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About the Cover

In "A Computational Analysis of Thermo-mechanical Fields in Hot Roll Bonding of Aluminum Validated by Experiments," by Brigit Mittelman, Gilad M. Guttmann, and Elad Priel, the process of hot roll bonding of composite Al1050 plates was investigated using both 2D and 3D coupled thermo-mechanical FE models. In this image, a representative computational mesh for a 3D model is shown. The FE models of the hot rolling were used for analyzing the time dependent thermomechanical fields which develop at the interface for different reduction ratios. The computed fields in the deformation zone were utilized to evaluate the bonding strength using a previously published bonding strength criterion for solid state bonding in bridge die extrusion.

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Advanced Nanocomposite Materials:

Structure-Property Relationships Composite Materials Committee Simona Hunyadi-Murph, Savannah River National Laboratory/ University of Georgia

Energy Materials: Part I

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The scope of *JOM* (ISSN 1047-4838) encompasses publicizing news about TMS and its members and stakeholder communities while publishing meaningful peer-reviewed materials science and engineering content. That content includes groundbreaking laboratory discoveries, the effective transition of science into technology, innovative industrial and manufacturing developments, resource and supply chain issues, improvement and innovation in processing and fabrication, and life-cycle and sustainability practices. In fulfilling this scope, *JOM* strives to balance the interests of the laboratory and the marketplace by reporting academic, industrial, and government-sponsored work from around the world.

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The Minerals, Metals & Materials Society (TMS) is a professional organization that encompasses the entire range of materials and engineering, from minerals processing and primary metals production to basic research and the advanced applications of materials.

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CFD Modeling and Simulation in Materials Processing: Part II

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in the final analysis

"I love it when a plan comes together!"

-Hannibal Smith. The A-Team



Number 2

February 2019

One of the joys of our digital modernity is the opportunity to binge watch every television show ever made via a growing number of video streaming services. Rising from obscurity, series that have been mothballed for decades are finding appreciative new audiences. Take, for example, the high-detonation/low-sophistication action nugget from the 1980s called *The A-Team*. The eponymous A-Team comprises a group of good-natured mercenaries who help the helpless by use of guile, disguise, muscle, brains, swagger, and an ordnance-laden GMC van. While the team also relies on tactical unpredictability, there is a rigid predictability to each episode. Invariably, our heroes find themselves in a desperately inescapable situation. At the darkest moment, they craft a brilliant if credibility-straining solution that saves the day, albeit not always in the way that the team planned. Triumph secured, the team leader, portrayed by George Peppard, unfailingly utters his signature "I love it when" line with an infusion of irony, self-satisfaction, or both. In the process, a go-to adage for the fan-base was born.

I, too, love it when a plan comes together, and one of my favorite forms of planning is strategic planning. Within TMS, I've been involved with 20+ years of strategic planning exercises with our Board of Directors. It is always an energizing process because our TMS volunteers are a genuine A-team—brilliant, innovative, and oftentimes visionary thinkers who have great passion for the Society. Granted, I'm biased, but I believe that every TMS strategic plan has been a good one, both in terms of conceptualization and implementation. While each plan tends to be envisioned as having a three-year life span, the plans are never static. The Board of Directors monitors progress against the goals several times per year and makes incremental adjustments throughout the plan life based on accomplishments, revised perspectives, and evolving circumstances. Our strategic planning rigor has made the Society growth- and opportunity-oriented while remaining mindful of the core that defines TMS.

Without exception, our past plans have been ambitious and very specific in those ambitions. That exactitude can make a plan difficult to bandy about in casual conversation. The Board's focus in 2018 was development of a plan both inspirational and succinct. The result is called "TMS Aspires," and I find it easy to embrace and easy to communicate. While next month's *JOM* will feature a proper article on the new strategic plan, I like that I can effortlessly summarize it here and still have room to blather about *The A-Team*.

TMS Aspires comprises three goals:

- 1. TMS aspires to be a *highly inclusive Society* where all materials students and professionals feel welcome and diversity is celebrated.
- 2. TMS aspires to be the place where *global materials practitioners come together and participate* in vibrant annual meetings, specialty conferences, courses, student activities, and other events.
- 3. TMS aspires to be the Society that *envisions, defines, and enables the future by gathering and empowering materials experts* to scope the future of materials science, engineering and technology.

If you find yourself on the proverbial elevator and someone asks, "What's happening at TMS?" You've got an easy-to-recall answer: "We're focusing on inclusivity and diversity, on holding vibrant events that convene the global materials community, and on helping materials experts scope the future of the field." One sentence that is easy to get excited about . . . nice!

If that elevator partner says that he or she would like to learn more, somewhere in the distance you might hear a Board member exclaim, "I love it when a plan comes together!"



James J. Robinson Executive Director

"While next month's JOM will feature a proper article on the new strategic plan, I like that I can easily summarize it here and still have room to blather about The A-Team."

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member news

Share the good news about your professional accomplishments! Contact Kaitlin Calva, JOM Magazine Managing Editor, at kcalva@tms.org. Please note that only news submitted by current TMS members will be considered.



Robert Franklin Mehl (Photo credit: David Rasel)

TMS Pinnacle Award to Celebrate 100 Years; Diran Apelian Receives Award

Nominate a Colleague for the 100th IOM/Mehl Award

One of TMS's highest honors will celebrate its centenary anniversary in 2021: the Institute of Metals/Robert Franklin Mehl (IOM/Mehl) Award. This happens to coincide with the 150th anniversary of the founding of the American Institute of Mining, Metallurgical, and Petroleum Engineers (AIME)—the antecedent society of TMS. An ad hoc committee has been established to plan a grand celebration at the TMS 2021 Annual Meeting & Exhibition, with the 100th IOM/Mehl Award recipient playing a key role in 150th anniversary activities.

As this award consists of a lectureship, recipients are considered two years in advance of the award year. Applications are being accepted for the 2021 IOM/ Mehl Award until April 1, 2019.

To nominate a colleague for this honor, completed applications, including a nomination form, nominator's supporting statement, current resume or curriculum vitae, and two to five letters of recommendation, must be submitted

> to TMS staff at awards@tms. org. Additional criteria and information are available at awards.tms.org.

Originally known as the IOM Lecture, the award was established by the Institute of Metals Division of AIME, a precursor to The Metallurgical Society that eventually became TMS. In 1972, the TMS Board of Directors approved the creation of a new award, the Robert Franklin Mehl Award, and its addition to the existing IOM Lecture. Today's combined IOM/Mehl Award recognizes an outstanding scientific leader by inviting him/her to present a lecture at the Society's annual meeting on a technical subject of particular interest to members in the materials science and

application of metals program areas. The honoree's lecture will also be published in an issue of *Metallurgical and Materials Transactions A*.

A deserving namesake for this pinnacle award, Robert Franklin Mehl (1898–1976) was instrumental in transforming the fields of metallurgy and materials science and engineering into the fields we know today. "His contributions were at several levels: partly in the research he himself did, partly in his effective advocacy of a more fundamental approach to materials, and partly in his establishment of a new concept for a curriculum for the education of metallurgists," said C.S. Smith and W.W. Mullins in *Biographical* Memoirs from the National Academy of Sciences. He spent much of his career as professor of metallurgy, director of the Materials Research Laboratory, and head of the Department of Metallurgical Engineering at Carnegie Institute of Technology (CIT; now Carnegie Mellon University). Prior to his time at CIT, Mehl served as the first head of the Division of Physical Metallurgy at the thenrecently established U.S. Naval Research Laboratory.

As a member of AIME, Mehl received the AIME Champion H. Matthewson Award in 1934, 1939, and 1944; the 1936 IOM Lecture Award; and the 1945 AIME James Douglas Gold Medal. In 1963. Mehl was selected as a member of the first class of what is now the TMS Fellows. He also played an important role in establishing Brazilian Metallurgical Society (now Associação Brasileira de Metalurgia, Materiais e Mineração, ABM) during a year spent at the Universidade de São Paulo. For the 70th anniversary of ABM in 2014, the Robert Mehl Symposium was held during the TMS-ABM Pan-American Materials Conference to recognize Mehl's influence on the evolution of materials science and engineering throughout the world.



TMS Pinnacle Award to Celebrate 100 Years; Diran Apelian Receives Award

WPI Honors Diran Apelian

TMS congratulates Diran Apelian on receiving the Worcester Polytechnic Institute (WPI) 2018 Innovator of the Year Award. Apelian, the Alcoa-Howmet Professor of Mechanical Engineering at WPI, is the first WPI faculty member to receive the award since its establishment in 2011. According to WPI, Apelian was awarded the honor "for his innovative work in metal processing and for his leadership as a researchers and educator." As a part of the award presentation, Apelian gave an address at WPI in November 2018.

A TMS member since 1976, Apelian's technical home within the Society is the Light Metals Division (LMD), where he has been a member of the Aluminum Committee and received the 2005 LMD Technology Award. He also served on the Continuing Education, Education and Professional Affairs, and Solidification Committees, among others, and was the 1999–2002 Public & Governmental Affairs Director and 2008 TMS President. Throughout his membership, he has received the 2004 TMS/ASM Joint Distinguished Lecturer in Materials and Society Award, 2006 Bruce Chalmers Award, and 2006 Fellow Award. He was a co-editor of the Journal of Sustainable Metallurgy from its establishment in 2015 to 2017.

Apelian has also earned many accolades outside of TMS, including: the 1992 American Institute of Mining, Metallurgical and Petroleum Engines (AIME) Champion H. Matthewson Award; 2007 Acta Materialia Hollomon Materials & Society Award; 2006 Brimacombe Prize; 2009 member of the National Academy of Engineering; 2005 Joan Hodges Queneau Palladium Medal from the Audubon Society; and

2017 Fellow of the National Academy of Inventors. He is also a Fellow of ASM International and the American Powder Metallurgy Institute (APMI) International.

His work on materials processing, aluminum alloys, metal casting, and recycling, particularly the industrial applications, has led to nearly 700 publications, 15 books, and 21 patents throughout his career. After earning his B.S. in metallurgical engineering from Drexel University and Sc.D. in materials science from the Massachusetts Institute of Technology, Apelian worked at the Homer Research Laboratories of Bethlehem Steel for several years. He then returned to Drexel in 1976 in a variety of faculty positions and, later, as vice provost. In 1990 he joined WPI, serving as provost of the university until 1996 when he founded WPI's Metal Processing Institute (MPI), an industryuniversity alliance for advancing materials science. In 2010, with the sponsorship of the National Science Foundation, he co-founded the Center for Resource, Recovery and Recycling (CR³), the first center dedicated to materials recycling in the United States.



Diran Apelian (Photo courtesy of WPI.)

TMS Welcomes New Members

The TMS Board of Directors approved professional membership for the following individuals at its December 2018 meeting. In compliance with the European Union's (EU) General Data Protection Rule (GDPR), we have not listed EU members who have not yet opted in to TMS communications. If you wish to receive communications from TMS, log in to tms.org and select My Account, then scroll down to My Details, and click on the Communication Preferences tab to select "Yes, I agree to receive communications from TMS."

Please join us in congratulating and welcoming the following individuals to all the privileges and benefits of TMS membership.

Abdul Jabbar, Md Hussain; Nissan Technical Center North America, United States

Aifantis, Katerina E.; United States

- Akia, Mandana; University of New Mexico, United States
- Almeshari, Abdulaziz; SABIC, Saudi Arabia
- Al-Sahli, Abdulmohsin; SABIC, Saudi Arabia
- Arora, Gaurav; University of Wyoming, United States
- Aylmore, Mark G.; Curtin University, Australia
- Bae, Chang-Jun; Korea Institute of Materials Science, South Korea
- Baker, Charles; Lumiant Corporation, United States
- Beach, Elvin; Worthington Industries Inc., United States
- Bechetti, Daniel H.; Naval Surface Warfare Center, United States

Benzio, Matt; FMP, United States

TMS Pinnacle Award to Celebrate 100 Years; Diran Apelian Receives Award

- Bowers, Matthew L.; Exponent Inc., United States
- Cao, Ye; University of Texas at Arlington, United States
- Caris, Joshua; Terves LLC, United States
- Cha, Byungchul; Korea Institute of Industrial Technology, South Korea
- Cheekatamarla, Praveen; Atrex Energy Inc., United States
- Chen, Xuehui; Central Iron and Steel Research Institute, China
- Cheng, Yang-Tse; University of Kentucky, United States
- Cheon, Jooyong; South Korea
- Chevrier, Vincent; 3M Center, United States
- Choi, Inchul; Korea Institute of Industrial Technology, South Korea
- Chou, Ryan; UTC Aerospace Systems, United States
- Chung, Ed; Amphenol Canada, Canada
- Coughlan, Aisling; United States
- Crawford, Folly; Center for Advanced Vehicular Systems, United States
- Cunningham, Ross; Owens Corning, United States
- Cyr, Edward; Marine Additive Manufacturing Centre of Excellence, University of New Brunswick, Canada
- Daniels, Thomas W.; Moog Inc., United States
- Daughton, David R.; Lake Shore Cryotronics, United States
- Davidson, M. Joseph; National Institute of Technology Warangal, India
- Dickens, Tarik; FAMU-FSU College of Engineering, United States
- Dodrill, Brad; Lake Shore Cryotronics, United States
- Dupel, Pascal; Vesuvius Research, United States
- Eftekhari, Ali; Apple Inc., United States
- Espinoza, Christian; Hyperion Materials and Technologies, United States
- Fu, Ming; GE Aviation, United States
- Gaikwad, Vijay Trambak; Bharat Forge Ltd., India
- Gallaher, Jack W.; Bechtel Marine Propulsion Corp., United States

- Gandha, Kinjal; Ames Laboratory, United States
- Garich, Holly; Faraday Technology Inc., United States
- Geerlings, Henry; CoorsTek, United States
- Gerlt, Austin; UES Inc. (AFRL/RXCM), United States
- Ghose, Sanjit; Brookhaven National Laboratory, United States
- Gnaupel-Herold, Thomas; National Institute of Standards and Technology, United States
- Goel, Kishan L.; Naval Air Systems Command, United States
- Guo, Jianzheng; ESI US R&D, United States
- Han, Yanfeng; Shanghai Jiao Tong University, China
- Hatta, Hidenori; United States
- Hegadekatte, Vishwanath; Novelis Inc., United States
- Heiden, Michael; Sandia National Laboratories, United States
- Herbert, Erik G.; Michigan Technological University, United States
- Hopkins, Taylor; AB Carter Inc., United States
- Hu, Zhongqiang; Xi'An Jiaotong University, China
- Ibrahim, Hamdy; University of Tennessee Chattanooga, United States
- Ishimaru, Manabu; Kyushu Institute of Technology, Japan
- Jalalahmadi, Behrooz; Sentient Science, United States
- Jewell, Daniel; Commonwealth Scientific and Industrial Research Organisation, Australia
- Ji, Changwook; Korea Institute of Industrial Technology, South Korea
- Jo, Ilguk; Korea Institute of Materials Science, South Korea
- Jun, Hyun Jo; ExxonMobil Research and Engineering, United States
- Kappagantula, Keerti S.; Ohio University, United States
- Karaca, Haluk E.; United States
- Katsarelis, Colton C.; United States
- Khan, Abdul Khader; Ansys Inc., United States

- Kim, Eoksoo; Korea Institute of Industrial Technology, South Korea
- Kim, Se-Jong; Korea Institute of Materials Science, South Korea
- Kim, Paul; Rutgers University, United States
- Kim, Hoonsik; Apple Inc., United States
- Klassen, Robert J.; University of Western Ontario, Canada
- Kosiba, Graham; United States
- Krause, David; Signicast, United States
- Kumar, Sampath; Indian Institute of Technology Madras, India
- Kumar, Nitish; University of New South Wales Sydney, Australia
- Lai, Chien-Lin; China Steel Corporation, Taiwan
- Lee, Kwang Seok; Korea Institute of Materials Science, South Korea
- Li, Ruozhou; China
- Li, Xiaochun; University of California, Los Angeles, United States
- Li, Xiao; Pacific Northwest National Laboratory, United States
- Lim, Peck; SLM Solutions NA, United States
- Lindamood, Lindsey; EWI, United States
- Linyou, Cao; North Carolina State University, United States
- Liu, Jingfu; Sentient Science, United States
- Liu, Su; ArcelorMittal, United States
- Liu, Bert; Air Force Institute of Technology, United States
- Lolla, Tapasvi; Electric Power Research Institute Inc., United States
- Lu, Pin; Questek Innovations LLC, United States
- Luo, Xiaobing; Central Iron and Steel Research Institute, China
- Lynch, Kenneth; Boeing, United States
- M. Adinarayanapp, Somashekara; Ames Laboratory, United States
- Mahlon, Christina; United States
- Mcnamara, Cameron; HC Starck, United States
- Meaige, Ben; Honda R&D Americas Inc., United States
- Mickelson, Larry; Alcoa, United States

TMS Pinnacle Award to Celebrate 100 Years; Diran Apelian Receives Award

Mitchell, Brandon; Naval Air Systems Command, United States

Monson, Todd C.; United States

Muhlstein, Christopher L.; Georgia Institute of Technology, United States

Muto, Yuki; JX Nippon Mining and Metals Corporation, Japan

Nassar, Abdalla R.; Pennsylvania State University Applied Research Laboratory, United States

Nicholas, Jason; Michigan State University, United States

Ohara, Brandon; Nice America Research Inc., United States

O'Hara, Ryan; Air Force Institute of Technology, United States

Ollagnon, Zoe; United States

Panahi, Damon; ArcelorMittal Global R&D - East Chicago, United States

Pang, Xin; CanmetMATERIALS - Natural Resources Canada, Canada

Pedraza, Juan Pablo; Ternium Mexico S.A. de C.V., Mexico

Peles, Amra; United States

Perez, Airan J.; Office of Naval Research, United States

Pierce, Dean; Oak Ridge National Laboratory, United States

Pietrucha, Matthew; Cameca Instruments Inc., United States

Pisarski, Pawel; Lumiant Corporation, Canada

Poulton, Jason; Akron Rubber Development Laboratory Inc., United States

Powell, Robert; Atlas Pressed Metals, United States

Prabhu, Nithyanand; Indian Institute of Technology Bombay, India

Radhakrishnan, Rajeswaran; Faraday Technology Inc., United States

Raj, Sai V.; NASA Glenn Research Center, United States

Rakers, Nicole; PPG Industries, United States

Ramanuj, Vimal; Oak Ridge National Laboratory, United States

Raplee, Jacob; Arconic, United States

Riddle, Matthew; United States

Roberts, Scott A.; Sandia National Laboratories, United States Rosprim, Mary; NanoSteel Company Inc., United States

Ross, Richard; 3M, United States

Ryou, Heonjune; U.S. Naval Research Laboratory, United States

Saha, Partha; National Institute of Technology, India

Salamanca-Riba, Lourdes G.; University of Maryland, United States

Santoyo, Rolando Herrera; Mexico

Schaffoener, Stefan; University of Connecticut, United States

Sen, Fatih G.; Novelis, United States

Shaikh, Shadab; Vesuvius USA, United States

Sharma, Prithu; Apple Inc., United States

Shin, Yung; Purdue University, United States

Shipley, Andrew J.; EWI, United States

Shyu, Terry; Apple Inc., United States

Sims, Christopher; National Institute of Standards and Technology, United States

Skolrood, Lydia N.; Oak Ridge National Laboratory, United States

Smith, Laverne; Clarkson Aerospace Corp., United States

Snider, Matthew; Fuel Cell Energy, United States

Somasundaram, John; Big River Steel, United States

Song, Xueyan; West Virginia University, United States

Song, Eun-Ju; Sandia National Laboratories, United States

Song, Rongjie; ArcelorMittal, United States

Stevenson, Bruce D.; Global Advanced

Stone, Donald S.; United States

Metals. United States

Stull, Jamie A.; Los Alamos National Laboratory, United States

Su, Liangbi; China

Taheri-Mousavi, S. Mohadeseh; Massachusetts Institute of Technology, United States

Tashkandi, Mohammed A.; Northern Border University, Saudi Arabia

Tate, Stephen; Electric Power Research Institute, United States

Thacker, Karen; Boeing, United States

Truninger, Abbey; United States

- Van Ende, Marie-Aline; Seoul National University, South Korea
- Venkateswaran, Natarajan; Reliance Industries Limited, India
- Vijapur, Santosh; Faraday Technology Inc., United States
- Wan, Li; Seagate Technology, United States
- Wang, Xiaoqiang; CEPREI, China

Wang, Dan; Faraday Technology Inc., United States

Wang, Chao; Pacific Northwest National Laboratory, United States

Wang, Zhiguang; Xian Jiaotong University, China

- Webb, Sydnee; Lincoln Electric, United States
- Weiland, Hasso; Scandium International, United States

Wenninger, Dustin J.; Kohler Co., United States

Wilthan, Boris; National Institute of Standards and Technology, United States

Wu, Hui; National Institute of Standards and Technology, United States

Xu, Jing; Faraday Technology Inc., United States

- Xue, Sichuang; Purdue University, United States
- Yang, Caifu; Central Iron and Steel Research Institute, China

Yang, James; United States

Yoshida, Kazunari; Japan

Young, Charles J.; United States

Yu, Haibo; Honeywell UOP, United States

- Zepeda-Alarcon, Eloisa; Los Alamos National Laboratory, United States
- Zhang, Zheng; Institute of Materials Research and Engineering, Singapore
- Zhang, Duyao; Royal Melbourne Institute of Technology, Australia

Zhi, Yue; CEPREI, China

- Zhu, Lilong; University of Florida, United States
- Zhu, Xiankui; EWI Structural Integrity, United States
- Zou, Min; University of Arkansas, United States

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Do you have business or industry news of interest to the minerals, metals, and materials community? Submit your announcement or press release to Kaitlin Calva, JOM Magazine Managing Editor, at kcalva@tms.org for consideration.

In Case You Missed It: Business News from the Field

Ford Motor Company to Use Graphene Components

Dearborn, Michigan, USA: Ford Motor Company announced that it will use the carbon nanomaterial graphene to enhance foam materials that are used in vehicle production. In tests performed by Ford, the foam materials with graphene illustrated a 17 percent reduction in noise, a 20 percent improvement in mechanical properties, and a 30 percent improvement in heat endurance properties. In 2018, Ford estimated that more than 10 underhood components enhanced with graphene would go into production by year's end on the Ford F-150 truck and the Ford Mustang vehicle models.

Vattenfall to Pilot Lumenion's Steel Energy Storage System

Berlin, Germany: Lumenion GmbH, a combined heat and power storage system company, entered into an agreement with power production company Vattenfall Energy Solutions and municipal housing company Gewobag that will allow Vattenfall to pilot their new steel energy storage system. The 2.4 megawatt-hour energy storage system will absorb power generated by local renewable energy plants as heat and convert it to an output of about two parts heat to one part electricity. The system is expected to be capable of storing energy for 48 hours.

Boreal Completes Exploratory Copper/Gold Drilling Program Burfjord, Norway: Mineral exploration

company Boreal Metals completed their copper and gold exploratory drilling

program in Norway. The program included the diamond drilling of seven holes, for a total of 951 meters. The project is focused on high-grade copper veins and has bulk tonnage of mining potential. Boreal collaborated with Arctic Drilling, local businesses, and the surrounding communities, in order to complete the project ahead of time and under budget.

PRF Composite Materials Opens New Facility

Poole, U.K.: British manufacturer and supplier of high-performance materials PRF Composite Materials opened their third facility. This facility is dedicated to sales and sales support, allowing their original facility to increase its laboratory and research and development capabilities. This move also allows for the installation of a second prepreg line at their original facility.

ICMM Adopts U.N. Business and Human Rights Principles

Geneva, Switzerland: The International Council on Mining and Metals (ICMM) announced new membership requirements for joining the council at the United Nations (U.N.) Annual Forum on Business and Human Rights. Prospective members must adhere to the U.N. guiding principles for business and human rights, which includes issues such as labor rights, resettlement, gender, access to grievance mechanisms, mine closure, and pollution. Currently, ICMM is developing guidance on how members will validate performance expectations for adhering to the guiding principles.



University Park, Pennsylvania, USA: United Kingdombased company Morgan Advanced Materials opened a Carbon Science Research Centre of Excellence at Innovation Park in partnership with The Pennsylvania State University (Penn State). The 30,000-square-foot building will house researchers studying industry and engineering applications of carbon materials, including aerospace, medical, power generation, and more. One of the company's current projects is the development of carbon current collectors to connect train carriages to overhead wires. The Centre of Excellence is also the home of Morgan Advanced Materials' thermal ceramics, technical ceramics, metals, and joining businesses. (Photo courtesy of Invent Penn State.)



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The Numbers Are In: Extraction 2018 Declared a Success

Lynne Robinson

"You are among friends."

Extraction 2018 conference co-chairs Boyd Davis, Michael Moats, and Shijie Wang used this phrase to conclude their welcome letter in the conference program. It was a prescient choice, in that those words also capture the collegial spirit that resonated through nearly every aspect of the event. Held August 26-29, 2018, in Ottawa, Ontario, Canada, Extraction 2018 could be viewed as something of an experiment. For the first time, three leading metallurgical societies-The Metallurgy and Materials Society (MetSoc) of the Canadian Institute of Mining, Metallurgy & Petroleum (CIM), the Society for Mining, Metallurgy & Exploration (SME), and TMS-joined forces to organize a global conference focused exclusively on extractive metallurgy.

Onsite at the Westin Ottawa, there was every indication that this new approach to gathering the extractive metallurgy community was successful. Session rooms were packed, social events were at capacity, and attendees took advantage of the many opportunities for informal networking and business development. The metrics gathered in the weeks after the meeting confirmed those perceptions.

Nearly 840 professionals and students representing more than 40 nations attended Extraction 2018. More than 330 oral presentations were delivered during 77 technical sessions, and 55 posters were showcased during the course of the meeting. Beyond the quantity of the programming and events, responses to a survey of meeting attendees revealed a high level of satisfaction with the quality of the meeting. Fifty percent of the survey respondents rated Extraction 2018 as excellent, while another 43 percent described it as good. When asked if they would be interested in future installments of Extraction, 92 percent of the respondents answered with a resounding yes.

Business, Technology, and a Little History

An intention of Extraction 2018 was to provide a forum where professionals representing both the technical and



The Extraction 2018 conference co-chairs welcome attendees to the Conference Banquet. Pictured (from left) are: Shijie Wang, Rio Tinto Kennecott Utah Copper Corp. and representing TMS; Boyd Davis, Kingston Process Metallurgy and representing MetSoc; and Michael Moats, Missouri University of Science and Technology and representing SME.





Larry Seeley, Seeley Group Ltd., fields a question after his Hydrometallurgy Keynote, "Critical Metals: The Foundation of Our Society's Essential Technologies." Well-attended sessions such as this were the rule at Extraction 2018.

business aspects of the global extractive metallurgy community could meet to develop a deeper understanding of how issues of common concern could be more effectively addressed. To provide the marketplace context, the conference kicked off on Sunday afternoon, August 26, with a special symposium, Extractive Metallurgy Markets and Economics. Session presentations were organized to mirror the trajectory of a mining project, starting with an overview, delivered by Mark Selby, RNC Minerals, of the funding challenges faced by junior mining projects in the current economic climate. Luisa Moreno, Tahuti Global, followed with a very straightforward perspective on what investors are looking for as part of their decision-making process. Effective information gathering and its impact on the value calculation for a technical pilot



The Extractive Metallurgy Markets and Economics symposium kicked off the meeting with thought-provoking discussion from a broad representation of business and industry experts. Pictured are (from left) Michael Samis, Ernst & Young; Tang Bin, China NERIN; Jay Hemenway, Ocean Partners; Luisa Moreno, Tahuti Global; Yao Suping, China NERIN; Boyd Davis, session chair; and Mark Selby, RNC Minerals.

project (Michael Samis, Ernst & Young) and insights into the complexities of commodity trading (Jay Hemenway, Ocean Partners), rounded out the discussion. Yao Suping and Tang Bin, both from China NERIN, complemented these talks with a case-study focused presentation on how Chinese copper smelters are addressing resource and geographic considerations to ensure profitability.

At the conclusion of the symposium, meeting attendees gathered for an allconference plenary that explored the legacy of extractive metallurgy. Jeremy Mouat, a historian from the University of Alberta discussed how the advent of industrialized warfare with World War I propelled the advancement of modern metallurgical practice. He subsequently traced the evolution of the field in response to challenges presented throughout the 20th century. Peter Warrian, University of Toronto, then looked ahead to the future of the mining industry in a digital economy.

The first official day of Extraction 2018 concluded with an Opening Reception that gave attendees their first glimpse at the services and opportunities offered by the companies on display in the Exhibit Hall.

The idea for Extraction 2018 was born out of the recognition that MetSoc, SME, and TMS were on schedule to collectively offer at least four important recurring symposia to a common membership community in the same year. To best serve that community, Extraction 2018 was developed to house these meetings, as well as new programming, in one convenient conference. Starting on Monday, August 27, that concept was put into action when technical programming began in earnest.

The largest contributor to the program was Hydrometallurgy 2018, a leading international symposium series organized on a revolving basis by MetSoc, SME, and TMS every four years. Within the hydrometallurgy topic area, MetSoc offered its popular Gordon Ritcey Symposium, while also organizing a new symposium, Processing of Critical Materials. TMS likewise brought the 7th installment of its well-regarded International Symposium on Advances in Sulfide Smelting, which occurs every six years, to the meeting. TMS and MetSoc also co-organized the Peter Hayes Symposium on Robinson



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The Sunday evening allconference plenary session examined the history and future of extractive metallurgy.

Pyrometallurgical Processing, and SME contributed a new symposium, Sulfide Flotation.

Attendees had the opportunity to supplement what they learned in the session rooms with a first-hand view of technologies on optional plant and refinery tours, one of which was conducted as an innovative real-time video experience.

Looking Ahead and Some Ways to Look Back

Based on the enthusiastic attendance and positive feedback received on Extraction 2018, the leadership of the three organizing societies are in active discussion regarding potential next steps for the meeting. In the meantime, visit www.extractionmeeting.org to sign up





Breaks and networking sessions in the Exhibit Hall gave attendees the opportunity to cultivate valuable business connections.

for news and updates as details become clear. To view a selection of recorded presentations from Extraction 2018, visit MetSoc's Live Learning Center at www.metsoc.org. Viewing photos taken at the event will provide a sense of the activity and excitement generated by the meeting. Photos are available in the Extraction 2018 album on the TMS Flickr account at www.flickr.com/photos/tmsevents/albums.

Finally, in the February 2019 issue of *JOM*: The Magazine, be sure to read "The World Needs Metallurgical Process Engineers" by Peter C. Hayes, based on his keynote address delivered at a joint session of the 7th International Symposium on Advances in Sulfide Smelting and the Peter Hayes Symposium on Pyrometallurgical Processing held at Extraction 2018.



A panel discussion following the keynote talk, "The Changing World of Metallurgical Education," delivered by Peter C. Hayes, explored themes such as technical knowledge gaps, retaining knowledge in an organization, industry/academic collaboration, and attracting and keeping people in the field. Read the article, "The World Needs Metallurgical Process Engineers" based on Hayes' talk and informed by the panel discussion in the February 2019 issue of *JOM*: The Magazine. Pictured from left are: Hayes; Christina Meskers, Umicore and session chair; Sari Muinonen, Glencore; Ken Coley, McMaster University; Maurits van Camp, Umicore; Mario Leobbus, Arubis; Bart Blanpain, Leuven University.



An Evening to Remember

A highlight of Extraction 2018 was the conference banquet and reception hosted in the magnificent Grand Hall of the Canadian Museum of History. Surrounded by art and architecture celebrating the culture of Canada's First Peoples, attendees enjoyed good food, good company, and an eclectic evening program. Distinguished members from each organizing society were honored during an awards ceremony, while a good-natured trivia contest kept the evening light and engaging.



Although sold out, the Extraction 2018 Conference Banquet was still somewhat dwarfed by the grandeur of its setting in the Grand Hall.



Michael Moats, Missouri University of Science and Technology (center), received the TMS/SME/AIME James Douglas Gold Medal from Barbara Arnold, 2018 SME President, and Kevin Hemker, 2018 TMS President, at the banquet awards ceremony.





James J. Robinson, TMS Executive Director (standing at podium), thanked and congratulated the organizers and legion of volunteers who were responsible for making Extraction 2018 a success. Also pictured (from left) are Boyd Davis, Extraction 2018 co-chair representing MetSoc; David Kanagy, SME Executive Director; and Brigitte Farah, MetSoc Managing Director.

Peter C. Hayes, University of Queensland (left), received the TMS Extraction & Processing Division (EPD) Distinguished Service Award from Cindy Belt, EPD Chair, at the awards ceremony.



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The World Needs Metallurgical Process Engineers

Peter C. Hayes

The Changing World

On the face of it, the metallurgical industry looks stronger than at any time in its development. Primary metal production is at record levels, and continues to expand in response to significant population and consumption growth. The rapid technological changes that are currently underway are creating new markets for metals.

The industry response to this demand will be increased investment in exploration and the discovery of new primary sources in the form of ore bodies. However, we can expect that as these finite sources are consumed, there will be further declines in mean ore grades. Without major technological innovations this trend means that, to maintain the same levels of production, there will be increased energy usage, and with it increased costs and the potential for greater environmental impacts. The problems will be most acute for nonferrous metals and those metals that are present in low concentrations in ores. The use and treatment of polymetallic ores will increase. Raw materials will be of greater complexity in terms of both microstructure and composition over those that have been used in recent times. These factors will create a need for further technological development and metallurgical innovation to be able to efficiently process these materials.

The profile of the metallurgical industries in Europe and the United States has changed significantly from one of primary metal production to manufacturing. Metallurgical engineers have played a key role in the development of new advanced materials and manufacturing technologies, creating opportunities for new industries in a diverse range of engineering applications. The advent of computerization and new technologies for energy generation and storage are already stimulating the need for new process technologies to produce a wide range of metallic elements—elements that, even in the recent past, have been regarded as being of no more than intellectual or academic interest.

Although small in volume, these are high value products, critical for the sustainability of our technologically advanced societies. Examples of these metals include, in photovoltaics-indium, gallium, germanium, silicon, silver; in electric vehicles and batteries-cobalt, copper, lithium, rare earth elements, vanadium; in fuel cells-gold, palladium, platinum, ruthenium; thermo- and optoelectrics-bismuth, antimony, arsenic, gallium, selenium, tellurium. These metals are needed in the form of pure metals, compounds, and solutions to tight chemical and physical specifications for each of these different manufacturing applications.

In Europe, issues such as materials scarcity and concerns over the supply of critical metals have prompted strategic moves involving both government and industry towards creating a circular economy; one in which waste and energy usage is minimized, and metal and materials recycling are maximized. These initiatives, and the need for industry, university, and government cooperation are exemplified by the establishment of the European Institute



Peter Hayes

Editor's Note: This article is based on the keynote lecture, "The Changing World of Metallurgical Education. delivered by Peter Hayes at a joint session of the 7th International Symposium on Advances in Sulfide Smelting and the Peter Hayes Symposium on Pyrometallurgical Processing at Extraction 2018 held in August 2018. Comments were provided by the following discussion panel: Bart Blanpain (Leuven University); Kenneth Colev (McMaster University): Mario Loebbus (Aurubis); Sari Muinonen (Glencore); and Maurits van Camp (Umicore). Extraction 2018 was organized by The Metallurgy and Materials Society (MetSoc) of the Canadian Institute of Mining, Metallurgy and Petroleum (CIM); the Society for Mining, Metallurgy & Exploration (SME); and TMS.

Do You Have a Perspective to Share?

JOM: The Magazine is seeking case studies, member perspectives, and nontechnical project overviews with strong industrial applications. To suggest an article idea, contact Kaitlin Calva, JOM Magazine Managing Editor, at kcalva@tms.org. of Innovation and Technology (EIT). Within this Institute, "raw materials" was designated as one of the key Knowledge and Innovation Communities charged with assisting the drive towards the circular economy.¹

The underlying message is clear. Our technologically based society cannot be sustained without the continued supply of metals from both primary and secondary sources. Metallurgical engineers are needed to provide innovative solutions to the emerging and complex challenges faced by the industry.

Status of Metallurgical Education Programs

Over the past 100 years, the principal pathways that have been developed for the education of our young engineers have been through tertiary institutions, our colleges and universities. In general, the standards of training of professional engineers have never been higher. All recognized engineering programs are subject to rigorous scrutiny by accreditation panels representing the various engineering professions. Accredited learning programs must fulfill minimum standards of learning outcomes covering fundamental and specialist knowledge, graduate attributes and professional engineering skills.2-4 Major efforts are being made across all tertiary institutions to improve teaching and learning practice, to enhance the quality of deep learning and provide the foundations for lifelong learning.

However, if we examine the structure and content of metallurgical engineering programs, we find, particularly in the United States and Europe, that the majority have morphed over time into materials science and engineering (MSE) programs —a matrix of disciplines that are related through the common elements of structure/ composition; properties; performance, and product synthesis.5 This change has been driven by major investments into the research and development of new materials, and their application to new manufacturing technologies. While the expansion and growth of metallurgical education into these new areas is welcome, close examination reveals a marked

decline in teaching, and in research and development capabilities in core aspects of metallurgical process engineering.⁶ Metallurgical process engineering has been reduced to a minor component of most of these MSE teaching and learning programs, and in many cases, key courses have disappeared from the curriculum. There has been a marked decline in student enrollments in metallurgical process engineering programs in industrialized countries.

In addition, those countries whose economies rely on primary metal production in general, do not have the financial resources or education infrastructures strong enough to establish and sustain strong mineral processing and metallurgical process engineering programs.

Across the globe, the strong support previously given by industry for mining and metallurgical education has faded. Schools of Mines, once the source of skilled workforces for primary production. have been closed. The numbers of academic positions at universities supported by industry have declined. The result is that, internationally, with the few exceptions of countries having centrally controlled economies, there has been a decline in financial resources directed towards providing opportunities for future metallurgical engineering professionals. In short, the quality and sustainability of metallurgical engineering education in most regions of the world are under threat at the very time that innovation and the ability to meet major technical challenges are becoming the central tenants to the future of the industry. Industry will be the first to lose if the availability of welltrained metallurgical engineers continues to decline. Those companies and countries that invest in their workforce are the ones most likely to survive the emerging challenges and to take advantage of the business opportunities ahead.

A concerted effort is needed by industry, professional societies, and academia to promote and sustain the education and research capacities in the field of metallurgical process engineering at our tertiary institutions.



Metallurgists of the Future

If the need for continued metallurgical education is accepted, it is timely to ask some important questions. What knowledge, skills, and attributes do we need from our future metallurgical engineering workforce to prepare them for the challenges that lie ahead? How are we to ensure that we provide appropriate learning and career pathways for future professional metallurgical engineers? We need metallurgical engineers who can understand and provide innovative solutions to complex problems, and who can adapt to the rapid changes in technologies.

All metallurgical engineers need a background and understanding of mathematics, the basic sciences, materials, and other engineering sciences in order to be able to communicate and effectively work with other professionals in the industry. Some would argue that a general engineering education is sufficient. However, the metallurgical industry also needs engineers with specialist knowledge and advanced skills in mineral (physical) processing, hydro/electro-metallurgy, and pyrometallurgy. In order to truly understand metallurgical processes and have an appreciation of the potential for process improvement, a graduate engineer should have an understanding of the whole value chain.

The metallurgist of the future will spend more time utilizing the powerful computer tools that have become available through the digital revolution rather than patrolling the shop floor controlling individual unit operations. Using these sophisticated computer-based tools to analyze complex data sets and predict process outcomes, metallurgical engineers can play a key role in increasing the productivities of integrated operations and/or optimizing the overall financial returns of these operations.7 The ability to apply these principles to different physical and chemical systems can be provided by integrating this specialist metallurgical knowledge with core process engineering knowledge and skills in chemical thermodynamics, mass and energy transport, reaction kinetics, process control, systems engineering analysis,



problem solving, and synthesis.

The common features that could be used to define the metallurgical process engineering (MPE) programs for the future, and the core knowledge and skills needed, can be summarized by four interrelated areas: specialist metallurgical process knowledge and skills; process control/ reaction engineering; process modeling and optimization; and process design and synthesis (see Figure 1).

It is not by chance that many of these areas of knowledge and core skills are common to chemical engineering graduates. That discipline has been successful in transforming itself from its origins in applied chemistry to encompassing a wide range of process industries that include petroleum, oil and gas, polymers, inorganic chemicals, biotechnology, environmental engineering, and new materials. It is time to combine the strengths of process and systems thinking, which are at the heart of modern chemical engineering, with specialist metallurgy knowledge and skills, to reinvigorate the metallurgical process engineering discipline. In this way, we can create educational structures that embrace the needs of the current and the future metallurgical industry.

A flexible yet sound and robust structure can be built by utilizing the strengths of process engineering in the early years of the programs. Basic and engineering sciences in year one and process engineering and modeling fundamentals in year two with contextual learning of metallurgical applications. In years three and four, the study plan would include specialist Figure 1. Common core knowledge and skills that can be used to define and develop metallurgical process engineering (MPE) programs.



Figure 2. A proposed program structure for bachelor's of engineering metallurgical process engineering programs based on a strong process engineering core with flexibility to cover the many branches and specializations that embody the discipline. metallurgical courses and courses from related disciplines as appropriate for local industry requirements. The proposed structure of such a program, one that incorporates the features of a core of process engineering and broadening through links to different branches and specialist fields of metallurgy, is illustrated schematically in Figure 2. In this way, a strong and sound metallurgical process engineering program can be constructed using, and building on, the existing teaching and learning resources within our engineering faculties. The model provides flexibility that enables individual institutions to offer or develop programs that reflect strengths in particular branches of metallurgical engineering.

This framework could be used to develop four-or five-year bachelor's or B.E./M.E. programs in metallurgical process engineering. The structure is not intended to be prescriptive and may not be suitable or appropriate for all tertiary institutions. It is, however, the basis for the B.E. dual major program in chemical and metallurgical engineering that has been running successfully since 2006 at The University of Queensland. In practice, the details of programs offered at different institutions will vary depending on local and regional industry needs. In some countries, the focus will be on mineral processing and the preparation of mineral concentrates; in others, the emphasis will be on the development of metal recovery and recycling or new process routes for the production of advanced materials. The point is that a common set of core knowledge and skills is required to be able to tackle these problems as a professional metallurgical engineer.

Essential Elements for the Sustainability of MPE

Continuing the analogy of the tree (see Figure 3 on the following page), the healthy growth of plants requires the provision of the atmosphere (sun, water, CO_2) and a fertile environment (essential elements, organic matter, nutrients, microbiological activity). We can draw some useful analogies between this example and the requirements for sustaining metallurgical education.

In the metallurgical context, *the atmosphere* that is essential for the growth and sustainability of metallurgical engineering as a discipline is one that includes:

- Acknowledgement at senior leadership (chief executive officer) levels and proactive industry support for metallurgical engineering education
- Creating attractive, challenging, and visible career paths
- Promoting a positive and exciting vision of the ways in which professional metallurgical engineers can contribute to the future sustainability of our society

The fertile environment necessarily includes:

- Ensuring that recognized tertiary institutions have appropriate numbers of academic staff and learning facilities to be able to provide specialist metallurgy learning at undergraduate and postgraduate levels
- Active engagement between university/ industry to identify the challenges faced by the minerals, primary and recycled metals, and advanced materials industries
- Providing supportive learning environments and collaborations between complimentary academic disciplines, e.g., MSE programs and chemical engineering departments
- Providing appropriate funding models to sustain undergraduate and postgraduate process metallurgy programs

Strategies to Develop Our Future Workforce

A major issue is attracting sufficient young would-be engineers into metallurgical engineering programs. For this to occur, there has to be a significant change in perceptions on their part. The industry needs to embrace a new vision and demonstrate that the focus is just not about making money—young people want to feel that they are genuinely playing a part in shaping the future. We need to excite their interest; to show them how they can utilize their skills in creating a sustainable society and a healthier environment.



Most university programs are active in recruiting students whenever and wherever they can, since their funding is principally based on enrolment numbers. Potential actions by universities to re-establish the profile of metallurgical process engineering include:

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- Re-establishing attractive undergraduate majors in MPE programs with a focus on core metallurgical and process engineering skills
- Developing flexible entry and pathways into MPE programs
- Articulating clear, exciting career pathways and opportunities for graduates
- Promoting and marketing a positive view of the future of the metallurgical industry

Figure 3. The essential conditions for the healthy growth of plants, which provides a useful analogy for the requirements for sustaining metallurgical education.

The numbers of students expected in these MPE programs are small relative to other engineering disciplines, which makes them hard to justify to university management. For this reason alone, the establishment of MPE programs needs additional moral and financial support from the minerals and metallurgical industries.

Potential actions by industry include:

- Actively supporting and engaging with academic and research staff through funding industry focused research
- Providing industry-funded academic positions in specialist fields of metallurgical engineering
- Developing long-term partnerships in support of research and development strengths in fundamental research in selected core fields of expertise
- Attracting prospective students into the industry through providing and supporting quality industrial work experiences and internships for early year (1, 2, 3) undergraduate students
- Providing mentoring, technical development, engineering skills and career guidance to early career graduate engineers
- Establishing continuing professional development programs within companies that support deep learning of advanced skills
- Establishing good relationships and ongoing dialogue between senior management in companies and universities, to provide a mechanism of explaining industry needs and opportunities for collaborations

Summary

The world needs metallurgical process engineers to ensure continued metal resource supply and sustainability of our technologically based society. This will require concerted efforts by industry, professional societies, and academia across the globe to promote and sustain the education and research capacities in the field of metallurgical process engineering at our tertiary institutions. In this article, I have put forward some thoughts about the knowledge, skills, and attributes needed in our future metallurgical engineering workforce and proposed a flexible educational structure, based on process metallurgy, that could be used to deliver the next generation of engineers. I look forward to hearing other ideas on how we can meet these goals, actions, and initiatives that can be taken so that we can address the rapid changes faced by the modern metallurgical industry, and move closer to the economic, technical, and social sustainability of our society.

End Notes

1. EIT, European Institute of Innovation and Technology, https://eit.europa.eu/eit-community /eit-raw-materials.

2. ABET, Accreditation Board for Engineering and Technology, Engineering Accreditation Commission, www.abet.org/.

3. EA, Engineers Australia, www.engineersaustralia.org.au/.

4. Institution of Chemical Engineers (IChem E), www.icheme.org/.

5. M.C. Flemings, "What Next for Departments of Materials Science and Engineering?", *Annu. Rev. Mater. Sci.* 1999, vol. 29, pp.1–23.

6. P.C. Hayes, "The Changing World of Metallurgical Education," Extraction 2018, 2018, pp. 57–67.

7. E. Jak, "The Role of Research in Pyrometallurgy Technology Development from Fundamentals to Process Improvements— Future Opportunities," Extraction 2018, 2018, pp.19–37.

Peter Hayes is professor of metallurgical engineering within the School of Chemical Engineering at The University of Queensland, Brisbane, Australia. He is currently the Metallurgical Engineering Program leader and is senior researcher in the Pyrometallurgy Innovation Centre (PYROSEARCH) at the university. He has been an active TMS member since 1986.





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A Celebration of Excellence: 2019 TMS Society Awards

Ashley-Anne Bohnert and Carol Matty



TMS awards are prestigious acknowledgements of a recipient's lasting contribution to the fields of minerals, metals, and materials science and engineering. Many of these awards celebrate distinguished service to the Society and to the professional community by highlighting scholarly, leadership, or mentoring accomplishments that elevate the field and inspire future generations.

The awards presented in this article will be conferred during the TMS–AIME Awards Ceremony, scheduled for Wednesday March 13, 2019, as part of the TMS 2019 Annual Meeting & Exhibition (TMS2019), held from March 10–14, in San Antonio, Texas. Receiving a TMS award is considered a significant milestone in any career, so the ceremony is open to TMS2019 attendees who wish to join in celebrating the accomplishments of their colleagues.

NOMINATE A COLLEAGUE BY APRIL 1

Nominations are now being accepted for 2020 TMS awards. Acknowledge the accomplishments of a distinguished colleague by submitting a nomination packet before the deadline of **April 1, 2019**.

To begin the nomination process or to see a complete list of awards, criteria, and instructions, visit the TMS Honors and Awards website at awards.tms.org. For additional information, contact Deborah Hixon, TMS Awards Program Administrator, at awards@tms.org.

SOCIETY AWARDS

2019 TMS FELLOWS

The class of Fellow is TMS's highest honor. To be inducted, a candidate must be recognized as a leading authority and contributor to the practice of metallurgy, materials science, and technology, with strong consideration given for outstanding service to the Society.



Thomas Bieler, *Professor and* Director, Michigan State University

Citation: For seminal scientific and technological contributions to the understanding of the influence of grain boundaries and texture on the processing and properties of engineering alloys.



M. Grace Burke, Professor and Director, University of Manchester Citation: For extraordinary experimental skills in determining the causes of brittle failure and stress corrosion cracking in nuclear reactor materials.



Roderick Guthrie, Director of McGill Metals Processing Centre, McGill University

Citation: In recognition of his outstanding research contributions to the development of ferrous and nonferrous processes, and a distinguished academic career in the education of students. "I have a deep respect for TMS,"

Guthrie stated. "Having been a TMS member since 1969, I have had the opportunity to present many of my, and my students', research contributions. Meantime, I have watched the TMS organization grow into a global force for good. Given the many active members and contributors from all around the world, I am hopeful that this will continue. As such, I accept this recognition of being named a Fellow of TMS with gratitude and pride."



Elizabeth Holm, Professor, Carnegie Mellon University Citation: For pioneering achievements and leadership in computational materials science and integrated computational materials engineering and for distinguished service to the materials profession.



Frank Crossley, Retired, Aerojet Propulsion Research Institute Citation: For the pioneering development and application of titanium alloys into crucial aerospace applications, both commercial and defense, including critical U.S. national security areas.



Dennis Dimiduk, Chief Technologist, BlueQuartz Software LLC

Citation: For leadership and contributions to high-temperature and intermetallic materials development, integrated materials modeling, 3D materials science, and the science of size-scale effects in plasticity.



Nack Joon Kim, Professor, Pohang University of Science and Technology Citation: For seminal contributions toward the development of high performance structural alloys through microstructure design, leading to commercialization of these alloys in various applications.

"I joined TMS as a graduate student in the United States and it has been one of my principal professional societies throughout my career, although I have been conducting research in Korea for some 30 years," Kim said. "As a long-time international member, I am deeply honored to be recognized by TMS and would like to share this honor with my colleagues, postdocs, and students, without whose support this prestigious award would not have been possible." A Celebration of Excellence: 2019 TMS Society Awards



Alan Taub, Professor, University of Michigan

Citation: For advancing materials technology and commercialization through a combination of personal research accomplishments and technology leadership in both industry and academia. "I first joined TMS as a graduate student and have relied on the

meetings and publications to learn about the latest developments in my field," Taub noted. "As a Society that embraces the intersection of science and engineering, TMS enables me to interact with a broad range of researchers from industry, national laboratories, and academia from around the world. It is quite an honor to be recognized as a Fellow by this community."



Dan Thoma, Director, Grainger Institute for Engineering, University of Wisconsin—Madison Citation: For pioneering research in advanced processing and alloy design as well as for leadership of and service to the materials profession. "Beceiving the prestigious TMS

"Receiving the prestigious TMS Fellow Award is a humbling

honor," expressed Thoma. "TMS is my primary source for professional information dissemination and networking. Since I was a student, I have admired the leadership and the contributions of past TMS Fellows. To be recognized within this esteemed group is truly rewarding. I look forward to future years of continued, productive interactions and service."

2019 BRIMACOMBE MEDALISTS

This mid-career award recognizes individuals with sustained excellence and achievement in business, technology, education, public policy, or science related to minerals, metals, or materials science and engineering, and a record of continuing service to the profession.

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Sean Agnew, Director of Engineering Science Major, University of Virginia Citation: For outstanding contributions to advancing the scientific understanding of deformation mechanisms and the associated mechanical response of magnesium-based and other metals.



Raymundo Arroyave, Professor, Texas A&M University Citation: For his leadership in integrating informatics and data science into materials design and for exemplary service to the materials community through his

dedication to TMS



Irene Beyerlein, *Professor, University of California, Santa Barbara*

Citation: For groundbreaking work on the plasticity of HCP metals and metal nanocomposites as well as for her commitment to mentorship of the next generation of materials scientists.



Jian Luo, Professor, University of California, San Diego

Citation: For significant contributions of understanding materials interfaces, especially developing grain boundary phase diagrams and uncovering the mysterious mechanisms of liquid metal embrittlement and activated sintering.

"I am truly honored to receive a TMS

Brimacombe Medal," Luo said. "Trained as a ceramist, I am currently working almost equally on metals and ceramics, with a focus on interfaces. TMS offers a wonderful interdisciplinary scientific discussion platform across different types of materials. Participating in technical committees and co-organizing symposia are also highly fruitful experiences for me, and TMS is instrumental in helping my career and professional development."



Jonathan Spowart, Senior Materials Research Engineer, United States Air Force Citation: In recognition of outstanding contributions to the field of materials characterization which have enabled numerous advances in materials science and engineering.

"TMS membership has provided

me with unparalleled benefits over a multi-decade career in the materials science profession," noted Spowart. "I have been an active member of TMS for over 25 years and, as my career has progressed, TMS has been there every step of the way. TMS membership has allowed me to grow substantially and professionally over that time, and has allowed me to make a difference in the lives of others. TMS membership provides a platform and foundation for personal and professional excellence, and has truly enabled me to accomplish those things that the Brimacombe Medal celebrates and recognizes in its recipients. I am extremely happy and genuinely humbled by this prestigious award, and I look forward to serving TMS for many years to come."



Dallas Trinkle, Associate Professor, University of Illinois at Urbana-Champaign Citation: For significant contributions to the prediction of alloying efforts on diffusion, solid solution strengthening and softening and for exemplary service to TMS.

"I am honored to receive this

award from TMS. TMS has been my home professional Society for fifteen years," said Trinkle. "I have had many opportunities to present new and exciting results for myself at first and now for my research group. As a 'bottom-up' organization, I have enjoyed working with my colleagues in the science and engineering community to develop programming and work for the community. I am honored to receive this recognition from my colleagues, and humbled to join the ranks of Brimacombe Medalist awardees."

ALEXANDER SCOTT DISTINGUISHED SERVICE AWARD

Recognizing a member's outstanding contributions to TMS, this award is typically presented for 10 or more years of TMS service in membership development, student chapters, education and professional affairs, and/or other Society level activity.



Robert Hyers, Professor, University of Massachusetts Citation: For more than a decade of selfless and dedicated service, and exceptional leadership to TMS through the organizing of symposia, committee memberships, Financial Planning Officer, and membership of the Executive Committee and Board of Directors.

"TMS is my main professional home," Hyers stated. "TMS is where I learned how to participate in a professional society. Volunteering for TMS gave me opportunities to meet most of the colleagues in my professional network, something to do with them so that we could build acquaintances into professional relationships, and once in a while, a chance to make a difference."

JULIA AND JOHANNES WEERTMAN EDUCATOR AWARD

This award recognizes an individual who has made outstanding contributions to education in metallurgical engineering and/or materials science and engineering.



David Van Aken, Professor, Missouri University of Science and Technology

Citation: For more than three decades of exemplary education of students in physical metallurgy and the development of innovative technologies to produce next generation high strength steels.

LEADERSHIP AWARD

This award recognizes an individual who has demonstrated outstanding leadership in the national and international materials community.



James Warren, Director, Materials Genome Program, National Institute of Standards and Technology

Citation: For exceptional leadership in realizing the vision of the Materials Genome Initiative (MGI) to discover, manufacture, and deploy advanced materials twice as fast, at a fraction of the cost.

"This award from my TMS colleagues is very meaningful," stated Warren. "TMS has been one of the most forwardlooking organizations in support of the mission of the Materials Genome Initiative, acting as a true partner in realizing the vision to accelerate materials discovery. Having devoted the last nine years of my career to this goal, having TMS in my corner has made an enormous difference. I believe that my leadership was buoyed by the leadership TMS has shown."

APPLICATION TO PRACTICE AWARD

This award recognizes an individual who has demonstrated outstanding achievement in transferring research results or findings into commercial production and practical use.



Don Lipkin, Senior Principal Scientist, GE Global Research Citation: For outstanding contributions to the application of materials science to gas turbine technology, especially on protective coatings that enable benefits in efficiency and environmental impact.

BRUCE CHALMERS AWARD

Honors outstanding contributions to the science and/or technology of materials processing by an individual.



Dieter Herlach, Full Professor, German Aerospace Center Citation: For his key contributions in rapid solidification and solidification experiments under reduced gravity, which have enlightened our understanding of dendritic growth at large undercooling and the influence of convection.

MORRIS COHEN AWARD

Recognizes an individual who has made outstanding contributions to the science and/or technology of materials properties.



William Gerberich, Professor Emeritus, University of Minnesota Citation: For developing mechanistic relationships between the structure and mechanical properties of materials. Gerberich reflected: "I can reminisce upon several outstanding events during my career: the ability to give a pre-doc lecture at

California Institute of Technology; an invitation from Max Williams to be editor of *International Journal of Fracture*; giving an American Association for the Advancement of Science contribution in 1968; attending TMS departmental receptions in the 1990s; and finally, being part of an honorary session at the TMS 2006 Annual Meeting & Exhibition. Above all, my fondest reminiscence is from last year's retirement of my best students calling me 'Mr. Sunshine' for encouraging excellence in materials science."

OLEG D. SHERBY AWARD

This award recognizes an individual, or small group of collaborators, who has made significant contributions to the understanding of the behavior of materials at high temperatures.



Michael Mills, Professor, The Ohio State University Citation: For understanding creep behavior in complex metallic alloys using advanced characterization methods to gain new insights into deformation mechanisms and develop new models of deformation.

WILLIAM HUME-ROTHERY AWARD

Awarded in recognition of exceptional scholarly contributions to the science of alloys.



Mark Asta, Professor, University of California, Berkeley Citation: For his foundational contributions to the theory and simulation of the thermodynamic and kinetic behavior of bulk and interfacial inorganic alloys.

INSTITUTE OF METALS LECTURER & ROBERT FRANKLIN MEHL AWARD

In receiving this pinnacle award, honorees present a lecture at the TMS Annual Meeting & Exhibition, which is also published in *Metallurgical and Materials Transactions A*.



Hael Mughrabi, Professor Emeritus, University of Erlangen-Nürnberg Citation: For seminal discoveries that had a profound effect on our understanding of plastic deformation and failure of metals with particular emphasis on fatigue and for global leadership. "During the past nearly 35 years

of my membership with TMS, I have repeatedly attended TMS meetings where I have given talks and enjoyed valuable scientific and personal connections with many other colleagues," Mughrabi said. "Over the years, I have witnessed how TMS has expanded its influence internationally. In this way, TMS has become an essential part of my professional and scientific activities. I consider the receipt of this prestigious TMS award a very special recognition of the work of my research group, and I am very proud to be honored in this way."

ELLEN SWALLOW RICHARDS DIVERSITY AWARD

Honors the contributions of an individual who reflects the pioneering spirit of Ellen Swallow Richards in overcoming personal, professional, educational, cultural, or institutional adversity to pursue a career in the minerals, metals, and/ or materials professions or in helping others in the field to overcome similar challenges.



Michelle Buchanan, *Deputy for* Science & Technology, Oak Ridge National Laboratory

Citation: For her efforts to increase diversity in hiring, exceptional mentoring, and advocacy for early career scientists, and tireless dedication to improving workplace culture. "TMS membership and the TMS

Foundation benefit me through broad communication of recent advances in materials research, both within the community and to the general public," Buchanan noted.

FRANK CROSSLEY DIVERSITY AWARD

Honors an individual who has personally overcome personal, professional, educational, cultural, or institutional adversity to pursue a career in minerals, metals, and/or materials.



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Olivia Underwood, Product Realization Team Leader, Sandia National Laboratories Citation: For a first generation college graduate; exemplifying persistence in her academic degree; a professional career leader; and outreach to underrepresented women in STEM. "TMS membership and the TMS

Foundation benefit me by providing me a platform to share my latest work with the research community along with the opportunity to be able to attend the different talks and workshops of others when attending the TMS conferences," Underwood stated. "It allows me to network and collaborate with others. It also allows me to stay connected to my colleagues. Last but not least, it is great to have access to the free journals and to be able to serve on different committees."

EARLY CAREER FACULTY FELLOWS

This award recognizes an assistant professor for his or her accomplishments that have advanced the academic institution where employed, and for abilities to broaden the technological profile of TMS.



Elsa Olivetti, Assistant Professor, Massachusetts Institute of Technology

Lecture: "Data Mining to Guide Synthesis Towards Resource-Effective Materials, Processes and Systems"

"TMS membership provides me with the opportunity to connect with colleagues from a range of

organizations and backgrounds on topics I'm interested in and am working on," Olivetti observed. "I'm grateful for the opportunity that TMS membership provides me with to build these networks, present my work and the work of my students for feedback, as well as identify new research opportunities and collaborations. TMS membership also provides me with an opportunity to connect my academic work with industry members or move research in a direction that is more valuable to industry. Finally, I'm able to learn about recent critical advances in the field." A Celebration of Excellence: 2019 TMS Society Awards



Ashley Spear, Assistant Professor, University of Utah

Lecture: "Data-Driven Materials Science: Successes, Challenges, and Opportunities"

"I first joined TMS as a graduate student in 2011. At that time, I was able to start developing a network by attending and presenting at the TMS Annual Meeting," Spear

noted. "I would always look forward to learning about the latest research in the community and meeting new people. Once I became a faculty member, my network within TMS expanded. I am pleased to say that my students are now active in the TMS community and have been presenting their research at the annual meeting for the last few years. I feel extremely fortunate to have found a strong and supportive community in TMS."

TMS BEST PAPER CONTEST

This award recognizes student essays on global or national issues as well as technical research papers, relating to any field of metallurgy or materials science.

Graduate—1st Place



Pranjal Nautiyal, Student, Florida International University

"I started my Ph.D. in materials engineering in 2015 and have been a Material Advantage (MA) member since then," Nautiyal stated. "I have participated in student contests, received TMS travel grants to attend conferences, and interacted with other fellow students and

researchers in the materials community. I also chaired the MA chapter in my university, which has helped me to gain leadership experience, engage in social outreach, and get to know successful professionals in my area. TMS has helped me develop skill sets that will be helpful for me to succeed."

Graduate—2nd Place



Rui Feng, Student, University of Tennessee, Knoxville

"It is my great honor to receive this award again," noted Feng. "I would like to thank the TMS Foundation and Material Advantage, which offer me a wealth of resources to connect with many excellent researchers and stay up to date with the cutting-edge progress in my field. With the stimulation from this award, I will continue my hard work and passion in my future academic research and any other engaged works."

AIME AWARDS

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AIME HONORARY MEMBERSHIP

Conferred upon an individual for outstanding service to or distinguished scientific or engineering achievement in the fields embracing the activities of the American Institute of Mining, Metallurgical, and Petroleum Engineers (AIME) and its member societies.



K. Linga Murty, *Professor, North Carolina State University*

Citation: For his contributions to the materials community through exemplary research and service in nuclear materials, high temperature deformation behavior, and nanostructured materials.

TMS/SME/AIME JAMES DOUGLAS GOLD MEDAL

Honors distinguished achievement in nonferrous metallurgy, including both the benefication of ores and the alloying and utilization of nonferrous metals. This award is administered through TMS's Extraction & Processing Division (EPD) and the Society for Mining, Metallurgy & Exploration's Minerals & Metallurgical Processing Division (MPD).



Jiann-Yang (Jim) Hwang, Professor, Michigan Technological University Citation: For creative and exceptional contributions and leadership for the mineral

processing and metallurgy community for over 40 years.

AIME ROBERT LANSING HARDY AWARDS

For more than half a century, this award has recognized professionals under the age of 35 in the broad fields of metallurgy and materials science for exceptional promise of a successful career.



Saryu Fensin, Scientist, Los Alamos National Laboratory Citation: For innovative and scientifically groundbreaking modeling research quantifying the role of grain boundary structure on the dynamic mechanical response of materials.



Nan Li, Staff Scientist, Los Alamos National Laboratory Citation: For elucidating the deformation mechanisms and irradiation response of nano-metals via in situ TEM nanomechanics. "I am truly honored to receive the prestigious AIME Robert Lansing Hardy Award," Li stated. "I would like to thank my nominators, my

advisor and mentors, my collaborators, the members of the TMS Award Committee, and TMS Foundation for their support. This is a significant milestone in my professional career. TMS is an exciting professional society, and every time I attend the TMS Annual Meeting & Exhibition, I am inspired by the science and networking opportunities there. I look forward to my continued contributions to this society."

AIME CHAMPION H. MATHEWSON AWARDS

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Awarded to the author(s) of a paper, or a series of closely related papers, representing the most notable contribution



to metallurgical science during the period under review. Pictured, left to right, are: Irene Beyerlein, Professor, University of California, Santa Barbara; Marko Knezevic, Associate Professor, University of New Hampshire; and Marcel Risse, BSH Home Appliances Corporation. Not pictured are: Christoph Fahrenson, Technical Staff Member, Technical University of Berlin; Martin Lentz, Project Manager, Hydro Aluminum Rolled Products GmbH; and Walter Reimers, Professor, Technical University of Berlin.

Paper, Light Metals Topic Area: "Elevated Temperature Effects on the Plastic Anisotropy of an Extruded Mg-4 Wt Pct Li Alloy: Experiments and Polycrystal Modeling," *Metallurgical and Materials Transactions A*, Vol. 48, January 2017.

"I feel very honored to be a recipient of this award. It is a strong motivator for further technical projects in the field of metallurgical and material science." Risse observed. Knezevic added, "Research efforts and accomplishments being recognized and rewarded by the TMS community always positively influence the professional development of its members. This award is a motivation for me to continue the good work and remain within the network of





TMS members."

Pictured, left to right (top row), are: Jonathan Cormier, Associate Professor, ISAE-ENSMA and Institut Pprime; Ana Casanova Gomez, Student, University of Cambridge; Jean-Michel Franchet, Materials & Processes Engineer, Safran Tech; (bottom row) Tresa Pollock, Professor, University of California, Santa Barbara; Damien Texier, CNRS Researcher, Institut Clement Ader, UMR CNRS; and Patrick Villechaise, Senior Researcher, Institut Pprime – CNRS. Not pictured is: Stephane Pierret,

Engineer, Safran Aircraft Engines.

Paper, Mechanical Behavior Topic Area: "Microstructural Features Controlling the Variability in Low-Cycle Fatigue Properties of Alloy Inconel 718DA at Intermediate Temperature," *Metallurgical and Materials Transactions A*, Vol. 47, March 2016.

"This award is a great honor that recognizes starting research activities with colleagues I particularly appreciate," noted Texier. Gomez added, "I am very honored to share this award with a team of great professionals that I deeply admire." Franchet noted, "This award recognizes a long-term collaboration on metallurgical and mechanical studies concerning high strength disk superalloys for rotating components in gas turbines." Villechaise added, "This is a nice recognition for an experimental study developed in collaboration between these research teams." Cormier noted, "TMS allowed me to network with colleagues all around the world and for me, TMS is the leading organization for dissemination of scientific knowledge through its journals and conferences."

AIME HENRY DEWITT SMITH SCHOLARSHIPS

Funded by AIME, of which TMS is a member society, this scholarship is awarded to graduate students majoring in mineral, metals, and/or materials engineering. The AIME Henry DeWitt Smith Scholarship aims to advance the mineral industries by assisting students in the pursuit of graduate education in mining, metallurgical, materials, or petroleum-related disciplines.

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Brady Dowdell, Student, North Carolina State University "In the first year of my Ph.D., I joined Material Advantage (MA) to start making professional connections, and learn more about the different career paths open to me," Dowdell reflected. "As a result, I have not only made several local connections with industry

professionals at MA meetings, but have been provided the opportunity to share my research with a broader audience at TMS conferences. I have also been afforded opportunities to conduct research on multiple projects that aren't directly related to my Ph.D. research as a result of attendance at MA meetings. This extra experience not only improved my confidence and competence in the techniques required to conduct my research, but has also helped me determine which career path I wish to take.



Pranjal Nautiyal, Student, Florida International University

"I started my Ph.D. in materials engineering in 2015 and have been a Material Advantage (MA) member since then," Nautiyal stated. "I have participated in student contests, received TMS travel grants to attend conferences, and interacted with other fellow

students and researchers in the materials community. I also chaired the MA chapter in my university, which has helped me to gain leadership experience, engage in social outreach, and get to know successful professionals in my area. TMS has helped me develop skill sets that will be helpful for me to succeed."



ACTA MATERIALIA AWARDS ACTA MATERIALIA GOLD MEDAL AWARD



Awarded to a proven leader in materials science and engineering whose research has significantly impacted the development of the discipline.

Ke Lu, Professor and Director, Institute of Metal Research

ACTA MATERIALIA SILVER MEDAL AWARD



This award honors scientific contributions and leadership from academic, industry and public sector leaders in the midst of their careers.

Xavier Savage, Deputy Director, CNRS - GPM - University Rouen Normandy

ACTA MATERIALIA HOLLOMAN MATERIALS & SOCIETY AWARD



This recognition honors an individual who promotes understanding of the relationship and interactions between materials technology and societal interest or needs.

Alexander H. King, *Professor, Iowa State University*

BRIMACOMBE PRIZE

The Brimacombe Prize recognizes an excellent researcher, visionary, and innovator for a better society, teacher, and world ambassador, creatively integrating science and technology. The Brimacombe Prize is supported by the Brimacombe Fund, an endowment held by the Vancouver Foundation.



John Grandfield, Director, Grandfield Technology Pty Ltd. Citation: For outstanding achievements in materials process engineering, including being an excellent researcher who creates new and practical insights, a visionary for a better global society, innovator, teacher, and world ambassador, creatively

integrating science and technology.

2019 TMS DIVISION AWARDS

Look to the March issue of *JOM* to view the recipients of the many awards administered by the Society's five technical divisions: Extraction & Processing (EPD), Functional Materials (FMD), Light Metals (LMD), Materials Processing & Manufacturing (MPMD), and Structural Materials (SMD).

TMS Division Awards laud outstanding accomplishments within a particular realm of technical expertise, and acknowledge noteworthy service to the division and the members it represents. To learn more about these awards or to view a list of past recipients, visit the TMS Honors & Awards home page at awards.tms.org. While there, you will also be able to learn more about the criteria and nomination process for each award.

Meaningful professional recognition is an important tool for acknowledging the achievements of our peers and for inspiring further advancements within our fields. Please consider advancing a deserving colleague by submitting a nomination packet before the April 1, 2019 deadline.





TMS2019 Proceedings Volumes and Papers Available for Purchase

TMS members receive a 40 percent discount on TMS proceedings published with Springer. Visit www.tms.org/ Bookstore and log in to acquire the discount code. The TMS 2019 Annual Meeting & Exhibition (TMS2019) registrants have free, online access to the meeting's proceedings publications as a benefit of attending. If you can't make it to the meeting, you can still purchase TMS2019 proceedings volumes, as well as individual papers, using the TMS Bookstore portal at www.tms.org/Bookstore. It is expected that all 13 publications will be available by the end of February 2019.

TMS members receive a 40 percent discount on TMS proceedings, and a 20 percent discount on TMS non-proceedings titles published with Springer. The discount codes that you need to enter during checkout are presented at www.tms .org/Bookstore when you are logged in to the TMS website. Read on to learn more about each of the TMS2019 titles.

10th International Symposium on High-Temperature Metallurgical Processing

This volume features thermal processing of minerals, metals, and materials that intends to promote physical and chemical transformations of materials to enable the extraction and production of valuable materials such as metals, alloys, ceramics, and compounds. Additionally, it focuses on innovative high-temperature technologies including those based on nontraditional heating methods as well as their environmental aspects such as handling and treatment of emission gases and byproducts.

Advanced Real Time Imaging II: Cutting-Edge Techniques in Materials Science Studies

This book is an assembly of materials studies utilizing cutting-edge, real-time imaging techniques, emphasizing their significance and impact. These techniques have never before been collectively featured in a single volume. It features a wide range of materials science categories, including real-time imaging techniques especially under non-ambient conditions including elevated temperatures, controlled atmospheres, and mechanical stresses.

Characterization of Minerals, Metals, and Materials 2019

The topics of this collection cover a wide range of materials characterization, from







composition, structure, process, property, and performance, and their interrelations in the materials from bulk-scale down to microscale and nanoscale. The material sequence and related processes are wide covered, which include minerals, metals and alloys, ceramics, polymers and composites, semiconductors, energy, optical, electronic, magnetic, environmental materials, and concrete.



TMS2019 Proceedings Volumes and Papers Available for Purchase







Energy Technology 2019: Carbon Dioxide Management and Other Technologies

The papers in this volume cover various technological aspects of sustainable energy ecosystems, processes that improve energy efficiency, reduce thermal emissions, and reduce carbon dioxide and other greenhouse emissions. Papers addressing renewable energy resources for metals and materials production, waste heat recovery and other industrial energy efficient technologies, new concepts or devices for energy generation and conversion, energy efficiency improvement in process engineering, sustainability and life cycle assessment of energy systems, as well as thermodynamics and modeling for sustainable metallurgical processes are included.

Friction Stir Welding and Processing X

This collection covers all aspects of friction stir technologies, including friction stir welding (FSW) of high melting temperature materials; FSW of lightweight materials; FSW of dissimilar materials; simulation of friction stir welding and processing (FSW/P); controls and inspection of FSW/P; and derivative technologies like friction stir processing, friction stir spot welding, additive friction stir, and friction stir extrusion.

Green Materials Engineering: An EPD Symposium in Honor of Sergio Monteiro

Green engineering is the design, use of processes, and the development of products that conserve natural resources, reduce pollution, and exert the smallest possible impact on the environment. It is not actually an engineering discipline itself, but a comprehensive framework

for all engineering disciplines. This book focuses on green materials including natural composites, bio-inspired armors, waste, clays added ceramics, lignocellulosic fibers, biodegradable polymers, and any type of natural material that could be related to engineering applications.

Light Metals 2019

Papers from the following Light Metals symposia are included in this volume: Alumina and Bauxite; Aluminum Alloys, Processing, and Characterization; Aluminum Reduction Technology; Cast Shop Technology; Cast Shop Technology: Energy Joint Session; Electrode Technology for Aluminum Production; REWAS 2019: Cast Shop Recycling Technologies; Scandium Extraction and Use in Aluminum Alloys; TMS-DGM Symposium on Lightweight Metals; and Ultrasonic Processing of Liquid and Solidifying Alloys.

Magnesium Technology 2019

Papers included represent all aspects of the field, ranging from primary production to applications to recycling, and explore everything from basic research findings to industrialization. *Magnesium Technology 2019* covers a broad spectrum of current topics, including alloys and their properties; cast products and processing; wrought products and processing; forming, joining, and machining; corrosion and surface finishing; and structural applications. In addition, there is coverage of new and emerging applications. TMS2019 Proceedings Volumes and Papers Available for Purchase

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Materials Processing **Fundamentals 2019**

Contributions to this volume include applications such as steel processing, modeling of steel and nonferrous alloys treatments for properties control, multi-physics and computational fluid dynamics modeling for molten metal processes and properties measurement. Extractive, recovery, and recycling process modeling is also presented, completing

a broad view of the field and practices of modeling in materials processing.

Rare Metal Technology 2019

This volume covers extraction and processing techniques of platinum group metals and rare earth elements as well as other less common metals, such as lead, antimony, molybdenum, tungsten, chromium, titanium, and vanadium. It also includes electrochemical processing. aqueous processing, biological separation, microwave heating, and supercritical extraction

REWAS 2019: Manufacturing the Circular Materials Economy

The focus of this year's REWAS 2019 conference is on manufacturing the circular materials economy, as unlocking the potential for circularity in the materials life-cycle can enable economic opportunities. REWAS 2019 is highlighted in four main thematic sessions, included in this publication: Disruptive Material Manufacturing: A Systems Perspective; Secondary and Byproduct Sources of Materials and Minerals; Rethinking

Production: and Education and Workforce Development. Works from a fifth session on Cast Shop Recycling Technologies are included in the Light Metals 2019 publication.

TMS

🖸 Springer

Shape Casting: 7th International Symposium **Celebrating Prof. John Campbell's 80th Birthday**

This volume continues to explore the leading edge technologies and the latest innovations in casting process design and quality improvements relative to shape casting through presentations by researchers from around the world. This year, special emphasis has been given to the contributions of Professor John Campbell, especially bifilms in castings.

TMS 2019 148th Annual **Meeting & Exhibition Supplemental Proceedings**

This collection features papers presented at the 148th Annual Meeting & Exhibition of The Minerals, Metals & Materials Society. The contributions represent 41 symposia from the meeting.

Explore TMS Publications

In addition to the most current releases presented in this article, TMS also offers convenient, searchable access to more than 300 past titles at its expanded online bookstore. To take advantage of this important member benefit, go to www.tms.org/Bookstore and log in to the TMS website to access a 40 percent on TMS proceedings and free shipping.

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Rare Metal



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TMS meeting headlines

View all upcoming meetings online at www.tms.org/Meetings.

Other Meetings of Note

Offshore Technology Conference (OTC) 2019 May 6–9, 2019 Houston, Texas, USA

Control of Potline Scrubbers & Fugitive Emissions for Aluminum Smelters Course June 17–20, 2019 Hamburg, Germany

5th World Congress on Integrated Computational Materials Engineering (ICME 2019) July 21–25, 2019 Indianapolis, Indiana, USA

11th International Conference on Porous Metals and Metallic Foams (MetFoam 2019) August 20–23, 2019 Dearborn, Michigan, USA

Materials Science & Technology 2019 Technical Meeting and Exhibition (MS&T19) September 29– October 3, 2019 Portland, Oregon, USA

ICTP 2020: The 13th International Conference on the Technology of Plasticity July 26–31, 2020 Columbus, Ohio, USA

14th International Symposium on Superalloys (Superalloys 2020) September 13–17, 2020 Seven Springs, Pennsylvania, USA

TMS 2019

March 10–14, 2019 Henry B. González Convention Center San Antonio, Texas, USA www.tms.org/TMS2019

- Speakers have been announced for the 2019 Magnesium Technology and Light Metals Keynote (The Aluminum Industry: Vision for the Next Decade) sessions, which can be viewed on the TMS 2019 Annual Meeting & Exhibition (TMS2019) website under the "Featured Sessions" tab.
- Special invited sessions for TMS2019 include: Science Policy within the Materials Reserach Community, Diversity in STEM, and Effective Business Improvement Methodologies for the Minerals, Metals, and Materials Industries.
- Use the resouces found in the Justification Toolkit in the "Registration & Travel" section of the TMS2019 website to demonstrate to your employer the value of attending TMS2019.



May 6–10, 2019 The Stanley Hotel Athens, Greece Discount Registration Deadline: March 29, 2019 www.tms.org/CastShop19

- The TMS Aluminum Cast Shop Science & Technology Course is an intensive five-day professional development opportunity focused on key cast shop processes for primary and secondary aluminum smelters.
- This course features proven methods to address industrial challenges, presented by leading experts in the field.



September 8–11, 2019 University of Birmingham Edgbaston Park Hotel and Conference Centre Birmingham, United Kingdom www.tms.org/LMPC2019

- The Liquid Metal Processing & Casting (LMPC) conference series provides experts in industry and academia with a forum to specifically discuss the latest technological and scientific advances related to industrial processes used to cast large ingots of highly alloyed metals.
- Staying at the conference hotel gives you convenient access to technical sessions and social functions, allowing plenty of informal networking opportunitites. Book your room at the special rate of £108 (GBP) by navigating to the "Housing & Travel" page of the conference website.



November 17–20, 2019 Hyatt at Olive 8 Seattle, Washington, USA Abstract Submission Deadline: April 15, 2019 www.tms.org/HEA2019

- The World Congress on High Entropy Alloys (HEA 2019) is a new, crossdisciplinary technical forum designed to share the latest research advances in metallic, intermetallic, and ceramic high-entropy materials, including singlephase and multiphase (compositionally complex) alloys.
- New social events and networking opportunities for HEA 2019 are still under development at press time, so check the congress website and click the "Sign Up for Updates" button on the homepage for additional program details.



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call for papers

JOM is seeking contributions on the following topics for 2019. For the full Editorial Calendar, along with author instructions, visit the *JOM* website at jom.tms.org.



August 2019: Manuscript Deadline: March 1, 2019

Topic: Solidification Defects in Additive Manufactured Materials

Scope: Solidification defects are commonly observed in a variety of metal additive manufacturing processes, not limited to powder bed fusion, direct energy deposition, and binder jet processes. Recent advances in both experimental and modeling techniques allow in-depth understanding and prediction for such defects during rapid solidification environments. New scientific discoveries and/or industrial applications to understand and/or control solidification defects are welcome for publication. **Guest Editor:** Lang Yuan

Sponsor: Solidification Committee

Topic: Characterization of Advanced Sintering Materials

Scope: Sintering is one of the major processes for synthesis and production of various materials such as ceramics, polycrystalline alloys, sintered ores, iron ore pellets, calcined minerals, slags, and organic metals. A solo achievement from one material has potential to inspire the process technology for other types of materials. This topic will focus on the sintering process, phenomenon, and mechanisms of a material by heating at high temperature.

Guest Editors: Mingming Zhang and Bowen Li **Sponsor:** Materials Characterization Committee

Topic: Multiscale Computational Strategies for Heterogeneous Materials with Defects

Scope: Multiscale modeling is a familiar theme, integral to heterogeneous materials. Challenges are encountered in the presence of evolving defects at multiple scales leading to extreme behavior. Such complexities may be addressed by a combination of hierarchical (bottom-up) and concurrent (top-down coupling) strategies. The models should be motivated and validated by experiments and characterization at relevant scales. Material heterogeneity also calls for uncertainty quantification in the treatments. This topic is devoted to

approaches addressing these issues. **Guest Editors:** Somnath Ghosh and David McDowell **Sponsor:** ICME Committee

Topic: Precipitation Mechanisms in Non-ferrous Alloys

Scope: This topic addresses the range of phase transformation behavior and mechanisms across a series of different non-ferrous metal alloys. The papers will address the implications of such phase changes on microstructure and associated properties.

Guest Editors: Gregory Thompson, Deep Choudhuri, Rajarshi Banerjee, and Eric Lass **Sponsor:** Phase Transformations Committee

September 2019: Manuscript Deadline: April 1, 2019

Topic: Aluminum: Recycling and Environmental Footprint

Scope: This topic covers recycling of aluminum and its alloys as well as the environmental ramifications of both primary and secondary aluminum.

Guest Editors: David Wong and Pascal Lavoie **Sponsors:** Aluminum Committee and Recycling and Environmental Technologies Committee

Topic: Advanced Electronic Interconnection

Scope: Papers are invited for this special topic covering recent advances of bonding technologies for 2.5D and 3D IC, wide-band-gap (WBG) semiconductors, and flexible electronics.

Guest Editor: Shih-Kang Lin **Sponsor:** Alloy Phases Committee

Topic: Advances in Processing, Manufacturing, and Applications of Magnetic Materials

Scope: Papers are invited on novel magnetic materials, advances in processing or relevant property measurement, and circular manufacturing of magnetic materials. Of interest are permanent and soft magnets and magnetocaloric



materials, and also multifunctional magnetic materials such as magnetoelastic, magnetoelectric, and magnetoresistive materials. Applications of interest include sensors and actuators, energy harvesting and storage, motors and generators, transformers and inductors, data storage, and memory applications.

Guest Editors: Orlando Rios and Ikenna Nlebedim **Sponsors:** Magnetic Materials Committee and Energy Conversion and Storage Committee

Topic: Recycling Methods for Industrial Metals

Scope: This topic will compare recycling methods for different metals which will stimulate thinking about similarities and differences and engender improvements in recycling processes and in the use of metals.

Guest Editor: Dirk Verhulst

Sponsor: Recycling and Environmental Technologies Committee

Topic: Sustainable Pyrometallurgical Processing Scope: Extractive metallurgy is experiencing a steady transformation towards more sustainable processes based on alternative sources and practices. This topic covers the development of recycling and bio-based fuel technologies to meet current environmental standards as well as sourcing issues. Fields include but are not limited to: process optimization, alternative material sourcing, by-product utilization, and energy efficiency.

Guest Editors: Joseph Grogan and Camille Fleuriault **Sponsor:** Pyrometallurgy Committee

Topic: Properties of Interfaced Materials and Films Scope: This subject is open to all types of interfaces including: ultra-thin layered films, thin films on bulk materials, nanocrystals embedded in bulk materials and textured coated surfaces to name a few. This special topic focuses on research papers that address the electronic, optical, biological, magnetic and mechanical properties of interfaced systems. It also welcomes in-situ characterization studies of interfaces, and encourages theoretical modeling approaches of interfaced materials and properties.

Guest Editors: Sufian Abedrabbo, Anthony T. Fiory, and Nuggehalli M. Ravindra

Sponsor: Thin Films and Interfaces Committee

October 2019: Manuscript Deadline: May 1, 2019

Topic: New Developments in Nanomechanical Methods

Scope: This special topic will focus on the advances used to measure mechanical properties of small-volume and low-dimensional materials, as well as bulk nanostructured materials. Of particular interest are new instrumentation, methods, and environmental control to evaluate mechanical behavior in terms of size effects, time scales, environmental testing, as well as in-situ experimental methods.

Guest Editors: Megan Cordill and Janelle Wharry **Sponsor:** Nanomechanical Materials Behavior Committee

Topic: Microstructure Evolution During Deformation Processing

Scope: Understanding how deformation processing techniques can control the microstructural evolution in metals is vital for alloy development. Processing-structure-properties-performance relationships can be created from the characterization data and, along with modeling, allow for the definition of material-specific process parameters to control the microstructural evolution and resulting material properties. Papers are invited that investigate all these aspects of microstructural evolution during deformation processing. **Guest Editor:** Daniel Koughlin

Sponsors: Shaping and Forming Committee and Advanced Characterization, Testing, and Simulation Committee

Topic: Progress in High-Entropy Alloys

Scope: High-entropy alloys (HEAs) loosely refer to multi-principal-element solid solution alloys due to their high configurational entropy. The unique compositions and the resulting attractive properties of HEAs have stimulated growing research interest due to scientific curiosity and potential industrial applications. This special topic on highentropy alloys invites contributions from authors working in the various fields of HEAs to disseminate the rapid progress in this fascinating and expanding class of advanced materials. **Guest Editors:** Chuang Zhang, Michael C. Gao, and Shih-Kang Lin

Sponsor: Alloy Phases Committee

Topic: Modeling and Simulation of Composite Materials

Scope: Progress in micro- and nanoscale composites has resulted in the development of a number of computational methods to address various length-scale phenomena in composites. This topic will highlight modeling and simulation currently used in advancing the understanding of the complex interactions and structure-property relationship in composite materials by ab-initio methods, atomistic methods, mesoscale simulations, finite element methods, and multi-scale modeling.

Guest Editors: Rakes Behera, Dinesh Pinisetty, and Dung Luong

Sponsor: Composite Materials Committee

Topic: Mesoscale Materials Science: Experiments and Modeling

Scope: Many in-situ techniques such as scanning and transmission electron microscopy, atomic force microscopy, and x-ray diffraction have been developed to probe materials at the mesoscale. At the same time, availability of faster and cheaper computational power lead to the development of high fidelity, mesoscopic models. This topic invites contributions in the area of advanced mechanical testing, enhancements in computational approaches, and integration of experiments and modeling for engineering the evolution of mesoscopic structures and defects.

Guest Editors: Saurabh Puri and Amit Pandey **Sponsor:** Invited



TMS Society and Partner Society Awards

A Recognition of Excellence

Nominations and Applications Due April 1

TMS SOCIETY AWARDS

- Alexander R. Scott Distinguished Service Award
- Application to Practice Award
- Brimacombe Medalist
- Bruce Chalmers Award
- Cyril Stanley Smith Award
- Early Career Faculty Fellow Award
- Ellen Swallow Richards Diversity Award
- Fellow Award
- Frank Crossley Diversity Award
- Institute of Metals Lecturer & Robert Franklin Mehl Award
- Julia and Johannes Weertman Educator Award
- Leadership Award
- Morris Cohen Award
- Oleg D. Sherby Award
- William D. Nix Award
- William Hume-Rothery Award

AIME AWARDS

- Champion H. Mathewson Award
- Robert Lansing Hardy Award

ACTA MATERIALIA AWARDS

Acta Materialia Gold Medal Award



"TMS has always served as the forum for reporting on new scientific discoveries, debating the laws of physics and chemistry in the context of materials science and metallurgy, and educating the next generation of materials scientists and engineers to meet our growing challenges as citizens of the world. I am grateful to my friends and colleagues in TMS for creating such a community of scholars, where all are welcome."

-Carol Handwerker, 2018 TMS Fellow

View award criteria and access the "Tips for Preparing Nominations" guide by visiting awards.tms.org. Nominations may be submitted to awards@tms.org.

You do not have to be a member of TMS to nominate individuals for many of these prestigious awards; however, only members may nominate an individual for the TMS Fellow Award.

