WWW.tms.org/JOM **JANUARY 2022** 

News and insights about TMS, its members, and the professions it serves

# **150 Years and Going Strong: Celebrating the Shared History**

of AIME and TMS

## Preview the New TMS High Entropy Alloys Study //

92nd AIME Annual Meeting THE METALLURGICAL SOCIETY OF AIME

> February 24-28, 1963 Dallas, Texa









Applications

Al – based alloys Co – based alloys Cu – based alloys Fe – based alloys Mg – based alloys Ni – based alloys Ti – based alloys TiAl – based alloys **Refractory alloys High-entropy alloys** More...

## Pandat Software Modules

Pandat Software adopts modular design and enables users to easily switch between modules and perform various types of simulations in the same workspace.



JOM THE MAGAZINE News and insights about TMS, its members, and the professions it serves

Volume 74 Number 1 January 2022

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## // About the cover



This cover image features historical artifacts from TMS and its parent organization, AIME, as they celebrate 150 years in 2021 and through March 2022. Key items shown are, from top: attendees at AIME 1917 Annual Meeting in St. Louis, Missouri (photo courtesy of AIME); the Marvine Breaker, Hudson Coal Co., as toured at the AIME 1921 Annual Meeting in Wilkes-Barre, Pennsylvania (Mining and Metallurgy, p. 15, 1921); TMS Anniversary Coins, 2017-2020; The American Institute of Mining, Metallurgical, and Petroleum Engineers (AIME) History Walk: A Companion Booklet, open to pages 14-15; bound JOM, vol. 49 (1997); and bound Journal of Metals, vol. 15 (1963). The inset photo depicts an aircraft engine, as shown on the cover of the TMS study, Defining Pathways for Realizing the Revolutionary Potential of High Entropy Alloys.



#### Access Technical Journal Articles:

TMS members receive free electronic access to the full library of TMS journals, including JOM. Technical articles published in JOM: The Journal are available on the Springer website. TMS members should log in at www.tms.org/Journals to ensure free access.

#### About JOM: The Magazine:

This print publication is excerpted from the publication of record, *JOM*, which includes both The Magazine and The Journal sections. *JOM: The Magazine* includes news and insights about TMS, its members, and the professions it serves. To access the publication of record, visit www.tms.org/JOM.

#### About TMS:

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. Learn more at www.tms.org.

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## // SPECIAL INSERT

#### TMS2022 Pre-Show Report









# IN THE FINAL ANALYSIS

"So, in January 1949, the first issue of the Journal of Metals was published. I was listed as both editorial and business manager and had a busy time getting some advertising and interesting articles to assure our journal's sound basis. Once Journal of Metals' success seemed assured, we started looking for an editor and an advertising manager."

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- Ernest Kirkendall, "Marking JOM's 50th Anniversary with a Look at the Journal's Origins," January 1999 JOM

Many are surprised to learn that the de facto first editor of *JOM* was Ernest Kirkendall—yes, he of Kirkendall Effect fame. As Ernest knew back in the 1940s, a solid editorial and business model was essential for success. That said, a vital third ingredient for a successful membership journal is a firm connection with the audience that the journal serves. *JOM* continues to have this, but I candidly sense that the tides of the time have *JOM* drifting a bit off course. This month's issue marks a roll out of changes that course correct and focus on maintaining and building on our essential connection to the membership. I'll explain.

We all know that journal publishing has changed considerably in the 2000s. In many ways, it has all become very . . . transactional—a manifestation of what Bill Gates coined as "Content Is King," with online audiences demanding more and more personalized content to consume. It is an era built more for the immediacy of search engines and metatags and less for the reader who appreciates the creativity of the thoughtful editor who crafts an engaging editorial flow. As a destination for publishing technical content, the modern *JOM* is a very attractive venue. As a membership journal, the mammothsized *JOM* of recent vintage has become inefficient as the member content can be overwhelmed by the sheer volume of technical articles. Candidly, receiving a 300-page issue monthly does more to numb readers than engage them. Not surprisingly, many TMS members have asked us to stop sending to them the journal—presumably to protect straining coffee tables and to preserve the backs and knees of overburdened mail carriers. With fewer issues of *JOM* being delivered and with anti-email laws proliferating worldwide, the opportunities for *JOM* to communicate TMS content to members has ironically diminished in the content-is-king era. . . . Do something TMS!

We are.... With this first issue of our 74th publishing year, our robust scholarly technical publishing continues unabated. But, all of the technical papers are housed exclusively online. No print (unless someone purchases a special subscription). In tandem, this month introduces the printing and mailing of JOM: The Magazine. This publication is an excerpt of the full JOM and delivers TMS member features, news, overviews, opinion and insight, and Society updates-the kinds of content that members enjoy contributing and reading. It is also where "In the Final Analysis" continues to reside. In the coming months, I believe that you will find The Magazine to be informative, engaging, and even fun. We refer to this format as giving members a "touch of TMS." That touch will come to all TMS professional members worldwide ten times per year. You'll have it in your hands when you want to read but don't want more screen time. If you prefer more screen time, each issue of JOM: The Magazine is also housed as a single PDF on the JOM website. The full monthly technical JOM, inclusive of The Magazine section, continues to be housed in its entirety as our TMS "publication of record" on SpringerLink. If you don't want to read in print or online, then print JOM: The Magazine is conveniently recyclable. It is also conveniently open to your editorial submissions and story suggestions. The member journal works best when the members are contributing!

As a past editor of *JOM*, I am very excited by these changes—all of the same content but more conveniently packaged to help engage and maintain the TMS community. That has been the goal since 1949, and we will continue to adapt our publishing platforms as necessary to continue to meet it for at least another 74 years. Volume 74 Number 1 January 2022



James J. Robinson Executive Director

<u> aJJRofTMS</u>

"With fewer issues of JOM being delivered and with anti-email laws proliferating worldwide, the opportunities for JOM to communicate TMS content to members has ironically diminished in the content-is-king era."



# **JOM TECHNICAL TOPICS**



*JOM*: The Journal includes peer-reviewed technical articles covering the full range of minerals, metals, and materials. TMS members receive free electronic access to the full library of TMS journals, including *JOM*. For the full Editorial Calendar, visit www.tms.org/EditorialCalendar.

Review the technical topics included in the current issue of *JOM*: The Journal here, and then go to **www.tms.org/JOM** to log in access technical journal articles on the Springer website.

## **JANUARY 2022**

#### **4IR in Extractive Metallurgy**

**Scope**: With the advent of the fourth industrial revolution, advanced digital technologies that facilitate engineering, design, optimization, and management are becoming increasingly pervasive across a wide range of industries. In extractive metallurgy, large processing plants often combine many unit operations together into highly complex and interdependent flowsheets, making them a rich field for potential application of 4IR technologies. This topic will explore past, present, and future research and development into the use of 4IR in the extractive metallurgy.

**Editors: Chris Aldrich,** University of Stellenbosch; **Quinn Reynolds,** Mintek; and **M. Akbar Rhamdhani,** Swinburne University of Technology

Sponsor: Pyrometallurgy Committee

#### Advanced Functional and Structural Thin Films and Coatings

**Scope**: This special topic encompasses all aspects of advanced thin films and nanomaterials for modern optical, photonic, and electronic devices with applications in photovoltaics, sensing, and display technologies. It also addresses coating technologies and surface structuring for tools, as well as multifunctional biomaterials, innovative approaches to new concepts, and applications.

Editors: Ramana Chintalapalle, University of Texas at El Paso; Adele Carrado, Strasbourg University; Gerald Ferblantier, Strasbourg University; Karine Mougin, CNRS – IS2M; Heinz Palkowski, Clausthal University of Technology; and Nuggehalli M. Ravindra, New Jersey Institute of Technology

Sponsor: Thin Films and Interfaces Committee

#### New and Novel Laboratory and Pilot Techniques for Pyrometallurgy

**Scope:** Laboratory and pilot testing is critical for advancing our understanding of pyrometallurgical processes. Due to advances in analytical techniques and our understanding of pyrometallurgy, laboratory, and pilot testing is advancing as well. This topic focuses on describing new and novel piloting and laboratory techniques, illustrating their use and the advances that have been made.

**Editors: Stuart Nicol**, Glencore Technology, and **Will Hannemann**, Glencore Technology

Sponsor: Pyrometallurgy Committee



Visit www.tms.org/JOM to access author tools that will answer your questions during every step of the manuscript preparation process, from determining the appropriate technical topic for your paper to reading the final product on SpringerLink.

For further information on contributing to JOM, contact JOM Editor Maureen Byko at mbyko@tms.org.

# TMS MEMBER NEWS



#### Share the Good News!

Contact Kaitlin Calva, *JOM: The Magazine* Managing Editor, at kcalva@tms.org to share your professional accomplishments. Please note that only news submitted by current TMS members will be considered.

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#### Early Career TMS Members Build Leadership Skills



The TMS contingent of the 2021 Emerging Leaders Alliance conference. Front row, left to right: Aurelien Perron, Lawrence Livermore National Laboratory; Danielle Jencks, Pratt & Whitney; Allie (Alexandra) Anderson, Gopher Resource; and Chukwunwike Iloeje, Argonne National Laboratory. Back row, left to right: Joy Gockel, Colorado School of Mines; Jonathan Raush, University of Louisiana at Lafayette; and Charles Fisher, Naval Surface Warfare Center – Carderock.

"The Emerging Leaders Alliance (ELA) was extremely helpful in understanding my personal leadership style, both its strengths and areas to grow. Using that knowledge will help me develop as a scientist and better support my team," said Charles Fisher, Naval Surface Warfare Center – Carderock, one of seven TMS members to attend the most recent ELA conference, held September 26–29, 2021, in Pittsburgh, Pennsylvania.

Each year, this program provides interdisciplinary training for future leaders of the science and engineering community. This high-quality training aims to equip early career individuals with the skills needed to guide the professions and address the needs of people in the 21st century. TMS is one of nine ELA partner societies, and attendance for TMS members was possible through the support of the TMS Foundation.

Alexandra Anderson, Gopher Resource and 2021 TMS Extraction & Processing Division Young Leader,

## **Emerging Leaders Alliance**

also found value in attending the program. "The Emerging Leaders Alliance conference gave me the opportunity to expand my professional network with like-minded individuals from across the industry," she said. "The leadership training was very insightful. I plan to apply these insights to my professional interactions at work, and I believe these skills will help me become a more effective leader moving forward."

Echoing the sentiments of her colleagues, Joy Gockel, Colorado School of Mines and 2021 TMS Structural Materials Division Young Leader, found value in the training provided by the ELA program. In particular, she appreciated "the opportunity to grow my non-technical skills needed for engineering and science leadership through understanding my own leadership style, the style of others, and building a successful team. I am looking forward to applying these skills at my university and towards continued involvement in TMS volunteer activities."

If you are interested in enhancing your own scientific leadership skills, TMS is now accepting applications for the next ELA conference, scheduled for September 2022. Applicants must be TMS members, typically ages 24–40, with rising or current leadership positions within their organizations. To apply for a seat at the 2022 conference, please send a letter of interest, one or two letters of recommendation, and a resume or curriculum vitae to Deborah Hixon, TMS Awards Program Administrator, at hixon@tms.org. The deadline to apply for the 2022 program is **May 15, 2022**.

It is clear through the stories of the TMS members featured here that this training provides a unique opportunity to interact across disciplines and obtain foundational, executive-level knowledge. More established TMS members can support future leaders of TMS by donating to the TMS Foundation. Any level of contribution helps ensure that the future leaders of our community have access to this valuable program, in addition to other Foundation initiatives geared toward developing early career professionals. Visit www.TMSFoundation.org to learn more and to make a donation.

## *Journal of Electronic Materials* Seeking Submissions for New Topical Collection

The *Journal of Electronic Materials* is planning a new topical collection, **Synthesis and Advanced Characterization of Magnetic Oxides**. Article



submissions are due **February 28, 2022**.

The objective of this collection is to publish articles focusing on magnetic oxides that are expected to be beneficial to both experts and the wider scientific community working in the field of materials science. Contributions in the following themes

and topics are invited for submission:

- Synthesis and fabrication of magnetic oxides
- Developmental of oxides with magnetic functionality and other important functional behavior

- Computational methods and their applications to magnetic oxides
- Magnetic and phase transformation studies in magnetic oxides using synchrotron x-ray methods, such as x-ray absorption spectroscopy
- Imaging methods such as magnetic force microscopy and x-ray near edge structureimaging
- Magnetic oxides for spintronics
- Magnetic oxides for energy and environmental applications
- Magnetic oxides for biomedical applications Guest editors for this collection include Manish

Kumar, Pohang Accelerator Laboratory, South Korea; R.C. Srivastava, G B Pant University of Agriculture and Technology, India; Shalendra Kumar, King Faisal University, Saudi Arabia; and Jitendra Pal Singh, Pohang Accelerator Laboratory, South Korea.

Articles for this collection can be submitted at www.editorialmanager.com/jems. Once there, select article type, "2022 Magnetic Oxides." For author instructions and additional details on the journal, visit www.springer.com/11664.

#### **TMS Announces New Study on Artificial Intelligence**

With interest in artificial intelligence (AI) growing rapidly, TMS launched the *Employing Artificial Intelligence to Accelerate Development and Implementation of Materials and Manufacturing Innovations* science and technology accelerator report in 2021. While TMS is leading the work on the study, funding comes from the National Institute of Standards and Technology (NIST) and the Office of Naval Research (ONR). The purpose of this project is to support innovative materials and manufacturing breakthroughs that are enabled by AI and will accelerate the development of and reduce the costs of new materials, processes, and products.

The final report, scheduled for release in April 2022, will include the following key takeaways:

- The application domains of most promise will be scoped and prioritized.
- For the identified high priority areas, concrete recommendations on key milestones and implementation pathways will be provided.

This study is being conducted by a team of 11 experts, chaired by **Elizabeth Holm**, Carnegie Mellon University. The other members of the study team are:

- Surya Kalidindi, Georgia Institute of Technology
- Adam Kopper, Mercury Marine
- Kenneth A. Loparo, Case Western Reserve University
- Benji Maruyama, U.S. Air Force Reserach



Laboratory Materials and Manufacturing Directorate

- Elsa Olivetti, Massachusetts Institute of Technology
- Kristin Persson, Lawrence Berkeley National Laboratory and the University of California, Berkeley
- Taylor Sparks, University of Utah
- Aarti Singh, Carnegie Mellon University
- Francesca Tavazza, National Institute of Standards and Technology
- Christopher Wolverton, Northwestern University

Visit www.tms.org/AIStudy to learn more about each of the team members and to sign up to receive updates about this study, including a notification when the free report is available.

#### TMS Members Honored with 2021 MetSoc Awards

Congratulations to the following TMS members

for being named recipients of the Metallurgy and Materials Society (MetSoc) of the Canadian Institute of Mining, Metallurgy, and Petroleum (CIM) 2021 awards. These awards were presented at the Conference of Metallurgists (COM) 2021: Advances in Metallurgy and Materials Engineering, celebrating the 60th anniversary of the MetSoc annual meeting, in August 2021.



Boyd R. Davis

Wenying Liu

Mathieu Brochu M

Mihaiela Isac

#### MetSoc Award for Research Excellence

Sponsored by Rio Tinto Boyd R. Davis, KPM

TMS Member since 1999

The MetSoc Award is the premier award for contribution to the metallurgy or materials field by a MetSoc member academic or research scientist in any Canadian research laboratory or Canadian university. The award recognizes a lifetime contribution in teaching and research or outstanding individual work resulting in a significant breakthrough in the metallurgy or materials practices.

Citation: For being at the forefront of research, opening a laboratory, and forming many young professionals.

#### MetSoc Brimacombe Award

Wenying Liu, University of British Columbia TMS member since 2016

The Brimacombe Award is to recognize early-career MetSoc member achievers who have made noteworthy contributions in any of the scientific and technological disciplines relevant to MetSoc.

Citation: For early and important contributions to the science and engineering of hydrometallurgical processes.

#### MetSoc Distinguished Materials Scientist Award Mathieu Brochu, McGill University

TMS member since 1999

This award recognizes highly significant contributions in the field of materials engineering. *Citation: In recognition of significant and novel contributions to a broad range of Advanced Materials Processing.* 

#### **CIM Fellowship**

Boyd R. Davis, KPM TMS member since 1999 Mihaiela Isac, McGill University TMS member since 2008

For outstanding continuous contributions to CIM and/or the mining, metallurgical, and petroleum industries.

#### **Pyrometallurgy Best Paper Award**

Petri Latostenmaa, Boliden Harjavalta TMS member since 2012 Pekka Taskinen, Aalto University TMS member since 1992

The Pyrometallurgy Best Paper Award was established by the Pyrometallurgy Section to recognize the best paper on this topic published in either the CIM Magazine, the Canadian Metallurgical Quarterly, or the Conference Proceedings from the previous year.



#### Announcing the 2022 TMS Meeting of the Membership and Open Board of Directors Meeting

The Minerals, Metals & Materials Society, Inc., in accordance with its bylaws (Article II, Section 2.6, and Article III, Section 3.7) will hold the 2022 Annual Meeting of the Membership with Open Board of Directors Meeting, on Thursday, March 3, 2022, at 8 a.m. (PT) at the Anaheim Marriott, during the TMS 2022 Annual Meeting & Exhibition in Anaheim, California.

# Our Greatest Traditions Gathering Together at the Annual Meeting

**Kaitlin Calva** 

Attendees and guests of 1899 meeting of the Institute gather around a stagecoach and prairie schooner at Sutter's Fort in Sacramento, California, as depicted in this colorized image from the event.<sup>1</sup>

OUR GREATEST TRADITION: GATHERING TOGETHER AT THE ANNUAL MEETING

It all started with a call for papers. It may not have been so named at the time, but in April 1871, three founding members of the American Institute of Mining Engineers (AIME) put forth a call:

Any one who may have devoted himself to a particular subject connected with either mining or metallurgy and who may be possessed of new facts in reference to it, would greatly aid in furthering the objects of the proposed association by preparing a paper giving the result of his experience, to be communicated at the first meeting.<sup>2</sup>

"Our Greatest Tradition: Gathering Together at the Annual Meeting," is the seventh article in a feature series highlighting the 150th anniversary of the American Institute of Mining, Metallurgical, and Petroleum Engineers (AIME) and TMS. The first article appeared in the March 2021 issue of *JOM*, with additional articles scheduled throughout 2021 and 2022. For more information, contact Kaitlin Calva, *JOM*: *The Magazine* Managing Editor, at kcalva@tms.org.

#### Meet the Interviewees



#### Ellen K. Cerreta

Division Leader, Materials Science and Technology, Los Alamos National Laboratory 2021 TMS President, past Membership & Student Development Director, past Structural Materials Division Chair



Eric A. Nyberg Product Engineer, Kaiser Aluminum Trentwood *Current Light Metals Division Chair* 



**James J. Robinson** TMS Executive Director



Dan J. Thoma Director, Grainger Institute for Engineering, and Professor, Materials Science and Engineering, University of Wisconsin-Madison 2003 TMS President, 2007 AIME President, 2019 TMS Fellow, 2021 AIME Honorary Membership Award Recipient

While it is widely known that the Institute began at a three-day meeting in Wilkes-Barre, Pennsylvania, what this call drives home is that the true purpose of the Institute lies in "the desire for the advancement of professional knowledge."<sup>2</sup> And what better way to advance the professions than through coming together at an annual meeting. The world may look vastly different today than it did in 1871. Even our own organization has shifted and grown with the times, becoming two separate entities with a shared history. But in 150 years, TMS and AIME have not missed an annual meeting. Not even a global pandemic could stop our minerals, metals, and material science and engineering community from coming together, as evidenced by the TMS 2021 Virtual Annual Meeting & Exhibition last year.

Now, *JOM: The Magazine* looks back at perhaps the Society's greatest tradition: the Annual Meeting & Exhibition. The following interviews from members and leaders of TMS share our history through personal experiences and memories, as we continue our 150th anniversary celebration.

## *JOM*: Could you share a few words about your history with the TMS Annual Meeting & Exhibition?

**Ellen K. Cerreta:** I have been attending the TMS Annual Meeting & Exhibition for over 20 years. I have found it an incredibly important place to network, hear about the latest within the field from colleagues, and present my own work.

Eric A. Nyberg: I began attending the TMS Annual Meeting & Exhibition back in the early 80s as an undergraduate student, where I would help as a student monitor. It was a great opportunity to learn about the real-world areas of metallurgical work and issues. As time progressed, I found a home in the Light Metals Division (LMD) where I was one of the founding members helping to establish the Magnesium Committee. Eventually I served as vice chair and chair of the committee. This experience led to my eventual selection as the vice chair and chair of the LMD where I volunteer today. The overall experience has been very satisfying personally and professionally. I am honored to be a part of, and to have served in, a vast array of positions with TMS over the last 40 years.

James J. Robinson: As a staff person, I've attended

Here, members and guests celebrate 50 years of AIME at the Institute's semi-centennial meeting, appropriately held in Wilkes-Barre, Pennsylvania, in September 1921.<sup>3</sup>



every annual meeting since TMS1985, which was in New York City. My early assignments were to work with the newly formed group of Journal of Metals advisors to help explain how the journal was manufactured (no desktop publishing back in the day), to be the meeting photographer, and to cover the meeting for news to publish in the meeting wrap-up. By the end of the decade, I was editor of now JOM, so I spent time seeking papers for issues and developing news coverage. By the mid-1990s, I was doing that and developing our website, which was a new idea to everyone. Our team put a lot of effort into making the TMS website very rich in annual meeting content, like adding the program with abstracts in a searchable format. No big deal now, but unique back then. By the late 1990s, I was attending the



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Even the earliest versions of the TMS website included space for the TMS annual meeting. Shown in this 1997 edition of "TMS News" in *JOM*, the Conference Management System, a precursor to today's ProgramMaster, allowed attendees to submit their abstract online for the first time ever for the TMS 1998 Annual Meeting & Exhibition.<sup>4</sup>

meeting not only for *JOM* content development but for participation in Society governance discussions as well and started to attend Board of Directors meetings. Now, I oversee the meeting enterprise and support our volunteer leadership.

Dan J. Thoma: I went to my first TMS annual meeting in Denver, Colorado. I think the year was 1987. In the 34 meetings since, I think I have only missed a few!

"TMS is more than a network; it is a community that thrives in the moments when it can convene, engage, meet new members, and remember the ones who have left too soon."

-James J. Robinson

JOM: Can you briefly describe the value of the meeting to attendees and/or the materials community?

**Cerreta:** TMS provides member-driven content through its meetings—and as such TMS provides the

opportunities to learn about the cutting-edge science within the materials field that is directly relevant to our members. By volunteering with TMS you have an opportunity to further shape that content and ensure that the product meets your needs as well as that of others in the profession.

**Nyberg:** The TMS annual meeting provides a unique opportunity to network with like-minded professionals. It also opens doors for collaboration and business opportunities. TMS is my home for obtaining state-of-the-art results in the materials science industry.

**Robinson:** The COVID-19 era has taught us that above all things, TMS members value greatly their ability to engage with each other and the TMS network. This is really difficult to replicate virtually and is one of the things that I believe will drive a strong return to form for the annual meeting and exhibition at TMS2022. TMS is more than a network; it is a community that thrives in the moments when it can convene, engage, meet new members, and remember the ones who have left too soon.

**Thoma:** Information dissemination is the most important value for me. This comes in many forms. In addition to the technical content, meeting new



colleagues from industry, academia, and government is always a great source of knowledge. Also, seeing new products and engaging with past associates and friends in the materials community is always a highlight.

#### JOM: How has the meeting changed over time? What aspects have remained the same?

Cerreta: The meeting has gotten much bigger over the years that I have attended. However, the content and that member-driven nature of the meeting has not changed.

"The meeting has gotten much bigger over the years that I have attended. However, the content and that member-driven nature of the meeting has not changed."

-Ellen K. Cerreta

Nyberg: Cell phones! Technological advancements, electronic registration, apps that let you coordinate your schedule and read articles, and on a nontechnical basis, a much more inclusive environment where we finally are seeing much more diversity in the field of materials science and engineering. What's the same? Reuniting with old colleagues and friends! Learning about technological breakthroughs and, of course, the Exhibition presented by materials-related suppliers and vendors.

Robinson: In one way, there are many, many changes: the exhibition was invented and then grew and shrank with the consolidation and internationalization of the aluminum industry; the technical program has quadrupled in size; we no longer use slide carousels and overhead projectors; we rely on WiFi, PowerPoint, and apps; we build our technical program using ProgramMaster online rather than using typewriters and bulletin boards; attendance has grown and grown; we have the Internet, smart phones, and virtualization. Regardless of the myriad changes that help us more easily organize ourselves and

convene, the core of the meeting is unchanged: we get people with like interests in the same place at the same time to advance the profession, advance the good of the order, and advance how science and technology improves our quality of life worldwide. The raison d'etre is the engagement and fulfillment of face-to-face communication that no changes to the administrative periphery will replace.

Thoma: For me, I always liked the general abstracts. The new stuff that did not fit the mold of the latest hot topic was always presented, but maybe to a less populated room. So that part has changed, but the format and methods of the technical committees have always produced high quality presentations.

#### JOM: How have world events shaped the meeting? How has TMS adapted to these changes?

Cerreta: I think that because the meeting has become so much bigger, it has more impact on the professions.

Nyberg: Excluding the obvious COVID issues, other world events such as the breakdown of the Soviet Union have opened up travel opportunities for many that may not have been able to attend previously.

"TMS has worked hard to create new modes of operation, while adapting, with the voice of the members being heard, as further changes improve the meeting experience."

-Eric A. Nyberg

TMS has worked hard to create new modes of operation, while adapting, with the voice of the members

being heard, as further changes improve the meeting experience.





of Fellows for The Metallurgical Society of AIME was bestowed. Pictured, left to right: Walter R. Hibbard Jr., Cyril Stanley Smith, Reinhardt Schuhmann Jr., John Augustus B. Kinzel, and Robert F. Mehl.<sup>5</sup>



τ.

to introduce the TMS Exhibition, still a staple of the TMS meeting experience today. The

. . . .

**Robinson:** As much as the Annual Meeting & Exhibition can feel like a world within itself, it is very much subject to the situation in the world at large. The changes in my time with TMS are many. Certainly, the technologies covered have expanded—additive manufacturing, artificial intelligence, the great expansion of computational power, sustainability, biomimetics, the list goes on and on and always will as TMS members are always at the forefront of progress. World events—9/11, the Great Recession, global tensions, COVID-19, and even weather—have had profound impacts on how we conduct meetings and who can travel to participate. Regardless of the circumstances, the show, as they say, must go on, so we adjust and adapt as circumstances dictate.

**Thoma:** This may be a deflection, but as scientists and engineers, I prefer to focus on solutions for areas for societal impact. Technology is always evolving, and material advancements enable the change. Therefore, I would argue that adaption to change and evolving technologies is why I go to see the research presentations at TMS. I think if the evolution did not occur continuously, the Annual Meeting would not exist. I think this is also evident in the growing market for materials research to include other disciplines.

## *JOM*: What do you see as the future direction of the TMS Annual Meeting & Exhibition?

**Cerreta:** Clearly after the year that we have had, TMS is carefully considering how virtual tools can be incorporated into the future of our meetings to enable more access and be more inclusive with all materials professionals. As TMS does this, we are carefully considering how to preserve the parts of the meeting that are so important to the members—dialogue between audience and speakers, networking time, and student interactions are a few on our mind.

**Nyberg:** More of the same! Live and semi-virtual presentations with interactive audience/speaker engagement. Continuing to grow the world's #1 meeting source for the latest in materials science, metallurgy, etc. TMS will continue to rise in prominence as the 200th meeting approaches.

**Robinson:** The TMS Board of Directors is actually in the midst of conducting a futuring exercise about

what the Annual Meeting & Exhibition will look like in 2031. The pandemic has schooled the association community that having virtual elements to our meetings will be a "must" in the future. How virtual and how to maintain technical exchange, networking, and exhibitions with the same effectiveness as an in-person event is all to be determined. There is no question, however, that technology is going to give more access to our meeting than we have ever been able to offer to the community before. I don't see the in-person meeting ever being replaced—the joy of seeing each other in person just cannot be replaced but there are new audiences to engage in new ways, and I look forward to TMS being a trendsetter in this realm.

**Thoma**: As long as the member-driven Society format exists, I would be hard-pressed to see a vision in the

"Technology is always evolving, and material advancements enable the change. Therefore, I would argue that adaption to change and evolving technologies is why I go to see the research presentations at TMS."

-Dan J. Thoma

crystal ball. TMS has always developed through ideas generated from its members, and that has served the profession very well.

## *JOM*: Describe your favorite memory associated with the meeting.

Cerreta: This is hard—I have a lot of good memories

from TMS meetings. But I think giving my first invited talk at a TMS meeting was a real achievement for me. One that I was





AIME and TMS celebrated 125 years at the TMS 1996 Annual Meeting & Exhibition in Anaheim, California.<sup>7</sup> The TMS 2020 Annual Meeting & Exhibition was the most wellattended meeting in TMS history, with 4,680 attendees. The meeting introduced new concepts such as digital posters in the Diffusion

OUR GREATEST TRADITION: GATHERING TOGETHER AT THE ANNUAL MEETING // 13

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## ...And What About the Annual Fall Meeting?

Another important event in the catalogue of TMS meetings that cannot be overlooked is the annual Materials Science & Technology (MS&T) Conference. For many years, the Society arranged the TMS Fall Meeting, while other societies hosted their own events around the same time of year. In the early 2000s, the

TMS Board of Directors began developing a plan to sponsor a joint fall meeting with other organizations in a collaborative effort to provide "opportunities for TMS members to be exposed to other voices, other insights, other opinions, other philosophies, and other networks."<sup>8</sup>

This led to the first MS&T conference, held November 9–12, 2003, in Chicago, Illinois, and organized by TMS and the Iron & Steel Society (now the Association for Iron & Steel Technology, AIST). In 2005, the American Ceramic Society (ACerS), the American Welding Society (AWS), and ASM International joined AIST and TMS to jointly program MS&T, with other organizations entering or exiting the fold over the years since to create the MS&T conference that TMS members know today.

Here, *JOM: The Magazine* talks with 2019 TMS President and past TMS Programming Director James C. Foley about the evolution of the MS&T conference series.

## *JOM*: Could you share a few words about your role in developing the MS&T conference series?

James C. Foley: I was the first TMS representative to the MS&T Programming Coordinating Committee for 2005. Each of the four societies had a programming representative to represent each of the societies. That first group set up a lot of the ground rules for MS&T and some still exist today. That first few years was quite challenging for each of the societies as we figured out how to work together better. One suggestion that I made after the 2005 meeting was to have a chair of the programming coordinating committee that rotated among the participating societies. It was liked so much that I was asked to be the first to fill that role in 2006. This was also the year I first served on the TMS Board of Directors as the Programming Chair.

## *JOM*: How has MS&T changed over time? What aspects of the meeting have remained the same?

Foley: During the first meetings I thought it was important that the societies work together to put on one meeting instead four co-located meetings. Co-located meetings that happened in the past were shown to not work very well. That is why I supported and encouraged

James C. Foley

the "branding" of the meeting to be MS&T and each society still had their special niche programming. We also put in place uniform talk lengths to enable people to session hop without missing a talk. Things have progressed now and there is a need to have more individual society branding so people know what

societies are behind the meeting. I believe we still strongly encourage uniform talk lengths. I think the other thing that has changed is that many in the individual societies don't remember what it was like before MS&T. This is good and bad. The good is that people expect the societies to work together to put on a conference. The bad is that some people don't remember how bad it was when each society tried to go it alone for a fall meeting.

## *JOM*: What do you see as the future direction of MS&T?

**Foley:** I strongly believe that MS&T will be successful as long as the participating societies work together to put on the

conference. Collaboration just doesn't happen, and it does take some work. I do believe that the societies involved will continue to work together and evolve the meeting to be a great value for all the members of each society.

## *JOM*: Describe your favorite memory associated with MS&T.

Foley: For me there were a lot of memories related to MS&T over the many years that I have participated, and it is hard to pick one favorite. If I had to pick something it probably would be the 2015 MS&T in Columbus. I was serving my last year on the ASM Board of Trustees and serving on the TMS Board as the Materials Processing & Manufacturing Division Director. That meeting was a milestone of over a decade of MS&T with four societies working together. It was a nice feeling to know that the meeting many thought would not last was still happening.

#### JOM: Is there anything else you would like to add?

Foley: In 2006, I said the following in a guest editorial: "In planning for MS&T06 we have strived to build a new meeting, one that seamlessly coordinates the efforts of all the organizations, while still retaining the important traditions of each. That it was pulled off at all is a tribute to the staffs of the member organizations, and its high quality is the result of the hard work of innumerable volunteers." I think that is still true today and I look forward to many more MS&T conferences.

# MS&T







The above photos, originally shared in the November 2005 *JOM* News & Update article, "Collaborative Theme Permeates MS&T '05," show just some of the many activities from the Materials Science & Technology 2005 conference, including invited speakers, poster sessions, and short courses.<sup>9</sup>

The 150th installment of the annual meeting was not left untouched by the COVID-19 pandemic, with the TMS 2021 Virtual Annual Meeting & Exhibition taking place in a completely online format. The meeting still featured a mix of recorded and live technical presentations, poster sessions, a virtual exhibit hall, and online networking, proving that the TMS Annual Meeting & Exhibition is still a destination to gather together. proud of when it happened and am still proud of even after having given many more since then. It meant so much to me, because it signaled to me that my peers within the Society, peers whose opinions and science matter within the field, thought that they might want to hear about my work. This was important to me.

**Nyberg:** I have many favorite memories. Technically, I am proud to have presented our newly patented hightemperature magnesium alloy. Exhibition-wise, I very much enjoyed the Superheroes of Materials Science. Socially, I have many happy moments with colleagues in New Orleans, Louisiana, listening to live music in "da Quarter!"

**Robinson:** There are many, but the one that comes to mind first is from TMS2019 in San Antonio, Texas, when Desne Crossley accepted the TMS Fellow Award on behalf of her just-passed father, Frank Crossley. She was warm, motivational, and inspirational. She spoke with touching passion about her father and his contributions to the field. Father and daughter received a much-deserved and enthusiastic standing ovation—a rarity for the TMS Awards Ceremony. I remain disappointed that I never met Frank personally, but knowing Desne is a joy.

**Thoma:** There are a lot of "TMS Moments," but my first presentation in Denver, Colorado, (a poster) is the one I remember most.

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# Unlocking the Potential of HIGH ENTROPY ALLOYS with New TMS Study

Dan Miracle



## **AVAILABLE NOW!**

Download your free copy of *Defining Pathways for Realizing the Revolutionary Potential of High Entropy Alloys* today at **www.tms.org/HEAPathways**.

Take advantage of even more technical resources—the entire suite of TMS science and technology accelerator studies are also available at www.tms.org/Studies.



Defining Pathways for Realizing the Revolutionary Potential of High Entropy Alloys is the newest in the series of TMS accelerator studies. High entropy alloys (HEAs), also called complex, concentrated alloys (CCAs) or multi-principle element alloys (MPEAs), give a new approach to design and develop materials by mixing concentrated blends of three or more principle elements. They

Dan Miracle

offer a vast range of new directions for basic research and applied development on essentially any class of inorganic material. Major new opportunities exist to overcome longstanding challenges in energy, defense, transportation, health, and environmental sectors. High entropy alloys offer a triple challenge due to the vast range of new compositions, a spectrum of new research topics, and a wide range of potential uses.

"Major new opportunities exist to overcome longstanding challenges in energy, defense, transportation, health, and environmental sectors."

The purpose of this TMS accelerator study is to develop a set of recommendations to help the technical and funding communities navigate the maze of HEA needs and opportunities. Sponsored by the Defense Advanced Research Projects Agency (DARPA) with the Air Force Research Laboratory (AFRL), this report emphasizes defense applications, but many other applications are also included. The study team consisted of 14 internationally recognized subject matter experts from academia, industry, and government who volunteered significant time to this project. A product of the COVID-19 environment, this report was produced by convening these experts in several online meetings, teleconferences, and virtual facilitated workshops. The study team provided content, and the writing, editing, and reviewing of the report was done by both TMS staff and the study team. A separate team of nine international experts provided an independent review of the report prior to publication.

After a brief introduction to the current state of HEA technologies, *Defining Pathways*: (1) gives a prioritized list of applications and alloy domains of most promise, particularly for defense-related applications; (2) identifies the key technology gaps, barriers, and enablers of the next stage of research in areas with the greatest potential for near term, substantive impact; and (3) provides recommendations and action plans to fuel significant progress within the next three to five years in the scientific exploration, engineering development, and industrial implementation of HEAs. A quick overview of the top-level findings described in the report are highlighted in this article.

A total of 16 applications and alloy classes were identified as high priority (see Table I). The first four are all materials for extreme temperature environments, and the highest priority is for refractory HEAs (RHEAs). These RHEAs provide new approaches to achieving many longstanding, high-impact aspirations in defense, energy, and transportation sectors. High entropy ceramic materials are included in the list of extreme temperature materials, as are thermal barrier coatings and, at the other extreme of the temperature spectrum, cryogenic materials. HEAs for catalysts and electrochemical uses, such as batteries and practical theromoelectric materials, offer high priority opportunities, and a range of applications that require resistance to environmental degradation, including corrosion, oxidation, marine fouling, and bacterial growth are also included. The ability to replace expensive or hard-to-get elements such as platinum or rare earth metals via concentrated alloying with multiple elements is a priority, and HEAs to enable alternative fuels, including hydrogen storage materials, are also on the list. High entropy brasses and bronzes, with applications in defense, health, and environmental industries, are included as the most likely HEAs to reach first application. It is perhaps a strange twist of fate that alloys produced by humanity's first venture into alloyed metals, brasses and bronzes, may also be the first to be improved by the high entropy concept.

## Table I. List of proposed target material classes and applications for HEA insertion:

- 1. Refractory HEAs (RHEAs)
- 2. Ultrahigh-temperature high entropy ceramics (HECs)
- 3. Thermal barrier coatings (TBCs)
- 4. Cryogenic systems
- 5. Catalysts
- 6. Corrosion-resistant coatings
- 7. Light-weight materials
- 8. Novelty HEA systems including:
  - a. Replacements for rare-earth and critical materials systems
  - b. Bulk metallic glasses with corrosion resistant properties
  - c. Anti-fouling or anti-bacterial coatings
  - d. Encapsulating frameworks for storing gases, reactants, or corrosion inhibitors
- 9. Batteries/superconductors
- 10. Thermoelectric materials
- 11. Electromagnetic application HEAs
- 12. HEAs with anti-bacterial properties/ applications
- 13. HEAs to enable renewable/alternative fuels
- 14. Quantum computing materials
- 15. Hydrogen-compatible/storage materials
- 16. High-entropy brasses and bronzes

Table I. This table presents potential application areas for high entropy alloys as defined in the *Defining Pathways* report. (*Defining Pathways for Realizing the Revolutionary Potential of High Entropy Alloys*, 2021, p. 14.)

Nine key challenge areas are identified and described in the report (see Table II). High throughput screening methods are essential to explore the vast, new composition space (HEAs expand the number of new alloy bases by up to a factor of 10<sup>7</sup>) and therefore are at the top of the list. The combination of three or more concentrated elements requires the development of new scientific theories, predictive models, and computational tools, and is listed next. Other challenges include availability of high throughput, high temperature test equipment, reliable sources of high-quality material feedstock (especially powder), expanded thermodynamic databases, and development of new composition-structureprocessing-properties relationships. Though it appears at the end of the list, the need to train the next generation workforce in these new theories and methods is a challenge with particularly high importance.

Table II: Key challenge areas and supporting needs/limitations.		
Key Challenge Area	Needs/Current Limitations	
A. High-Throughput Screening Methods and Experimental Tools	<ul> <li>High-throughput, automated, and/or autonomous tools and processes for integrated synthesis, characterization, and evaluation of HEAs</li> <li>High-throughput experimental approaches for melting temperature; tensile strength and ductility; and toughness</li> <li>High-throughput surrogate experiments for expensive and/or slow tests</li> </ul>	
B. Predictive Models and Computational Tools	<ul> <li>Fundamental theory for complex compositional space</li> <li>Uncertainty-based predictive computational models for HEA development</li> <li>Accurate cross-potentials for computational models</li> <li>Computational tools for predicting structural and functional properties</li> <li>ML approaches to help guide alloy selection</li> <li>Visualization tools for interpreting complex phase spaces</li> </ul>	
C. High-Temperature Equipment and Testing	<ul> <li>High-temperature processing, testing, and property measurements</li> <li>Addressing simultaneously the constraints of processing conditions (heating and oxidation) and sample size for high-temperature testing</li> <li>Methods to process high melting point (e.g., &gt;2000°C) RHEAs</li> <li>Robust high-temperature die materials</li> </ul>	
D. Scattered Data with Uncertain Materials Pedigree	<ul> <li>Robust, coordinated, pedigreed datasets to supplant the disparate current data across the wide spectrum of HEA compositions</li> <li>Widely adopted schema to establish provenance for HEA metadata</li> </ul>	
E. Fundamental Composition- Processing-Microstructure- Properties Knowledge	• Enhanced composition-processing-microstructure-properties correlations with as broad an applicability range as possible	
F. In Situ Characterization Methods	<ul> <li>In situ monitoring and characterization tools to track all test parameters</li> <li>Ability to monitor microstructural evolution in situ</li> </ul>	
G. Thermodynamic Databases	<ul> <li>Publicly available thermodynamic databases for HEAs</li> <li>Consistency across methods used to gather HEA data</li> <li>Multicomponent data to extrapolate into un-explored space</li> <li>Entropy properties (in thermodynamic databases) that are efficient and flexible</li> </ul>	
H. Availability of Affordable Powder	Solutions to overcome prohibitively expensive HEA raw material costs	
I. Workforce Trained in HEA Exploration and/or Development	A workforce skilled in using experimental and/or computational approaches and tools geared toward HEA exploration and development	

Table II. This table presents high-priority challenge areas for future R&D of HEAs on the left, while also cataloguing specific needs and/or limitations in each of these areas on the right. (*Defining Pathways for Realizing the Revolutionary Potential of High Entropy Alloys*, 2021, p. xxvi.)

These challenges are used to form 36 specific, actionable recommendations that can guide future research and development efforts. Some of these recommendations also address other aspects of the science and technology enterprise-efforts to coordinate government agency funding, to form consortia that share pre-competitive data, and to conduct student-oriented, multi-institute HEA workshops and programs are listed, for example. Finally, the challenges and recommendations are combined to produce five coherent action plans. Each action plan consists of detailed tasks to more fully describe the needed efforts. For example, one of the tasks in the action plan for high throughput evaluation and testing moves beyond conventional high throughput methods by describing an autonomous materials research capability tailored for the challenges introduced by HEAs (see Figure 1). The action plans also give the recommended duration, progress metrics, estimated

costs, and the types of key players and roles required for success. The action plans in *Defining Pathways* give stakeholders a detailed framework of prioritized recommendations to help accelerate the discovery, development, and implementation of these potentially game-changing materials.

"The action plans in *Defining Pathways* give stakeholders a detailed framework of prioritized recommendations to help accelerate the discovery, development, and implementation of these potentially game-changing materials."



Figure 1. This figure represents the autonomous materials research (AMR) process, which incudes artificial intelligence (AI) and unsupervised machine learning (ML). (Defining Pathways for Realizing the Revolutionary Potential of High Entropy Alloys, 2021, p. 42.)

Dan Miracle is a Senior Scientist in the Materials and Manufacturing Directorate of the Air Force Research Laboratory (AFRL). He is the *Defining Pathways* study team lead and current chair of the TMS Structural Materials Division.

# ANNOUNCING THE 2022 TMS SCHOLARS

Megan Enright

The 2022 class of TMS Scholars reflect the bright future of the minerals, metals, and materials professions. As we hear in their own words, the TMS community has provided these promising young individuals with opportunities to grow and learn, to meet new people in their fields, and much-appreciated financial assistance which has allowed them to continue their studies and work in these fields.

In addition to helping with the cost of education, many of the scholarships awarded include travel grants to aid these students in attending highly regarded professional meetings, like the TMS annual meeting. This allows these students to begin networking with professionals in their field, to expand their technical knowledge, and to build their professional profile. Several of these scholarships will be awarded during the TMS 2022 Annual Meeting & Exhibition (TMS2022) technical division functions, portions of which are open to all TMS2022 attendees. Be sure to support this promising group of scholars and congratulate them on their achievements. Furthermore, various other awards and scholarships will be conferred at the TMS-AIME Awards Ceremony during TMS2022; all are invited to attend. TMS2022 will be held from February 27–March 3, 2022, in Anaheim, CA. Learn more and register today at www.tms.org/TMS2022.

#### **APPLY FOR A 2023 TMS SCHOLARSHIP**

If you are a full-time undergraduate or graduate student interested in financial assistance, early career recognition, and important opportunities for advancement through technical exchanges at the TMS Annual Meeting & Exhibition, consider applying for a 2023 TMS Scholarship.

Applicants must submit their completed TMS scholarship application, up to three recommendations, a personal statement, and a transcript with current GPA online at www.tms.org/Awards. The deadline to apply for a 2023 award is March 15, 2022.

Visit www.tms.org/Awards to access application forms and for future notices about changes on how to submit your application package. For questions on TMS Scholarships, please contact awards@tms.org.



#### TMS DIVISION AWARDS

TMS Division Scholarship recipients will also receive a dollar-for-dollar scholarship match through the Battelle Matching Scholarship Program. This is made possible through the generous support of Battelle and its retired chief executive officer, Jeffrey Wadsworth.

Additionally, students who receive a Battelle Matching Scholarship will be eligible for a Battelle Materials Graduate Student Award when they matriculate to a graduate school to continue studies in a materials-related field.

#### Extraction & Processing Division (EPD) Scholarship

Awarded through the EPD and the TMS Foundation to sophomore or junior undergraduate students majoring in the extracting and processing of minerals, metals, and materials.



#### Jennifer Johnson South Dakota School of Mines and Technology

"This scholarship will allow me to continue in my goal, since middle school, of graduating college debt-free. I am also very excited to have the opportunity to attend the TMS 2022 Annual Meeting & Exhibition and be surrounded by industry leaders and researchers in

the metallurgy field!"



#### Madison Pixler

University of Notre Dame "I chose to attend Notre Dame because I knew the education that I would receive would be one that cultivates both my mind and my heart. I also knew a membership with TMS would help me to develop critical skills to apply in the materials industry. The funds of this scholarship will go directly to paying

for my tuition and will allow me to relieve financial stress while focusing on my chemical engineering degree."



#### Madison Rutherford

*Worcester Polytechnic Institute* "Thanks to my involvement in TMS and to the professors who supported me along the way, I have determined what I want to do with my future and gained the confidence to eventually pursue a Ph.D. in materials science. I hope to continue researching sustainable methods of material production and recycling. I'm

honored to receive the EPD Scholarship and am proud of the work I have done so far and what is to come."

#### Functional Materials Division (FMD) Gilbert Chin Scholarship

Awarded through the FMD and the TMS Foundation to sophomore or junior undergraduate students studying subjects related to synthesis and procession, structure, properties, and performance of electronic, photonic, magnetic, and superconducting materials, as well as materials used in packaging and interconnecting such materials in device structures.



#### Tylee Oldham University of Kentucky

"TMS and the TMS Foundation have provided a plethora of scholarship, networking, and materials-related sources that are truly valuable to its members. As an out-of-state top scholar in a collegiate materials engineering program, TMS has enabled me

with connect to others in my field and develop strong engineering ties through networking. I am excited to see my future with the assistance of TMS to help with my college support and resources."

#### Light Metals Division (LMD) Scholarship

Awarded through the LMD and the TMS Foundation to outstanding sophomore or junior undergraduate students majoring in metallurgical and/or materials science and engineering with an emphasis on both traditional and emerging light metals.



#### Jarrett Loseke Iowa State University

"TMS and Material Advantage provide numerous opportunities for learning and connecting with others, offering me a significant advantage in my studies and search for an internship, research, or a job further down the road. I am extremely grateful for the opportunities provided and am excited to continue

my education as an undergraduate."

#### **ENSURE A STRONG SCIENCE AND ENGINEERING FUTURE**



The events of the last two years have underscored the importance of science and engineering in successfully overcoming urgent and complex challenges, yet the economic and social impacts have put additional stresses on our most vulnerable colleagues—science and engineering students. Just like the individuals featured in this article, students will lead society through future crises.

Each of the scholarships presented in this article are made possible by the TMS Foundation and its generous supporters. You can ensure the good work on the Foundation continues by making a donation today at www.TMSFoundation.org/Contribute. For more information or to discuss donation options, contact TMS Foundation staff at TMSFoundation@tms.org.

#### Materials Processing & Manufacturing Division (MPMD) Scholarship

Awarded through the MPMD and the TMS Foundation to sophomore or junior undergraduate students majoring in metallurgical and/or materials science and engineering, with an emphasis on manufacturing, integrating process control technology into manufacturing, and basic and applied research into key materials technologies that impact manufacturing processes.



Megan Burrill

Illinois Institute of Technology "Participation in Material Advantage, and in particular the TMS Bladesmithing program, has been influential in my aspirations as a materials scientist. TMS Bladesmithing ignited my love for materials science, and I sought every opportunity to learn more.

Working with the graduate students I met through Bladesmithing, I began performing research during my second semester of college and have worked on a wide variety of projects. In addition, I have been the project leader for Bladesmithing, providing me with the valuable experience of leading a research project and presenting the results at the TMS 2020 Annual Meeting & Exhibition. All these experiences make me excited to take on the challenge of a Ph.D. in materials science and I look forward to using computational methods to inform and accelerate the experimental discovery of novel battery materials."

#### TMS SOCIETY AWARDS

#### Structural Materials Division (SMD) Scholarship

Awarded through the SMD and the TMS Foundation to sophomore or junior undergraduate students majoring in metallurgical and/or materials science and engineering with an emphasis on the science and engineering of load-bearing materials, including studies into the nature of a material's physical properties based upon its microstructure and operating environment.



#### Sheron Tavares

University of California, San Diego "The TMS Foundation is a component of one of the most important societies in the world— TMS. I feel honored to be part of this institution. I am completely happy to have been awarded this scholarship. This award represents my passion and dedication to the field of materials science. I hope

to receive more awards from TMS throughout my professional career. My dream is, after finishing my doctorate, to be a talented professor and scientist in the vast field of materials."

#### TMS International Symposium on Superalloys Scholarships

This award is for undergraduate and graduate students majoring in metallurgical and/or materials science and engineering with an emphasis on all aspects of the high-temperature, high-performance materials used in the gas turbine industry and all other applications. Awards are presented in conjunction with the Materials Science and Technology Conference and the International Symposium on Superalloys.



#### Preston Nguyen University of Pittsburgh

"This scholarship is a significant milestone for me that indicates that all the hard work I have put forth and all the obstacles I had to overcome were worth the effort. TMS and Material Advantage have helped me improve my interpersonal and professional

skills. I hope to use the skills that TMS and Material Advantage have helped me develop to pursue further materials research in superalloys."



#### Rafael Rodriguez University of Pittsburgh

"I am very thankful to TMS and honored to receive this award. This scholarship represents a recognition of what my hard work has accomplished and a strong encouragement to continue pursuing excellence in the materials science field. I am excited for this opportunity as this

award constitutes strong support to continue my studies and research work in the field of superalloys."

## In Case You Missed It: BUSINESS NEWS FROM THE FIELD



**Gothenburg, Sweden:** Volvo Group unveiled a first-ofits-kind vehicle that was made using fossil-free steel: a four-wheeled, electric-powered load carrier made for quarrying and mining. The autonomous vehicle can follow a pre-programmed route to transport materials at a job site. Swedish manufacturer SSAB supplied the vehicle's green steel. Volvo says that 70% of a truck's weight comes from steel and cast iron, and decarbonizing its production is key to achieving its goal of climateneutrality by 2040. (Photo Credit: Volvo Group)

#### Solar Energy Fuels First Steel Mill

**Pueblo, Colorado, USA:** EVRAZ North America, in partnership with global solar leader Lightsource bp and Xcel Energy, launched the new 300-MW Bighorn Solar project, representing the world's first steel mill to be powered predominantly by solar energy. Sitting on 1,800 acres on EVRAZ Rocky Mountain Steel's property in Colorado, Bighorn Solar is the largest on-site solar facility in the U.S. servicing a single customer. The project was initially announced in 2019 and will support more than 1,000 jobs at the plant.

#### **Partners Add Scandium to EV Parts**

Manitowoc, Wisconsin, USA: Eck Industries, a U.S. aluminum producer, and Canada's Imperial Mining are building prototypes for a battery box for electric vehicles (EVs) made from a high-strength scandiummodified aluminum alloy, which has potential to create a significant end-use market for scandium. Imperial began working with Eck to investigate adding scandium to a widely available commercial alloy known as AlMag, or alloy 535—a lightweight aluminum alloy that contains 7pc magnesium. Eck uses AlMag in commercial products for the automotive sector. Adding scandium increases the yield strength, opening new structural applications. 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: The Magazine* Managing Editor, at kcalva@tms.org for consideration.

#### South32 Commits to Chilean Copper Mine

**Perth, Australia:** South32 Limited announced two binding conditional agreements with Sumitomo Metal Mining and Sumitomo Corporation to acquire a 45% interest in the Sierra Gorda copper mine in Chile via the acquisition of a 45% indirect interest in Sierra Gorda S.C.M. for an upfront cash consideration of \$1.55 billion. South32 also agreed to provide Sumitomo with a contingent price-linked consideration of up to \$500 million, payable at threshold copper production rates and prices in the years 2022 to 2025. Sierra Gorda, located in the prolific Antofagasta region, is expected to produce 180,000 t/y of copper, 5,000 t/y of molybdenum, 54 000 oz/y of gold, and 1.6 million ounces per year of silver in 2021.

#### **Optomec Advances Turbine Repair**

Albuquerque, New Mexico, USA: Optomec Inc. delivered a multi-functional additive manufacturing machine to a leading supplier to the \$37 billion worldwide aviation engine Maintenance Repair and Overhaul (MRO) market. The new machine combines two turbine repair process operations that are typically done manually, not only reducing the cost of engine overhauls, but also improving quality and consistency. Optomec's proprietary process uses a combination of advanced machine vision, adaptive software, on-the-fly laser power adjustment, and automation to precisely add metal to worn engine components, restoring them to the geometric specifications set by the original turbine engine manufacturers.

#### New Hydrogels Produce Energy

Raleigh, North Carolina, USA: North Carolina State University researchers developed a stretchy, energy-harvesting device out of liquid metal and soft polymers known as hydrogels. The device holds promise for powering wearable devices because it produces small amounts of electricity and can operate in water and air. The team was inspired by a 2013 paper by Korean researchers that found they could harvest energy from an electrical double-layer capacitor by depressing arrays of water droplets sandwiched between two rigid electrodes, thereby spontaneously charging the capacitor. Rigidity proved to be a shortcoming, so the team sought to create a flexible version.

## **TMS MEETING HEADLINES**



TMS is committed to your safety during the pandemic. Meeting dates and locations are current as of November 15, 2021. For the most recent updates on TMS-sponsored events, visit www.tms.org/Meetings.



TMS 2022 Annual Meeting & Exhibition (TMS2022)

February 27– March 3, 2022

#### Anaheim, California, USA Discount Registration Deadline: January 18, 2022

Join us for TMS2022, which will feature the next TMS Bladesmithing Competition and three co-located meetings: the fourth Summit on Diversity in the Minerals, Metals, and Materials Professions (DMMM4), Furnace Tapping 2022, and the 7th installment of the REWAS conference series.

www.tms.org/TMS2022



6th International Congress on 3D Materials Science (3DMS 2022)

June 26–29, 2022 Washington, D.C., USA

## Submit an Abstract by January 21, 2022

3DMS 2022 seeks to provide the premier forum for presentations of current interest and significance to the three-dimensional characterization, visualization, quantitative analysis, modeling, and development of structureproperty relationships of materials, as well as big data and machine learning issues associated with 3D materials science.

www.tms.org/3DMS2022



2022 Liquid Metal Processing & Casting Conference (LMPC 2022) September 18–21, 2022 Philadelphia, Pennsylvania, USA

#### Submit a Manuscript by April 1, 2022

LMPC 2022 is a unique event that showcases the latest technological and scientific advances related to those industrial processes used to cast large ingots of highly alloyed metal. The program will feature highly technical talks and a balanced representation of industry and academia.



Materials Science & Technology 2022 (MS&T22)

October 9–13, 2022 Pittsburgh, Pennsylvania, USA

#### Submit an Abstract by March 15, 2022

This twentieth installment of the MS&T conference series will include approximately 80 symposia in 15 technical tracks developed by the three MS&T partner societies: the American Ceramic Society (ACerS), the Association of Iron & Steel Technology (AIST), and TMS. www.matscitech.org

**/MST22** 

## $^\prime$ Other Meetings of Note



6th World Congress on Integrated Computational Materials Engineering (ICME 2022) April 24–28, 2022 Lake Tahoe, Nevada, USA www.tms.org/ICME2022

#### **Co-Sponsored Meetings**

Offshore Technology Conference (OTC) Asia 2022 March 22–25, 2022 Kuala Lumpur, Malaysia



Congress on Safety in Engineering and Industry 2022 August 15–17, 2022 Fort Worth, Texas, USA www.SafetyCongress.org

Offshore Technology

Conference (OTC) 2022

May 2-5, 2022

Houston, Texas, USA



Additive Manufacturing Benchmarks (AM-Bench) 2022 August 15–18, 2022 Bethesda, Maryland, USA www.tms.org/AMBench2022

ALTA 2022 Nickel-Cobalt-

Copper, Uranium-REE, Gold-

PM, In Situ Recovery, Lithium

& Battery Technology

**Conference & Exhibition** 

May 20-27, 2022

Perth, Australia



Superalloy 718 and Derivatives 2023 May 14–17, 2023 Pittsburgh, Pennsylvania, USA www.tms.org /Superalloy718-2023

8th International Conference on Solid - Solid Phase Transformations in Inorganic Materials (PTM2022) June 27–July 1, 2022 Xi'an, China

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We look forward to another successful year in 2022.



www.TMSFoundation.org





# **TMS2022 Pre-Show Report**



Meeting Dates: February 27–March 3, 2022 Exhibit Dates: February 28–March 2, 2022 Anaheim Convention Center & Anaheim Marriott Anaheim, California, USA www.tms.org/TMS2022 #TMSAnnualMeeting

## TMS2022 Exhibitors (as of November 11, 2021)

<b>Company Nam</b>	e Booth Number
ABB, Inc	
AdValue Techno	logy LLC
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Bruker	
California Nanot	echnologies631
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<b>Claudius Peters</b>	Projects GmbH408
EDAX	
FemtoTools AG	
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Haarslev Industries Press	
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Hycast AS	
KLA Corporation	
Leica Microsystems	
Light Metal Age	
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## Join Us!

Opportunities to connect with TMS2022 attendees are still available. Contact us today to reserve your booth or to learn about sponsorship opportunities.

#### **Book an Exhibit Booth**

Gavin McAuliffe TMS2022 Exhibit Manager Corcoran Expositions 1-312-265-9649 gavin@corcexpo.com

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#### **Reserve a Sponsorship**

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Poster Boards





Science and artistry will be on display at the 2022 TMS Bladesmithing Competition! The TMS Bladesmithing Competition is a popular event that challenges student teams to produce a knife or sword blade by hand hammering or trip hammer forging. On Monday, February 28, and Tuesday, March 1, visitors to the TMS2022 Exhibit will have the unique opportunity to view these quality examples of metalwork and learn the story behind each blade.

www.tms.org/Bladesmithing

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