

A scanning electron micrograph (SEM) showing a complex, textured surface of a mineral or material. The surface features various ridges, valleys, and granular features, typical of a mineral specimen under high magnification. The image is in grayscale, with highlights and shadows that emphasize the three-dimensional topography of the surface.

Characterization of Minerals, Metals, and Materials 2013

Edited by

Jiann-Yang Hwang

Chengguang Bai

John Carpenter

Shadia J Ikhmayies

Bowen Li

Sergio Neves Monteiro

Zhiwei Peng

Mingming Zhang

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TMS

Characterization of Minerals, Metals, and Materials 2013

Proceedings of a symposium sponsored by
the Materials Characterization Committee of
the Extraction and Processing Division of
TMS (The Minerals, Metals & Materials Society)

Held during the
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Shadia J Ikhmayies

Bowen Li

Sergio Neves Monteiro

Zhiwei Peng

Mingming Zhang



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Preface

To process minerals, metals, and materials, it is always necessary to understand the chemistries, physical properties, forms, structures, occurrences, functions, relations, etc., of the associated materials prior, during, and after the processing of materials. This type of work, which is broadly understood as characterization, is usually the first step taken to define and solve the industrial processing problems. Various characterization technologies have been developed and applied to meet the needs. In many cases, characterization has served as the brain for the processing of materials. To facilitate materials scientists in different disciplines to communicate their findings in characterization technologies and applications, the Materials Characterization Committee is formed under TMS.

The Materials Characterization Committee of TMS sponsors the symposium on Characterization of Minerals, Metals, and Materials annually as a major event of its activities to support the TMS annual meeting. Selected papers presented at the symposium in conjunction with the TMS 2013 Annual Meeting in San Antonio, Texas, USA, are collected in this volume.

The Characterization Symposium has grown to become one of the largest symposia in TMS. The 2013 symposium received more than 180 abstracts from all over the world. Among them, 141 were selected for presentations on the symposium and more than 60 papers were accepted for publication in this book after a peer review process.

The book is divided into twelve sections and each section has different focus. They include Characterization Technologies, Ferrous Metals, High Performance Alloys, Nonferrous Metals, Minerals and Ceramics, Extractive Applications, Environmental and Construction Materials, Inorganic Materials, Soft Materials, Advanced Materials, Surface, Joint and Processing, and Green Materials. In each section, the characterization technologies developed and applied for the specific material are discussed with various examples.

There are very few books published with focus on characterization. We hope this book will serve as a good reference book in this area. We understand the breadth of characterization and materials processing, and this book will by no means be able to fill all the needs. But it will provide the up-to-date information on the current and newly developed characterization technologies with examples on how they have been applied for the processing of various materials. This can be handy and stimulative for people trying to solve problems in the material industries.

We are very grateful to the authors of the included papers for their knowledge contributions, the reviewers for their time and effort dedicated to the manuscripts during the review process, and the publisher for their assistance on the final details. We are also thankful to TMS for giving us the platform to carry out this task. Finally, we would like to express our gratitude to all the previous chairs and members of the Characterization Committee. Their vision and work have made this field prosperous.

Jiann-Yang Hwang

Chengguang Bai

John Carpenter

Shadia J Ikhmayies

Bowen Li

Sergio Neves Monteiro

Zhiwei Peng

Mingming Zhang

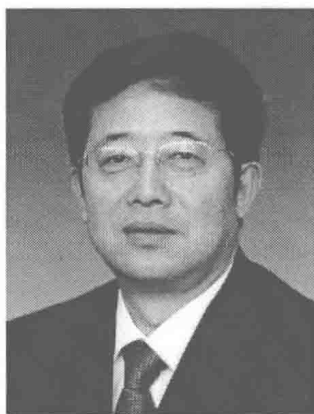
Editors

Jiann-Yang (Jim) Hwang is a Professor in the Department of Materials Science and Engineering at Michigan Technological University. He is also the Chief Energy and Environment Advisor of the Wuhan Iron and Steel Group Company. He has been the Editor-in-Chief of the *Journal of Minerals and Materials Characterization and Engineering* since 2002. Several universities have honored him as a Guest Professor, including the Central South University, University of Science and Technology Beijing, Chongqing University, and Kunming University of Science and Technology.



Dr. Hwang received his B.S. degree from National Cheng Kung University 1974, M.S. in 1980 and Ph.D. in 1982, both from Purdue University. He joined Michigan Technological University in 1984 and has served as its Director of the Institute of Materials Processing from 1992 to 2011. He has been a TMS member since 1985. His research interests include the characterization and processing of materials and their applications. He has been actively involved in the areas of separation technologies, pyrometallurgy, microwaves, hydrogen storages, ceramics, recycling, water treatment, environmental protection, biomaterials, and energy and fuels. He has more than 20 patents, published more than 200 papers, and founded several companies. He has chaired the Materials Characterization Committee and the Pyrometallurgy Committee in TMS and has organized several symposiums.

Chenguang Bai is the vice president of Chongqing University, China. He received a bachelor degree in Metallurgical Engineering in Chongqing University, 1982, and then received a Master and Doctor degree in Metallurgical Engineering there. He has published more than 150 papers, and about 90 were cited in SCI and EI. His research topics focus on Slag chemistry, new iron-making process, microwave application on metallurgical engineering, and mineral processing. He is an expert on the blast furnace process with V-Ti-Magnetic.



John Carpenter is a technical staff member in the Materials Science and Technology Division at the Los Alamos National Laboratory. Dr. Carpenter received his Ph.D. in Materials Science and Engineering from The Ohio State University in 2010 after performing his undergraduate studies at Virginia Tech.

His research interests include the characterization, processing, fabrication, and mechanical testing of metallic nanocomposites. Currently his work focuses on understanding the relationship between plastic strain, texture, and the mechanical properties of Cu/Nb bimetallic nanocomposites fabricated via accumulative roll bonding. This research involves the use of several characterization techniques including neutron scattering, x-ray synchrotron, PED, TEM, EBSD, and SEM. Mechanical testing for this work includes methods such as micropillar compression, microtension, and nanoindentation. He has published 12 papers and given ten invited technical talks related to these areas. In addition, he has served as a co-editor for *JOM* sections related to neutron characterization and coherent x-ray diffraction imaging methods for materials studies.

Dr. Carpenter currently serves as the vice chair and *JOM* editor for the Materials Characterization Committee and is also a member of the Mechanical Behavior of Materials, Nanomechanical Behavior, and the Advanced Characterization, Simulation, and Testing Committees of TMS. He is the 2012 recipient of the Young Leaders Professional Development award for the Extraction & Processing Division of TMS.



Shadia Ikhmayies received the B.Sc. from the physics department in the University of Jordan, Jordan in 1983, the M.Sc. in molecular physics from the same university in 1987 and the Ph.D. in producing CdS/CdTe thin film solar cells from the same university too in 2002. She worked as a part time lecturer in the University of Jordan in the physics department from 2003-2004 then in the Applied Science University in Jordan as an assistant professor from 2004-2009, and now she works in Al Isra University in Jordan too as an assistant professor. Her research is focused on producing and characterizing semiconductor thin films such as SnO₂, ZnO, CdS, CdTe, CuInS₂ and CuInSe, thin film bilayers such as SnO₂/CdS and thin film CdS/CdTe solar cells. These are mainly prepared by the spray pyrolysis technique and some of them were produced by thermal evaporation. Beside this she also works in studying structural,



optical and electronic properties of some carbides and nitrides such as NbN and NbC by computation using Wien2K package.

Shadia is a member of the Jordanian Renewable Energy Society (JRES), The Minerals, Metals & Materials Society (TMS) and the World Renewable Energy Network (WREN). She is an associate editor in the *Journal of Physics Express* for Simplex Academic Publishers, a member of the editorial board of the *International Journal of Materials and Chemistry* for Scientific & Academic Publishing, the editor in chief of a review book project titled "Advances in the II-VI Compounds Suitable for Solar Cell Applications" -under construction- for the Research Signpost/Transworld Research Network. She is also elected to be the technical advisor for the *JOM* to represent the Materials Characterization committee for the year 2014. Shadia is a reviewer in 14 international journals for Elsevier, Springer, and others beside three international conferences. She published 25 research and technical papers in international scientific journals, a chapter in a book, and 34 research and technical papers in conference proceedings. She is a member of the organizing committee of TMS and she was also a member of the organizing committee of the International Conference and Exhibition on Green Energy and Sustainability for Arid Region and Mediterranean Countries held in Amman, Jordan, November 10-12, ICEGES 2009.

Bowen Li is a Research Associate Professor in the Department of Materials Science and Engineering and Institute of Materials Processing at Michigan Technological University. His research interests include materials characterization, metals extraction, ceramic processing, antimicrobial additives, and applied mineralogy. He has over 80 publications, and 12 patents. Bowen Li received a Ph.D. degree in Mineralogy and Petrology from China University of Geosciences Beijing in 1998, and a Ph.D. degree in Materials Science and Engineering from Michigan Technological University in 2008. He has been a TMS member since 2005, and served as a member in Materials Characterization Committee and Powder Materials Committee.

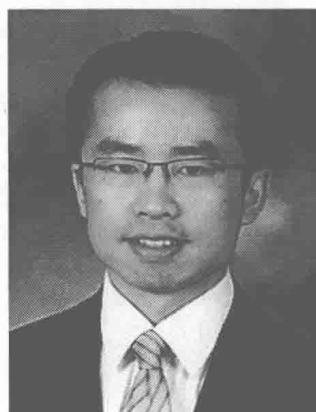


Sergio Neves Monteiro graduated as a metallurgical engineer in 1966 from the Federal University of Rio de Janeiro (UFRJ). He received his MSc (1967) and PhD (1972) from the University of Florida, followed by a course 1975 in energy at the Brazilian War College and post-doctorate (1976) at the University of Stuttgart. In 1968, Dr. Monteiro joined the Metallurgy Department and was appointed full professor of the post-graduation program in engineering (COPPE) of the UFRJ. He was elected head of department (1978), coordinator of COPPE (1982) and under-rector for research (1983). He was invited as under-secretary of science for the state of Rio de Janeiro (1985) and under-secretary of college education for the federal government (1989); he retired in 1993 and joined the State University of North Rio de Janeiro (UENF).



Dr. Monteiro is now a professor in the materials science department of the Military Institute of Engineering, IME, Rio de Janeiro. He has published over 1,000 articles in journals and conference proceedings and has been honored with several awards including the ASM Fellowship. Dr. Monteiro is presently a top researcher (1A) of the Brazilian Council for Scientific and Technological Development (CNPq), President of the Superior Council of the State of Rio de Janeiro Research Foundation (FAPERJ), consultant for the main Brazilian R&D agencies, and a member of the editorial board of three international journals.

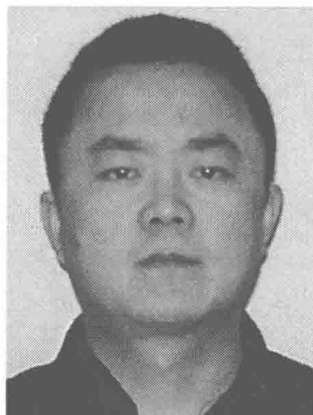
Zhiwei Peng is a Research Assistant Professor in the Department of Materials Science and Engineering at Michigan Technological University. He received his B.E. and M.S. degrees from Central South University in 2005 and 2008, respectively, and his Ph.D. degree in Materials Science and Engineering from Michigan Technological University in 2012. His research interests include heat transfer in microwave heating, dielectric characterization of materials, non-thermal microwave effects, ferrous metallurgy, computational electromagnetics, and microwave absorbing materials.



He has published over 30 papers, including 16 peer-reviewed articles in journals such as *Metallurgical and Materials Transactions A*, *Energy & Fuels*, *IEEE Transactions on Magnetics*, *ISIJ International*, and *Applied Physics Express*. He has served as a key reviewer for a number of journals and been on the editorial board of the *Journal of Minerals and Materials Characterization and Engineering* since 2012. He received a TMS

Travel Grant Award in the 141st TMS Annual Meeting & Exhibition, and Doctoral Finishing Fellowship and Dean's Award for Outstanding Scholarship from Michigan Technological University in 2012. He is a member of The Minerals, Metals & Materials Society (TMS), Materials Research Society (MRS), Institute of Electrical and Electronics Engineers (IEEE), American Society for Metals (ASM), Association for Iron and Steel Technology (AIST), and American Ceramic Society (ACerS).

Mingming Zhang is currently working at ArcelorMittal Global R&D at East Chicago, Indiana. Dr. Zhang has over 10 years of research experience in the field of mineral processing, metallurgical and materials engineering. He obtained his Ph.D. degree in Metallurgical Engineering from the University of Alabama and his Master degree in mineral processing from General Research Institute for Non-ferrous Metals in China. He has conducted a number of research projects involving mineral beneficiation, thermodynamics and kinetics of metallurgical reactions, electrochemical processing of light metals, energy efficient and environmental cleaner technologies. Upon graduation with a Ph.D. degree he joined Nucor Steel Tuscaloosa and was assigned to the melting shop technical departments. He managed a number of process improvement and upgrade projects on melting and casting process.



He has published over 20 research papers and he is the recipient of one WIPO patent and one USA patent. Dr. Zhang also serves as editor and key reviewer for a number of prestigious peer-reviewed journals. These include *Metallurgical Transactions B*, *Journal of Phase Equilibria and Diffusion*, *Mineral Processing and Extractive Metallurgy*, and *ASME Journal of Thermal Science and Engineering Applications*. Dr. Zhang has made more than 10 research presentations at international conferences in China and the United States. He has been invited to a number of international conference committee gatherings to make presentations and to serve as a key reviewer. These conferences include 2011 International Manufacturing Science and Engineering Conference (MSEC), 2010 International Heat Transfer Conference (IHTC), 2009 US-EU-China Thermophysics Conference - Renewable Energy (UECTC-RE).

Awards and Honors: Graduate Student Poster Contest Winner, 136th TMS Annual Meeting & Exhibition, 2007; Graduate Student of the Year Award, Engineering Council of Birmingham (ECOB), 2006; Graduate Council Research/Creative Activity Fellowship, University of Alabama; 2007; TMS Travel Grant Award, 135th TMS Annual Meeting & Exhibition, San Antonio, TX, 2006.

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