfide Smelting: Principles, Technologies and Environmental Considerations"** held in San Diego, CA, 2003.

He has served in many **leadership positions** in national and international organizations. He has been and actually is Chair/Vice-Chair/member of about **20 professional society committees** and has been a chair of about **15 technical sessions**. He is **Editorial Board member** of European Journal of Mineral Processing and Environmental Protection and the Minerals and Metallurgical Processing Journal and a peer reviewer of articles in various professional journals. He has organized several major successful International Symposiums during the last years and has been member of Organizing Committees or Scientific Committees of about a **dozen** of Professional International conferences.

He has excellent business management and organizations skills which have been instrumental in steering his company toward new ground breaking technologies.

Dr. Ramana G. Reddy

Dr. R. G. Reddy is an **ACIPCO Professor** of Department of Metallurgical and Materials Engineering and **Associate Director** of Center for Green Manufacturing at The University of Alabama, Tuscaloosa, Alabama. His academic and research work experiences include: **Professor and Chairman** of the Department of Chemical and Metallurgical Engineering at University of Nevada, Reno; **Visiting Researcher** at Lawrence Berkeley Laboratory, Berkeley; Indian Institute of Technology, Bombay; and Argonne National Laboratory, Chicago.

Professor Reddy has over **25 years of teaching and research experience** in the field of chemical and materials engineering. He obtained his Ph.D. degree from the University of Utah. He has conducted projects involving **thermodynamics and kinetics** of metallurgical reactions; plasma processing of materials, molten salts and ionic liquids electrolysis, and fuel cells.

He has **published over 286 research papers** in more than 40 journals and **10 books** including one undergraduate student **textbook in thermodynamics**. He has also delivered more than **168 invited lectures** and research presentations (43 invited, 12 distinguished /plenary and 4 keynote) in **20 nations** (United States, Austria, Australia, Belgium, Canada, Chile, Finland, France, Germany, Greece, India, Italy, Japan, Kuwait, Mexico, Netherlands, South Africa, Sweden, Turkey, and the United Kingdom). He is the recipient of **3 USA patents**.

As an Endowed Chair Professor in the college of engineering and administrator of many research projects (funding from including NSF, DOE, DOD, Industries), Dr. Reddy **advised and worked with** over **75 research scholars**, students and visiting scientists. For his outstanding contribution to the field, **his alma mater** the University of Utah **recognized** him as a John Lewis **Distinguished Lecturer of the year**.

Dr. Reddy has served in many **leadership positions** within the College of Engineering, University and other national and international organizations. **Chair/member** of **24** professional societies committees, **43** technical sessions, and **25** public and universities committees; **consultant** to **25** industries, federal institutions and Universities; taught **12** continuing education/short courses; **Associate Editor** of Journal of Phase Equilibria and Diffusion and **Editor-in-chief** of an International Journal for Manufacturing Science & Production. He is serving on several committees at the materials societies including TMS, SME and ASM international. He has successfully **organized 18** national and international **symposia** including most recently the National Science Foundation **2003 NSF Design, Service, and Manufacturing Grantees and Research Conference**. He was **appointed** as the **University of Alabama Coordinator** for the National Space Science and Technology Center (NSSTC) and NASA, and served as **Council Member** for the **Alabama State Committee** for Department of Defense-EPSCoR programs.

Honors and awards include: Who's Who in Technology Today, National Dean's list, Phi Kappa Phi, Tau Beta Pi Society. Several of his students received outstanding student /research awards. Dr. Reddy is a **Fellow** of ASM International. He has received the **Service Award** and the **Best Research Paper Award** from Light Metals Division, TMS. Dr. Reddy also received the **Research Award** from J. Manufacturing Society. He is the recipient of the **Eminent Engineer** of the Tau Beta Pi Society and also the TMS Extraction & Processing **2002 Distinguished Lecture Award**, and the **2005 Milton E. Wordsworth Award for Extractive Metallurgy** of SME, a member society of AIME.

ORGANIZING COMMITTEE

Chair:



Dr. Florian Kongoli
Executive President (CEO)
FLOGEN® Technologies Inc., Canada/USA

Co-Chairs



Dr. Ramana G. Reddy
Professor
The University of Alabama, Tuscaloosa, Alabama, USA



Dr. Patrick R. Taylor
Professor
Colorado School of Mine, Colorado, USA



Dr. Shigeo Asai
Professor
Nagoya University, Japan



Dr. Kang-In Rhee
Director, Recycling Center
Korea Institute of Geosciences and Mineral Resources, Korea



Dr. Seshadri Seetharaman
Professor
Royal Institute of Technology, Sweden

INTERNATIONAL ORGANIZING COMMITTEE

This symposium is organized by an international committee spanning six continents and representing major industrial ferrous and nonferrous companies as well as universities from around the world.

Africa

Wally P. Channon, Makwiro Platinum, Zimbabwe
Lourens Erasmus, BHP Billiton, South Africa
R. Hürman Eric, University of the Witwatersrand South Africa
Rodney Jones, Mintek, South Africa
Burger Le Roux, Mittal Steel, South Africa
P.C. Pistorius, University of Pretoria, South Africa
Kobus Sutherland, Highveld, South Africa

Australia/Asia

Pulak Barua, Steel Authority of India, India
Qiu Dingfan, General Inst. of Mining & Metallurgy, China
Zhang Duomo, Central South University of Technology, China
David Fallas, WMC, Australia
John Floyd, Ausmelt, Australia
Tom Gonzales, Pasar, Philippines
Frank Jorgensen, CSIRO Minerals, Australia
A.K. Lahiri, Indian Institute of Science, India
Balashandran P. Kamath, Sterlite, India
Madhu Nilmani, NCS Asso, Australia
John Rankin, CSIRO Minerals, Australia
Markus Reuter, University of Melbourne, Australia
Veena Sahajwalla, University of New South Wales, Australia
Andrew A. Shook, BHP Billiton Technology, Australia
Amarendra K. Singh, TRDDC, India
Syoni Soepriyanto, Institute of Technology, Indonesia
Doug Swinbourne, RMIT University, Australia
Pierre Vix, Xstrata, Australia
Jian Zhang, Maanshan Iron & Steel Co., China
Jiayun Zhang, University of Science and Technology, China
Michael Zinigrad, College of Judea and Samaria, Israel

Europe

Ata Akcil, Suleyman Demirel University, Turkey
Maurits Van Camp, Umicore, Belgium
Paolo Emilio Di Nunzio, Centro Sviluppo Materiali, Italy
Pascal Gardin, Arcelor, France
Lauri Holappa, Helsinki University of Technology, Finland
Ivan Imris, Technical University of Kosice, Slovakia
Tapani Jarvinen, Outokumpu Technology, Finland
Animesh Jha, University of Leeds, United Kingdom
Kari Knuutila, Outokumpu Research, Finland

Kostas Komnitsas, Technical University of Crete, Greece
 Wlodzimierz Kozminski, KGHM, Poland
 Theo Lehner, New Boliden, Sweden
 Christian Ludwig, Paul Scherrer Institut, Switzerland
 Juho K. Makinen, Finish Academy of Technology, Finland
 Miguel Palacios, Atlantic, Spain
 Fabrice Patisson, LSG2M, France
 Norbert L. Piret, Piret & Stolberg Partners, Germany
 Michael Stelter, Tu Bergakademie Freiberg, Germany
 Andrey V. Tarasov, GINTSVETMET, Russia
 Mustafa Ürgen, Istanbul Technical University, Turkey
 Peter Willbrandt, Norddeutsche Affinerie, Germany
 Emmanuel N. Zergolis, National Technical University of Athens, Greece

Korea/Japan

Jin-Hwan Chung, POSCO, Korea
 Akio Fuwa, Waseda University, Japan
 Yoon Bong Hahn, Chonbuk National University, Korea
 Mitsutaka Hino, Tohoku University, Japan
 Seongwon Kang, LG-Nikko, Korea
 Kimio Itagaki, Tohoku University, Japan
 Masa Iwase, Kyoto University
 Hyo-Tae Jeong, Kangnung National University, Korea
 Toshiharu Kanai, Sumitomo, Japan
 Masahiro Kawakami, Toyohashi University of Technology, Japan
 Yong-Hack Lee, Korea Zinc, Korea
 Kazuki Morita, University of Tokyo, Japan
 Tetsuya Nagasaka, Tohoku University, Japan
 Masaaki Naito, Nippon Steel, Japan
 Takahiko Okura, Nikko Techno Services, Japan
 Chang Hee (Peter) Rhee, POSTECH, Korea
 Junji Shibata, Kansai University, Japan
 Tomio Takasu, Kyushu Institute of Technology, Japan
 Mikiya Tanaka, National Inst. of Advance Industrial Technology
 Toshihiro Tanaka, Osaka University, Japan
 Hidekazu Todoroki, Nippon Yakin Kogyo, Japan
 Fumitaka Tsukihashi, Tokyo University, Japan
 Tateo Usui, Osaka University, Japan
 Katsunori Yamaguchi, Iwate University, Japan
 Chikabumi Yamauchi, Chubu University, Japan
 Hyun Soo Yang, Chungnam National University, Korea
 Yutaka Yasuda, Nippon Mining & Metals, Japan
 Akira Yazawa, Tohoku University, Japan

North America

Patrick R. Atkins, ALCOA, USA
Wm. Gordon Bacon, INCO, Technology & Engineering, Canada
Mike Best, US Steel, USA
Larry Boxal, Fluor, USA
Robert Budd, FLOGEN® Technologies Inc., USA
Servando C. Cantu, Grupo Mexico, Mexico
Mike Canty, Department of Energy, USA
Pinakin Chaubal, Ispat Inland, USA
Migen Dibra, Quebec Court of Appeal, Canada
Barry Felton, ISG, USA
Tony Filmer, INCO Technical Services, Canada
Tom A. Goodman, H.B.M.S., Canada
Qingyou Han, Oak Ridge National Laboratory, USA
Jeffery J. Haslam, Lawrence Livermore National Laboratory, USA
Jiann-Yang J. Hwang, Michigan Technological University, USA
John E. Jetkiewicz, SMI-Texas, USA
Ignacio Q. Jimenez, MetMet Penoles, Mexico
S. Komar Kawatra, Chemical Eng., Michigan Technological University, USA
Richard S. Kunter, S. Kunter & Associates, USA
Brajendra Mishra, Colorado School of Mines, USA
Marcel Pineau, SNC Lavalin, Canada
Adam C. Powell, MIT, USA
Eugene Pretorius, NUCOR, USA
Manuel Ramos, ASARCO, USA
Sridhar Seetharaman, Carnegie Mellon University, USA
Marius Stan, Los Alamos National Laboratory, USA
Ahmed Vahed, Inco, Canada
A.E.M. Warner, Consultant, Canada
Rodney L. Williamson, Sandia National Laboratories, USA
Bhaskar Yalamanchili, Gerdau Ameristeel, USA

South America

Jose Feria Bengoa, Southern Peru, Peru
Maria Carolina C. Bezerra, Carboox, Brazil
Juan Luis Bobadilla Morales, El Teniente, Chile
Patricio Chacana Buchard, Falconbridge, Chile
Jonkion Font Carmona, IM2, Chile
Gerardo Achurra Herrera, Codelco, Chile
Jorge Madias, Instituto Argentina de Sid erurgia, Argentina
Pedro Morales Cerda, Codelco, Chile
Henrique Mosquera, Caraiba Metais, Brazil
Alex Moyano Magna, Codelco Norte, Chile
Rafael Padilla, University of Concepcion, Chile
Luis Patricio Ruz Guerrero, IM2, Chile
Mario Sanchez, University of Concepcion, Chile
Michael Sankovitch, La Oroya, Peru
Varadarajan Seshadri, Univ. Federal de Minas Gerais, Brazil

SESSION CHAIRPERSONS

Plenary Session: Florian Kongoli

Symposium: Thermo and Physicochemical Principles

Non-Ferrous High Temperature Processing: Kinetics: *F. Patisson, S. Seetharaman*
Non-Ferrous High Temperature Processing: Thermodynamics I: *O. Yücel, M.E. Schlesinger*
Non-Ferrous High Temperature Processing: Thermodynamics II: *Y. Waseda, K. Itagaki*
Non-Ferrous High Temperature Processing: Recycling and Recovery: *F. Jorgensen, Juergen Antrekowitsch*
Non-Ferrous High Temperature Processing: Waste Treatment: *J. Shibata, A. Fuwa*
Ferro Alloys and Titanium Extraction: *A. Jha, R.H. Eric*
Alloys and Refining Processes: *Bill Corcoran, M.I. Zinigrad*
Experimental Measurements and Techniques: *K. Itagaki, R.W. Hyers*

Iron Making: Alternative Routes, Blast Furnace, Coke and Coal: *Y. Matsui, P. Chaulal*
Steel Making: Thermodynamics and Kinetics: *T. Tanaka*
Steel Making: Liquid Steel Processing and Reactors: *J. Zhang, Sridhar Seetharaman*
Steel Making: Inclusions and Steel Cleanliness: *H. Todoroki, P. Gardin*
Steel Making: Casting: *V. Seshadri, L. E. K. Holappa*
Steel Making: Modeling and Processing: *H. Jalkanen, P.J. Koros*

Nano and Composite Materials I: *Y.-B. Hahn, R.Y. Lin,*
Nano and Composite Materials II: *M. Kawakami, D. Chandra*
Ceramics, Refractories and Polymers: *J.S.J. van Deventer, D. Forrest,*
Aqueous Processing: Leaching and Flotation: *D. Fray, M. Cross*
Aqueous and Electrochemical Processing I: *R. K. Mishra, V.G. Papangelakis*
Aqueous and Electrochemical Processing II: *O. A. Bascur, D. Dreisinger*
Electrochemistry and Molten Salts: *A.C. Powell, R. O. Suzuki*

Symposium: New, Improved and Existing Technologies

Non-Ferrous High Temperature Processing I: *Michael Potesser T. H. Okabe*
Non-Ferrous High Temperature Processing II:- *Dinesh Agrawal, Christian Wieckert*
Non-Ferrous High Temperature Processing III: *E. Vidal, U. Pal*
Non-Ferrous High Temperature Processing IV: *A.V. Tarasov, L.Sh. Tzemekhman*

Materials Processing I: *Balashandran P. Kamath, Kalathur S. Narasimhan*
Materials Processing II: Nano, Ceramic and Composite Materials: *O. Yamamoto, K. Koyama*
Iron Making: *A. Ullah, J. J. Poveromo*
Steel: *S. Asai, J.-Y. Hwang*

Recycling I: Batteries, Electronic Scrap, and Light Metals: *F. Tedjar, T. Takasu*
General Recycling and Waste Treatment I: *Kang-in Rhee, A.E. Bohé*
General Recycling and Waste Treatment II: *M. Pasetto, P.-D. Oudenne*
Waste Treatment and Remediation: *P. Taylor, Robert W. Bartlett*

Aqueous Processing I: Leaching and Biotechnology: *S.K. Kawatra, R. Padilla*
Aqueous Processing II: *M.C. Ruiz, W. Dunaway*
Aqueous Processing III: Preparation and Synthesis: *T. Carvalho, Dirk Verhulst*
Aqueous Processing IV: *G. Deschênes, N.E. Izatt*
Electrochemistry: *M. Stelter, M. L. Free*
Geothermal in Mineral Recovery and General Minerals Processing: *J.M. Canty, R.G. Bloomquist*

Symposium: Industrial practice

Non-Ferrous High Temperature Processing: *A. Moyano.*
Iron Making: *M. Naito, T. Usui*
Steel: *Eugene Pretorius, A. K. Singh*
Metals and Materials Processing: *R.D. Peterson, P.F Mendez*
Aqueous and Electrochemical Processing: *C.G. Anderson, M. Brueggeman*

Sulfide Smelting

Smelter Projects: *Y. Yasuda, F. Kongoli*
Technologies and Recent Developments I: *M. Van Camp, U. Kerney*
Technologies and Recent Developments II: *A. Lossin, C. Acuna??*
Sulfur and Gas Handling: *T. Okura, K. Yamaguchi,*
Analysis and Optimizations I: *T. Edens*
Analysis and Optimizations II: *A. Vahed*

Symposium: Legal, Management and Environmental Issues

Legal Perspectives: *M. Dibra, F. Kongoli,*
Business Management: *B. Yalamanchili, Pedro Morales*
Management of Environmental, Recycling and Waste Treatment I: *M. Palacios*
Management of Environmental, Recycling and Waste Treatment II: *M. Sánchez*

SPONSORS

TMS Extraction & Processing Division including:

1. Aqueous Processing Committee
2. Copper, Nickel, Cobalt Committee
3. Materials Characterization Committee
4. Process Fundamentals Committee
5. Process Modeling, Analysis and Control Committee
6. Pyrometallurgy Committee
7. Recycling Committee
8. Waste Treatment and Minimization Committee

CO-SPONSORS

Organizations

1. Academis Mexicana de Ciencia de Materiales
2. American Foundry Society
3. American Institute of Chemical Engineers
4. APMI International
5. ASM International
6. Asociacion Argentina de Materiales
7. Association for Iron & Steel Technology
8. Associazione Italiana di Metallurgia
9. Australasian Institute of Mining and Metallurgy
10. Austrian Society for Metallurgy and Materials
11. Beijing General Research Institute of Mining & Metallurgy
12. Benelux Metallurgie
13. Brazilian Association for Materials and Metallurgy
14. Brunei Darussalam Institute of Chemistry
15. Ceramic Society of Japan
16. Chemical Society of Japan
17. Chemical Society of Pakistan
18. Chemical Society of Peru
19. Chilean Chemical Society
20. Chinese Society for Metals
21. Cobalt Development Institute
22. Colegio de Ingenieros de Chile
23. CSIRO, Australia
24. Czech Society for New Materials and Technologies
25. Danish Ceramic Society
26. Danish Chemical Society
27. Danish Metallurgical Society
28. Electrochemical Society
29. Electrochemical Society of Japan
30. Engineering Conferences International
31. Eurometaux

32. European Ceramic Society (includes 23 societies)
33. Federation of European Materials Societies (includes 21 societies)
34. Georgian Ceramic Society
35. German Society for Mining, Metallurgy, Resource and Environmental Technology
36. Gintsvetmet Institute
37. Gipronickel Institute, JS
38. Hellenic Ceramic Society
39. Indian Institute of Metals
40. Institute for Nonferrous and Rare Metals
41. Institute of Materials Engineering Australasia
42. Institute of Materials, Minerals and Mining
43. Institute of Metals and Technology
44. Institute of Non-Ferrous Metals
45. Instituto Argentino de Siderurgia
46. Integrated Chemists of the Philippines
47. International Aluminium Institute
48. International Energy Foundation
49. International Lead Zinc Research Organization, Inc.
50. Iron and Steel Institute of Japan
51. Israel Chemical Society
52. Japan Institute of Metals
53. Jordanian Chemical Society
54. Korean Academy of Science and Technology
55. Korean Chemical Society
56. Korean Institute of Chemical Engineers
57. Korean Institute of Metals and Materials
58. Malaysian Institute of Chemistry
59. Materials Research Society
60. Materials Society of Portugal
61. Metallurgical Society of CIM
62. Minerals Engineering International
63. Mining and Materials Processing Institute of Japan
64. Nonferrous Metals Society of China
65. North American Thermal Analysis Society
66. Polish Association of Metallurgical Engineers and Technicians
67. Portugese Chemical Society
68. Slovak Metallurgical Society
69. Slovenian Ceramics Society
70. Slovenian Society of Materials
71. Société Française de Chimie
72. Société Française de Métallurgie et de Matériaux
73. Societe Royale de Chimie
74. Society for Mining, Metallurgy, and Exploration
75. Society of Chemical Engineering Japan
76. South African Institute of Mining and Metallurgy
77. Swedish Society for Materials Technology
78. Swedish Steel Producers Association
79. Technologisch Instituut VZW
80. The American Ceramic Society
81. The Chemical Society of Thailand
82. The Finnish Association of Mining and Metallurgical Engineers

Independent Journals and Publishers

1. Canadian Mining Journal
2. Ferrous Metals Journal
3. Industrial Minerals
4. Journal of Technical Electronic Materials
5. Magnesium Monthly Review
6. Materials Engineering News
7. Mineral and Metallurgical Processing
8. Mineral Processing Journal
9. Mining Journal
10. Nonferrous Metals Journal
11. Ore and Metals Publishing House
12. The European Journal of Mineral Processing and Environmental Protection

Corporations

1. Ausmelt
2. FLOGEN® Technologies Inc.*
3. Korea Institute of Geoscience and Mineral Resources*
4. Korea Zinc Co. Ltd.*
5. LS-Nikko Copper*
6. Outokumpu Technology*
7. Posco*
8. Umicore Precious Metals Refining*
9. Xstrata Technology*

Personal Sponsor

John Floyd, Australia

* Refer to the "Corporate Section" for the information about the cosponsor