

JOM THE MAGAZINE

SEPTEMBER 2023

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

EXPANDING HORIZONS BY ENHANCING ACCESSIBILITY



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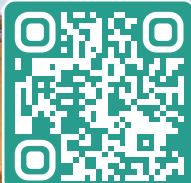
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ABOUT THE COVER



This month's cover depicts the theme of Expanding Horizons by Enhancing Accessibility, which is explored in a series of four articles in this issue of the magazine. The articles, which look at increasing accessibility for nontraditional students in education and for individuals with disabilities in professional settings, were developed by the TMS Diversity, Equity, and Inclusion (DEI) Committee. Pictured on the cover, from left to right, are DEI Committee co-liaisons to JOM Kiyo T. Fujimoto and Tashiema L. Ulrich, along with two of the TMS members who contributed to this article series, David Estrada and Amy Wat. The cover was designed by Bob Demmler, TMS Visual Communications Coordinator.



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 science 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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IN THE FINAL ANALYSIS

"I think separating the technical articles and having them only as on-line is a big improvement. The journal was getting to [sic] unwieldy and the on-line version is preferred. The Magazine is a nice thing to get at my home to remind me what's happening."

—JOM Survey Respondent

No new news in this lede: The periodical printing business is continuing an inexorable contraction. Printing presses and mailing houses are increasingly curiosities as we reach for our phones, tablets, laptops, e-readers, and other touch-sensitive doodads. As TMS is a scholarly publisher serving the materials community, it is a daily conversation within the Society as to how we navigate changes in how content is accessed and consumed.

TMS has been delivering journal content digitally since before the "www" era when we launched a telnet site to deliver paper titles and abstracts. A robust JOM site was a priority in our initial web development. We conducted a multi-year JOM-e initiative to publish papers enhanced with web and multimedia components. Clearly, JOM has been one of our favorite laboratories for experimentation! Until about 15 years ago, JOM was the only TMS periodical printed and mailed to TMS members gratis. Now, thanks to our partnership with Springer Nature, TMS members have free access to every article published by every TMS journal as well as 20 other scholarly material journals via the SpringerLink site. As a member benefit, that's an e-bookshelf comprising every volume year of 26 periodicals.

While we are awash in digital options and virtual access points, we have not forgotten that print publishing may still have a role to play. Today, receiving an item in the physical mail is novel and attention-getting. This helps TMS separate its message from the constant e-noise. So, we continue to experiment with the delivery of JOM. Over the last few years, we have

- Ceased printing and mailing the incredibly thick JOM (Magazine + Journal) to members each month.
- Initiated printing and mailing just the compact and broad-interest Magazine section to members monthly.
- Reduced the number of Magazine mailings from twelve to eight per year. The remaining four Magazine sections are available exclusively online.

Gauging how our members are reacting to these changes and how they view the quality of the Magazine was the subject of this year's JOM readership survey. Indulge me as I recount a few of my insights:

- **Members like reading the Magazine both in print and online:** 36% see both print and digital as equally acceptable, 34% prefer to read the Magazine digitally, and 30% prefer print only. Print is most popular with our retirees and our members based in the United States.
- **Members like what they are reading:** 27% call the overall quality of the Magazine "excellent," 54% "good," and 19% "average" or lower. 81% call the editorial content "excellent" or "good." The Structural Materials Division members are most pleased with the editorial content with 90% saying it is "excellent" or "good."
- **Members like learning about TMS initiatives:** The most popular content in the Magazine is news of upcoming TMS events as 82% call that coverage "excellent" or "good." Second most popular: Updates on TMS publications (72%).
- **It's all about me:** 20% of members have no opinion on In the Final Analysis. (Insert sad face emoji.) However, of the 80% of members who do read the column, 86% rate it as "excellent" or "good." Okay, I am affirmed.

What is to be done with the results? Inform our future experiments, of course! What will those experiments be? Well, the 80% of TMS members who read this column will be the first to know!

Volume 75

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September 2023



James J. Robinson
Executive Director

 @JJRofTMS

"As TMS is a scholarly publisher serving the materials community, it is a daily conversation within the Society as to how we navigate changes in how content is accessed and consumed."

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 for access to technical journal articles on the Springer website.

SEPTEMBER 2023

Advanced Functional and Structural Thin Films and Coatings

Scope: This special topic celebrates the contributions of Professor Heinz Palkowski from Clausthal University of Technology, Germany, in the areas of materials science and engineering. Manuscripts are presented in the topical areas of coatings and engineered surfaces for reducing corrosion and wear as well as making use of lubricant-free (green) production and coatings for biomedical and healthcare, electronic and structural applications.

Editors: Ravindra Nugehalli, New Jersey Institute of Technology; Adele Carradò, University of Strasbourg; Karine Mougín, French National Centre for Scientific Research; Ramana Chintalapalle, University of Texas at El Paso; and Gerald Ferblantier, University of Strasbourg

Sponsor: Thin Films and Interfaces Committee

Pyrometallurgical Techniques Driving Recycling and the Circular Economy

Scope: Widespread use of metals in a multitude of industries and private applications leads to the need for recycling and reutilization of constituent components in materials. Improving and developing the recycling technology of metals is a continuous effort and far from maturity today. The current methods need to be analyzed, improved, and adapted for upcoming recyclables to drive the circular economy.

Editors: Will Hannemann, Aurecon; Mohamed Elzohiery, Guardian Industries; and Stuart Nicol, Glencore Technology

Sponsor: Pyrometallurgy Committee

Recent Advancements in Optoelectronics & Photonics

Scope: Significant advancements in optoelectronics and photonics encompass new materials including 2D materials, active and passive devices, circuits and systems, and methods of integration. From a materials perspective, there has been a better understanding of the processes, role of defects and dislocations, stresses, and scaling. The mature, reliable, scalable, and cost-effective approach to silicon technology is slowly and steadily making its way to silicon photonics. The significant advancements in silicon and non-silicon based optical filters, transceivers, modulators, waveguides, photodetectors, sensors, solar cells, LIDARs, spectrometers, and other related devices are just a few examples of the growth in photonics and optoelectronics. This special topic is anticipated to bring together results from research that is being performed in academia, industry, and national labs.

Editors: Sufian Abedrabbo, Khalifa University; Anthony Fiory, Bell Labs (Retired); and Nugehalli Ravindra, New Jersey Institute of Technology

Sponsor: Thin Films and Interfaces Committee

Smart Energy Utilization for Metallurgical Recycling of Battery and Electronic Waste

Scope: Recycling of battery and other electronic waste by various metallurgical processing poses multiple challenges. Notably, one such challenge is energy consumption or utilization in processing. As the industry is continuously growing, researchers are slowly developing energy solutions to overcome this challenge and make metallurgical processing of these wastes more attractive. This special topic presents research papers on various solutions to the energy challenges.

Editors: Joseph Hamuyuni, Metso Outotec; Fiseha Tesfaye, Metso Outotec Metals Oy/Åbo Akademi University; Chukwunwike Iloeje, Argonne National Laboratory; and Hong (Marco) Peng, University of Queensland

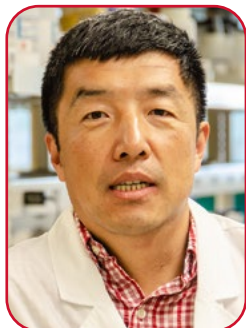
Sponsor: Energy Committee, Recycling and Environmental Technologies Committee, Process Technology and Modeling Committee

TMS MEMBER NEWS

Share the Good News!

Contact Kelly Zappas, *JOM: The Magazine* editor, at kzappas@tms.org to share your professional accomplishments. Please note that only news submitted by current TMS members will be considered.

Xingbo Liu Honored with DOE Hydrogen Program AMR Award



Xingbo Liu, West Virginia University, was honored by the U.S. Department of Energy's (DOE) Hydrogen Program with a 2023 Annual Merit Review (AMR) Award. These awards were presented in June 2023 at the 2023 Annual Merit Review and Peer Evaluation Meeting. The Hydrogen Program presents

these awards to individuals from partner institutions for contributions to overall program efforts and to recognize research, development, and demonstration

achievements in specific areas.

Liu received the Hydrogen Production Technologies award "for outstanding contributions to developing high-performing, efficient, and durable intermediate-temperature proton conducting solid oxide electrolysis cells."

A TMS member since 2002, Liu has served on several TMS committees, including the High Temperature Alloys Committee, the Energy Conversion & Storage Committee, and the Nominating Committee. He is currently a member of the Public & Governmental Affairs Committee. He is a recipient of the 2010 Early Career Faculty Fellow Award and is a 2016 Brimacombe Medalist.

TMS Members Meet at Superalloy 718 & Derivatives 2023

In Pittsburgh, Pennsylvania, from May 14–17, 2023, TMS members gathered to explore all aspects of metallurgical processing, materials behavior, and microstructural performance for a distinct class of 718-type superalloy and derivatives at the 10th International Symposium on Superalloy 718 & Derivatives 2023 (Superalloy 718 & Derivatives 2023).

Attendees gathered to hear from a multitude of experts in the field and made new professional connections at various networking and social events. The conference included plenary presentations from

Melissa Martinez, ATI Metals, and **David Furrer**, Pratt & Whitney.

Meeting registrants can access the *Proceedings of the 10th International Symposium on Superalloy 718 and Derivatives* electronically at www.tms.org/Superalloy718Proceedings.

Hard-copy books and additional e-books may be purchased through the TMS Bookstore at www.tms.org/Bookstore. TMS members should log in through the Bookstore to receive a 40% discount, plus free shipping.



Superalloy 718 & Derivatives 2023 organizing committee members meet on site at the conference. From left to right: **Michael Fahrman**, Haynes International; **Eric Ott**, GE Aviation; **Tim Smith**, NASA Glenn Research Center; **Chantal Sudbrack**, U.S. Department of Energy (DOE) National Energy Technology Laboratory; **Joel Andersson**, University West; **Andrew Wessman**, The University of Arizona; **Kevin Bockenstedt**, ATI Specialty Materials; and **Paul Jablonski**, U.S. DOE National Energy Technology Laboratory.

Awards Presented to TMS Members at ICME 2023

The 7th World Congress on Integrated Computational Materials Engineering (ICME 2023) took place from May 21–25, 2023, in Orlando, Florida. At this congress, TMS members gathered to share insights and learn from leading researchers and practitioners in the field. ICME 2023 provided a hub of interaction among software developers and process engineers along the entire production chain, as well as for materials scientists and engineers developing new materials.

ICME 2023 Chair, **Charles Ward**, presented **Andrew Bobel**, General Motors Global Research & Development, with the Materials Processing & Manufacturing Division (MPMD) ICME Industry Implementation Award, which he accepted on behalf of General Motors Global Research & Development during the congress. This TMS award recognizes the significant achievements that industry has made to implement ICME methods into a manufacturing process and/or design of a new material.

Also at ICME 2023, several student attendees were

rewarded for their submissions to the ICME 2023 Student Poster Contest. A total of 17 posters were on display, and judges awarded the top three prizes to the following students:

First Place: Brayan Murgas, Johns Hopkins University
Poster Title: "A Generative Adversarial Network for the Creation of Complex 3D Bimodal Polycrystalline Microstructures: Application to Cold-spray Al7050 Alloy"

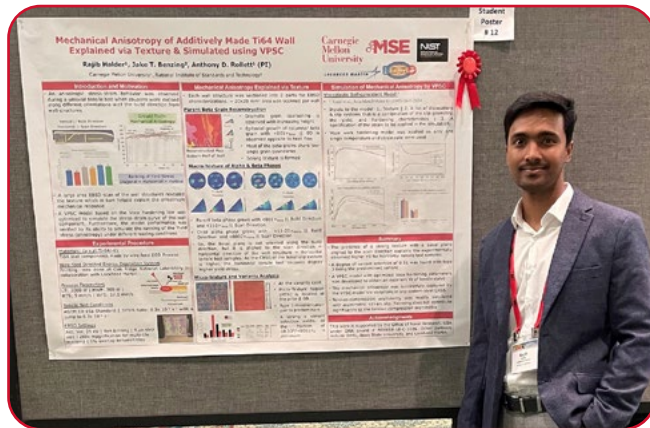
Second Place: Rajib Halder, Carnegie Mellon University
Poster Title: "Effect of Cooling Rates on the Evolution of Microstructure, Phase Transformation, and Strain in Ti-6Al-4V Studied by High-Speed Synchrotron X-ray Diffraction"

Third Place: Deepa Bhuvanagiri, Case Western Reserve University
Poster Title: "Geospatiotemporal Modeling of Near Subsurface Temperatures of the Continental United States for Assessment of Materials Degradation"

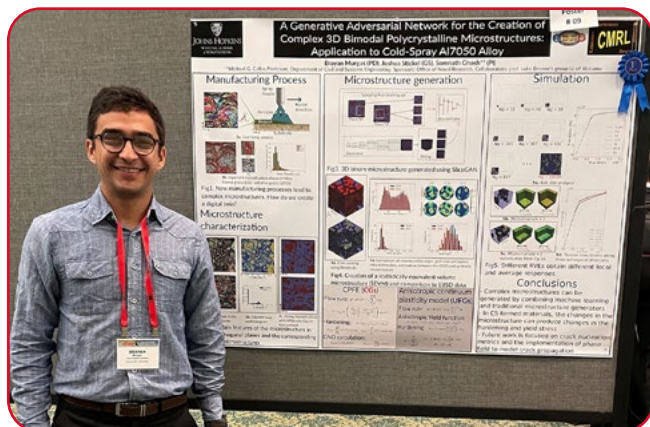
Congratulations to these award recipients.



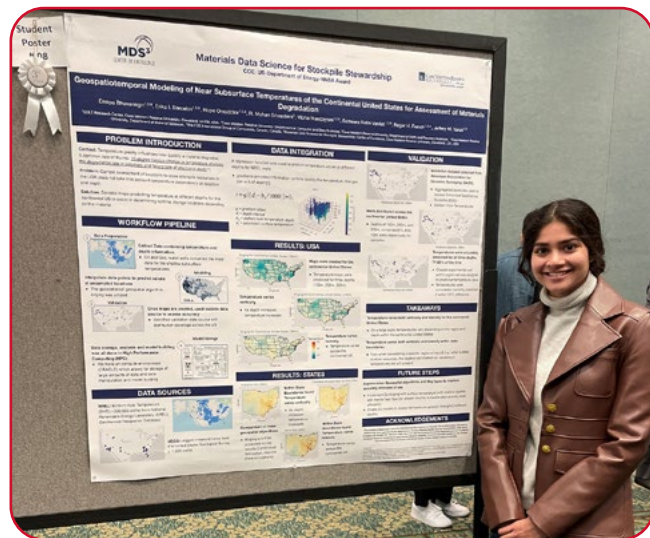
Charles Ward (left), ICME 2023 chair, presents **Andrew Bobel** (right) with the MPMD ICME Industry Implementation Award, which he accepted on behalf of General Motors Global Research & Development.



Rajib Halder, Carnegie Mellon University, receives the second place award in the ICME 2023 Student Poster Contest.



Brayan Murgas, Johns Hopkins University, receives the first place award in the ICME 2023 Student Poster Contest.



Deepa Bhuvanagiri, Case Western Reserve University, receives the third place award in the ICME 2023 Student Poster Contest.

Call for Papers Opens for OTC 2024



The Offshore Technology Conference (OTC) 2024 is scheduled for May 6–9, 2024 in Houston, Texas, USA. You are invited to submit a paper proposal presenting your technical solutions, innovations, advancements, and

knowledge at OTC, the world's largest offshore energy conference and trade show.

Help shape a vibrant future for the offshore energy sector by contributing to the world-class technical program. For a complete list of topics and to submit a paper, visit **2024.otcnet.org**. Proposals will be accepted through **September 12, 2023**. Authors whose paper proposals are accepted will be required to provide a manuscript for the conference proceedings, copyright forms, and a paper information form by February 6, 2024.

New Content Added to Light Metals Digital Library



The Light Metals Digital Library has been expanded to include volumes from 2011 to 2015. This additional content includes 1,128 total papers that can now be accessed in the library. This online collection consists of more than 6,300 technical papers published from

1971 to 2015 as part of TMS's signature *Light Metals* proceedings series, which publishes the collected proceedings from Light Metals symposia held at the TMS Annual Meeting & Exhibition each year.

Individual articles can be purchased for \$10 each for TMS members or \$25 for nonmembers. TMS members can purchase a subscription to the library for \$50 per year, providing them access to the complete collection of articles. This subscription can be purchased through the TMS membership renewal form during the renewal process. Institutional subscriptions are also available; contact **publications@tms.org** for more information. Visit **www.tms.org/LightMetalsLibrary** to explore this new content and purchase papers.

Journal of Sustainable Metallurgy Seeks Submissions for Topical Collection



The *Journal of Sustainable Metallurgy* is seeking submissions for the new topical collection, **New Approaches for Sustainable Steel Production and Processing**. This collection aims to provide a platform for the exchange of knowledge and ideas related to sustainable metallurgy

approaches for steel production and processing using renewable energy resources, low-grade input materials, recycled scraps, and impurity tolerant material/process design. Topics for this collection will include, but are not limited to:

- Strategies for efficient utilization of low-grade input materials
- Data-driven prediction and optimization of

metallurgical processes

- Fundamental understanding of physical, chemical, and mechanical phenomena in sustainable metallurgical processes
- Sustainable metallurgical approaches using recycled scraps, impurity element detections, and impurity-tolerant material/process design
- New processes and manufacturing techniques with reduced environmental impact or increased circularity

The guest editors for this topical collection are **Yan Ma**, Max-Planck-Institut für Eisenforschung GmbH, and **Alexander Gramlich**, Steel Institute of RWTH Aachen University.

To submit your work, go to **www.editorialmanager.com/sume**. After logging in, choose "Submit New Manuscript," and then select article type "Thematic Article." When reaching the "Additional Information" screen, indicate that you are submitting for the topical collection "Sustainable Steel 2023" from the list of options. Author instructions and additional journal details are available at **www.springer.com/40831**. Article submissions are due by **October 31, 2023**.

EXPANDING HORIZONS BY ENHANCING ACCESSIBILITY

Kiyo T. Fujimoto and Tashiema L. Ulrich



"It is through accessible education, inclusive workplaces, and barrier-free environments that we foster innovation, collaboration, and societal progress."



The TMS Diversity, Equity, and Inclusion (DEI) Committee article series in the September 2023 *JOM: The Magazine* highlights diversity concepts and the ongoing work that TMS and the overall STEM community are doing to enhance accessibility to catalyze efforts in fostering a more inclusive and diverse community. From this series of articles, we hope you feel encouraged to engage in meaningful discussions on the intersection of expanding horizons and enhancing accessibility in higher education, professional societies and programs, and the workplace. Using these articles as a jumping off point, we strive to create a world where accessibility is not a mere afterthought but a natural and integral part of our shared awareness.

The significance of accessibility in our personal and professional lives cannot be overstated. It is through accessible education, inclusive workplaces, and barrier-free environments that we foster innovation, collaboration, and societal progress. By expanding our horizons and championing the cause of enhanced accessibility, we can ignite a transformative chain reaction that uplifts not just individuals but entire communities and industries. As such, the three articles in the series are focused on enhancing accessibility to support DEI efforts within the STEM community.

In the first article, "Cal State LA: An Example for Successful DEI Outcomes for Students," Amy Wat, Travis Hu, and Mohsen Eshraghi introduce us to a materials science and engineering master's program with a focus on improving DEI to create an inclusive environment that attracts diverse talent and ensures materials development benefits a wide range of individuals and communities. The authors are all examples of alumni success stories, which are included in the article, that highlight pursuing postdoctoral degrees and employment in relevant industries. Supported by a grant from the National Science Foundation, California State University, Los Angeles (Cal State LA) accommodates working students with evening classes and by providing research opportunities and fostering connections with industries to offer a solution to the challenges of inaccessibility and lack of role models in the field.

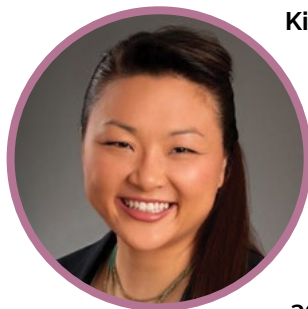
In the second article, "Enabling Success: Enhancing Accessibility in Professional Societies and Programs for Disabled Individuals," Hillary K. Fishler and Kiyo T. Fujimoto discuss the importance of engagement in professional societies and career development for scientists, highlighting how it can boost recognition, confidence, and community. The article calls for greater attention to disability inclusion in DEI efforts in STEM. It also suggests tips for improving accessibility and accommodating the needs of individuals with disabilities in professional settings.

Our concluding article "Expanding Opportunities: Promoting Accessible Higher Education for Non-Traditional Learners," is a question-and-answer feature that presents an interview with David Estrada conducted by Kiyo T. Fujimoto. Both Estrada and Fujimoto embarked on their educational journeys as non-traditional students, balancing the pursuit of doctoral degrees with the responsibilities of raising a family. Throughout this interview, an emphasis is placed on the need for universities to provide specialized support services, financial planning assistance, and resources for non-traditional students to ultimately enhance accessibility to higher education for non-traditional students. Estrada shares how his experiences shaped his career goals and ultimately the mission of his laboratory at Boise State University.

Along our journeys, we may find that we are often presented with opportunities that expand our horizons, allowing us to better recognize and pursue the uncharted depths of our potential and to unlock boundless possibilities. As we each pave our trail, it is important to acknowledge that certain individuals may face limited opportunities that may be constrained by systemic discrimination, inadequate representation, implicit bias, disparities in education, socioeconomic circumstances, and/or inaccessible environments. It is through this acknowledgment that expanding our horizons becomes a dual pursuit, not only championing our own personal growth but also fostering the growth of those around us, enabling everyone to flourish and thrive. By doing so we can create a world where we can realize the true potential of diversity, equity, and inclusion.

Enhanced accessibility is a powerful catalyst for promoting diversity, equity, and inclusion. By breaking down barriers, nurturing inclusion, and embracing the transformative potential of accessibility, we create a society that values the contributions of all individuals. Let us all work to expand our horizons so we can create a brighter and more inclusive future, where access knows no limits and diversity thrives.

"By breaking down barriers, nurturing inclusion, and embracing the transformative potential of accessibility, we create a society that values the contributions of all individuals."



Kiyo T. Fujimoto serves as the Advanced Manufacturing Laboratory Lead at the Center for Advanced Energy Studies and is a research scientist at Idaho National Laboratory where she focuses her work on additive manufacturing of sensors and electronics for

harsh service conditions. As a TMS member, she is part of both the Functional Nanomaterials and Energy technical committees, is a mentee in the TMS Leadership Development Initiative, serves on the Public and Governmental Affairs Committee, and is a DEI JOM co-liaison.



Tash Ulrich is a research scientist in the Nuclear Fuel Element Performance Group at Oak Ridge National Laboratory. Her research is focused on the fabrication and characterization of novel nuclear fuel forms as well as post irradiation examination

of commercial and research reactor fuels. Ulrich also supports the Department of Energy Nuclear Smuggling Detection and Deterrence Program (NSDD) Investigation Support Functional Team as a subject matter expert. She is serving as the DEI JOM co-liaison.

CAL STATE LA: AN EXAMPLE FOR SUCCESSFUL DEI OUTCOMES FOR STUDENTS

Amy Wat, Travis Hu, and Mohsen Eshraghi

California State University, Los Angeles (Cal State LA) has started a materials science and engineering (MSE) master's program that can have a profound impact in improving diversity, equity, and inclusion (DEI). Promoting DEI in MSE fosters an inclusive and equitable environment that attracts and retains the talent necessary for a vibrant and innovative scientific community and ensures materials development is beneficial for a wide range of individuals and communities. However, initiatives to improve DEI in MSE are often stymied by the challenges of inaccessibility of the field and lack of role models or mentors to foster an inclusive learning environment. Cal State LA provides an example of how these issues can be addressed in a comprehensive university.

Comprehensive universities offer a profound solution to these issues because they are accredited institutions that offer undergraduate and master's degrees to students with various socioeconomic backgrounds, ages, and ethnicities. These schools charge a fraction of the tuition costs found in elite colleges and account for 70%¹ of all enrolled undergraduate students within the United States. Cal State LA is a gold standard of comprehensive universities and a leader in improving DEI in science. Cal State LA is rated the best university in the United States in upward mobility of its students according to the Equality of Opportunity Project.² This study found that Cal State LA has propelled the most students from the bottom fifth of income into the top fifth of U.S. earners. Cal State LA started an MSE master's program in 2019 and has a history of providing support and opportunities to underrepresented minorities to pursue a career in MSE. This article discusses the resources and best practices from Cal State LA and how they are such a powerful tool in improving DEI in MSE.

"Cal State LA started an MSE master's program in 2019 and has a history of providing support and opportunities to underrepresented minorities to pursue a career in MSE."

The program prepares graduate students for industrial positions in related fields and for further study at the doctoral level. The MSE program at Cal State LA aims to educate historically under-represented groups residing in neighborhoods around the campus for success in advanced studies. The student demographics are very diverse and reflect the historically under-represented groups of Southern California. The demographic data below illustrate this point:

- 41% of the applicants and 30% of those who enrolled in the program were female.
- 38% of the applicants and 60% of those who enrolled in the program were underrepresented minorities.
- 29% of the applicants and 13% of those who enrolled in the program were first-generation college students.
- 37% of the applicants and 60% of those who enrolled in the program were Hispanic.

The MSE Program at Cal State LA was partially supported by a National Science Foundation (NSF) grant from the Partnership for Research and Education in Materials (PREM) program in collaboration with Pennsylvania State University.

MSE is an interdisciplinary program housed directly under the college of Engineering, Computer Science, and Technology. The core courses are often offered by Mechanical Engineering, Chemistry, and Physics departments. The MSE students conduct research with faculty from those departments and many complete a thesis. Most of the MSE students who select the thesis option and work with MSE faculty are sponsored by research grants from different agencies. The students work in established research laboratories that provide state-of-the-art research opportunities. The faculty have active research grants, publish journal articles, and encourage their students to present their findings at scientific conferences.

The Materials Characterization Lab (MCL) at Cal State LA was renovated recently. Over \$1 million worth of equipment has been added to the facility during the last couple of years, including a new scanning electron microscope (SEM), an advanced digital optical microscope, X-ray diffraction (funded by PREM), atomic force microscope, and a universal testing machine. The facility is open to all Cal State LA researchers, neighboring industry, and the public to promote and support MSE-related educational and research activities (Figure 1).



Figure 1: Matthew Enquist, a Hispanic first-year MSE student working with the SEM at Cal State LA's materials characterization lab. Enquist won second place at the Cal State Grad Slam among almost 50 selected students from 23 California State campuses.

A best practice for educating these students is to accommodate the needs of individuals who work full-time or part-time. The program offers classes in the evening or late afternoon hours. This also supports students who are prepared to engage in research and study full-time because it enables flexibility in their schedules. This also enables the local community to employ the students as they become trained for highly technical positions and adapt to the demands of the industry. This adaptation and flexibility enable upward economic movement for the students, as reflected in the Equality of Opportunity Project.

See the sidebar “Perspectives from a Cal State Alumnus” to learn about the experience one of this article’s authors had as a student at Cal State LA before the MSE master’s program was implemented.

PERSPECTIVES FROM A CAL STATE ALUMNUS

Amy Wat graduated from Cal State LA prior to the inception of the MSE master’s program. She leveraged a network of programs and faculty that enabled her career in MSE, despite being a first-generation college student. This ranged from enrolling in the mechanical engineering program and learning about materials science as a discipline to gaining opportunities to conduct research in MSE within Cal State LA and world-class scientific institutes. The National Science Foundation (NSF) grant from the Partnership for Research and Education in Materials (PREM) program enabled Wat’s first exposure to research in a world-class scientific institute in materials science and industrial research and development opportunities through the senior design program. Louis Stokes Alliances for Minority Participation, which was administered by the biology department, funded research presentations at research conferences and exposure to internship opportunities at the national laboratories funded by the Department of Energy (DOE). The California Pre-Doctoral Program offered by the California State University System granted resources to visit graduate programs and to conduct research at the University of California Santa Barbara.

This broad array of undergraduate experiences was essential preparation for her graduate work at the University of California, Berkeley, and a career as a staff scientist at Lawrence Livermore National Laboratory. Cal State LA managed to provide these opportunities before creating any formal materials science program.

Now that the school is systemically committing resources to train a new generation of students specifically in MSE, the possibilities it presents to improve DEI within MSE is unparalleled. The school is creating a concrete connection between the various departments with aligned interests in MSE by creating a master’s program and recruiting a diverse pool of students. The school prepares these students through research opportunities and flexibility in class scheduling to enable them to continue their full- or part-time employment. This is clear with the successes of the students within Cal State LA’s programs. Among the MSE alumni who graduated over the past three years, two are currently pursuing doctoral degrees at UCLA and Penn State. Others are currently employed in industry in roles relevant to their MSE studies. The campus has hired a Hispanic alumna with expertise in ceramics and high-temperature materials. Her addition will contribute to diversifying the MSE faculty and will expand the research expertise.

This combination of an increasingly diverse faculty, a growing student body, and various accommodations to grow as a materials scientist and engineer makes Cal State LA’s program an extraordinary example of DEI in education.

NEXT STEPS

With this MSE MS program, Cal State LA aims to create mentoring experiences to enhance research education and increase STEM career opportunities for historically underrepresented minority students. The campus is open and eager to pursue collaborations and new opportunities to expand. The MSE program has formed an External Advisory Board to help create a network among industry professionals, government scientists, and academic scholars in MSE to inform Cal State LA of potential opportunities to collaborate and grow the program.

This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344 LLNL-AR-849974.

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2. Raj Chetty, John N. Friedman, Emmanuel Saez, Nicholas Turner, and Danny Yagan, “Mobility Report Cards: The Role of Colleges in Intergenerational Mobility” (The Equality of Opportunity Project) http://www.equality-of-opportunity.org/assets/documents/coll_mrc_summary.pdf



Amy Wat is a staff scientist at the Lawrence Livermore National Laboratory and studies ultra-high temperature ceramics and using biological materials to heal concrete infrastructure. In the TMS DEI committee, she chaired the Best Practices and Policy Working Group to improve accessibility at TMS events, and she is the secretary of the TMS Mechanical Behavior of Materials Committee.



Mohsen Eshraghi is a professor of mechanical engineering and has been director of the MSE master's program since its inception in 2019 at Cal State LA. His research interests are in the areas of computational materials science and additive manufacturing. He is deeply committed to equity, diversity, and inclusion in his research and educational activities.



Travis Hu is an associate professor of mechanical engineering and the graduate coordinator for mechanical engineering and MSE master's programs at Cal State LA. His research focuses on nanomechanics, bio-/nanotribology, and multifunctional and responsive materials. He is dedicated to promoting DEI via task forces and outreach programs.

LEARN MORE ABOUT TMS DEI ACTIVITIES

The TMS Diversity, Equity, and Inclusion (DEI) Committee is dedicated to developing TMS programs, initiatives, and activities that address the professional needs and aspirations of underrepresented individuals in the fields of minerals, metals, and materials science and engineering.

Here are two ways you can become involved today:

- 1) **Join the DEI Committee:** Contact the committee chair to learn how you can get involved in upcoming activities.
- 2) **Nominate a Recipient for TMS Diversity Awards:** Nominate a colleague for the Frank Crossley Diversity Award or the Ellen Swallow Richards Diversity Award to recognize individuals who have personally overcome or who have helped or inspired others to overcome adversity to pursue a career in minerals, metals, and/or materials.

Learn more about these and other TMS DEI activities at www.tms.org/Diversity.

ENABLING SUCCESS: ENHANCING ACCESSIBILITY IN PROFESSIONAL SOCIETIES AND PROGRAMS FOR DISABLED INDIVIDUALS

Hillary K. Fishler and Kiyo T. Fujimoto

We are told as career scientists that engagement in our professional societies, holding leadership roles, winning awards, and receiving honors is a pathway to being regarded as a subject matter expert in our field. In addition to a robust record of publications and funding, engagement in our professional societies is a pathway to external recognition that can boost our careers, increase our confidence in ourselves as research professionals, and create a community around us that makes contributing to our field a worthwhile endeavor.

Missing out on these opportunities in graduate school and as an early career professional can be detrimental to our ability to find jobs and grow as scientists. Additionally, these consequences can be compounded by the absence of quality mentorship and have subsequent impacts to mental health and our quality of life. For those that don't engage in career and professional development at levels that lead to early- and mid-career honors, awards, and recognition, their experiences of job satisfaction and overall wellbeing in the workplace may be at risk.

Current efforts towards diversity, equity, inclusion, and accessibility (DEIA) are geared toward workforce development of populations underrepresented in STEM. Headway has been made in training and retention of those historically underserved in the STEM workforce.

“For those that don’t engage in career and professional development at levels that lead to early- and mid-career honors, awards, and recognition, their experiences of job satisfaction and overall wellbeing in the workplace may be at risk.”

However, despite a focus on accessibility, these efforts often miss members of the disability community—especially women and those individuals Assigned Female at Birth (AFAB). Additionally, disabled individuals are often left out of DEIA conversations, and requests for accessibility often focus on bare minimum accommodations from our institutions and management.

Yet, disabilities among employees and colleagues are more common than we think.¹ While physical and mobility-related disabilities are often those most visible in our society, a person may have a visible or invisible disability, chronic illness, or other condition. And, particularly following the COVID-19 pandemic, in which some of the workforce has been chronically impacted by the disease, incidents of disability via long-term COVID have likely touched a number of our coworkers.

For disabled and chronically ill individuals, extracurriculars—or pursuit of activities that are additional or adjacent to job success beyond our position descriptions—can sometimes feel out of reach. As individuals with invisible disabilities that impact social and behavioral cognition, career advancement activities and additional professional development opportunities—including professional recognition and pursuing honors and awards—can feel less important than the daily management of our disabilities, performing regular job duties, caring for our families, and caring for ourselves. For us, reasons we may have had to lessen engagement in our professional lives have been compounded by the time, energy, and resources it takes to manage our disabilities.

“For disabled and chronically ill individuals, extracurriculars—or pursuit of activities that are additional or adjacent to job success beyond our position descriptions—can sometimes feel out of reach.”

Greater challenges also exist in traditionally expected functions of STEM careers. Activities such as networking, attending conferences and society meetings, traveling, long hours, attending discussions, and volunteering time on boards and in leadership positions often feel inaccessible. At times, the time and energy required to manage our disabilities can feel insurmountable, particularly when responsibilities to ourselves, our families, and our careers are compounded by demanding environments in which non-disabled folks may have more resources at their disposal.

During the pandemic, workplaces and professional societies showed disabled people that environments could be more accessible and inclusive. Suddenly, we were able to attend conferences online, access slide decks, and have important conversations from our home. Inherently, professional spaces became more inclusive for many folks, not just the disabled community. However, following the pandemic, many of these accommodations went away. Virtual meeting fatigue may have prompted senior researchers and leaders to do away altogether with these accessible forms of communication. And, with in-person work returning to normal, accommodations that had enhanced our job performance and feelings of belonging and wellbeing at work—i.e., closed captioning, visual aids, and limits to costly travel—may have disappeared in the end.

The costs related to managing a disability in the workplace are different for all folks, and not all disabilities affect the ways that we engage with our careers. However, in the creation of accessible spaces for employees, we must always ask: for whom? For those serving on our society or employer's DEIA committees, in employee groups, and serving the communities, it would behoove us to acknowledge that issues with consideration for the disabled community are critical to inclusion and employee retention. Barriers to becoming subject matter experts in our fields should not be compounded by the lack of access to spaces with which our non-disabled colleagues do not struggle.

Instead, we encourage leadership of all organizations and institutions to fully engage with disabled individuals to understand some of the ways in which accommodations may fall short and how we can overcome the issue of accessibility and its impacts on employee achievement and career trajectories. Here, leadership should set an expectation of accessibility across organizations, seeking to understand the unique challenges of each disabled person within the community, and championing accessibility for all.

“During the pandemic, workplaces and professional societies showed disabled people that environments could be more accessible and inclusive.”



Hillary K. Fishler serves as the professional recognition and awards lead in the Office of Research Excellence at Oak Ridge National Laboratory (ORNL). She is a member of the graduate faculty in the Micron School of Materials Science and Engineering at Boise State

University, and prior to her position at ORNL, she served as a program manager at Idaho National Laboratory. She lives with both visible and invisible disabilities—including ADHD, autism, and Ehlers-Danlos syndrome—and is a workplace disability rights advocate.



Kiyo T. Fujimoto serves as the Advanced Manufacturing Laboratory Lead at the Center for Advanced Energy Studies and is a research scientist at Idaho National Laboratory where she focuses her work on additive manufacturing of sensors

and electronics for harsh service conditions. As a TMS member, she is part of both the Functional Nanomaterials and Energy technical committees, is a mentee in the TMS Leadership Development Initiative, serves on the Public and Governmental Affairs Committee, and is a DEI JOM co-liaison.

ADDITIONAL TIPS FOR IMPROVING ACCESSIBILITY FOR INDIVIDUALS WITH DISABILITIES

- ☐ Account for the disability community—both visible and invisible—when planning for diversity, equity, and inclusion strategies.
- ☐ Engage with the disabled community, listen, and champion suggested changes to your organization based on feedback.
- ☐ Revisit your stance on online versus in-person engagement and meetings. Plan events that allow for online options to engage, and encourage leadership to champion these new ways to engage.
- ☐ Provide visual and auditory aids for individuals attending conferences and meetings, and promote accessible presentation styles. Consider providing printout of slides, ASL interpreter for keynotes, and briefs/summaries for talks.
- ☐ Provide safe spaces at conferences or meetings for individuals to care for themselves in a private space during these events.
- ☐ Attend to those in need of mentorship and pathways to engaging in professional societies, and define pathways to awards, society fellows, and other honors.

Reference

1. Centers for Disease Control and Prevention. “Disability Impacts All of Us” (U.S. Department of Health and Human Services, 2023) <https://www.cdc.gov/ncbddd/disabilityandhealth/infographic-disability-impacts-all.html> (accessed June 24, 2023).

EXPANDING OPPORTUNITIES: PROMOTING ACCESSIBLE HIGHER EDUCATION FOR NON-TRADITIONAL LEARNERS

David Estrada and Kiyo T. Fujimoto

The term “non-traditional student” is used to acknowledge and support a diverse group of learners who take a different path to pursue their educational goals. These students are identified as individuals who do not fit the traditional profile of a full-time student attending college or university immediately after completing high school. There are a number of reasons for this, which include that they have taken a break from education, entered the workforce, served in the military, started a family, or pursued other life experiences before deciding to pursue higher education.

Non-traditional students are typically older than traditional students and often have different responsibilities and commitments, such as work, parenting, or caring for family members. The inclusion of non-traditional students in conversations surrounding diversity, equity, and inclusion (DEI) allows institutions the ability to foster a more inclusive and supportive environment that recognizes and appreciates the contributions of all students, regardless of their age, background, or circumstances. Such inclusivity not only enhances the overall student experience but also enriches the learning environment and further contributes to the goals of DEI in higher education.

“The inclusion of non-traditional students in conversations surrounding DEI allows institutions the ability to foster a more inclusive and supportive environment that recognizes and appreciates the contributions of all students . . . ”

MEET THE PARTICIPANTS



David Estrada is an associate professor of materials science and engineering at Boise State University, where he serves as the site director for the National Science Foundation's ATOMIC Center, as well as the associate director for the

Center for Advanced Energy Studies. He holds a joint appointment with the Idaho National Laboratory in advanced manufacturing. Estrada received his doctorate from the University of Illinois at Urbana Champaign in electrical and computer engineering, and he studied electrical and thermal transport in emerging nanomaterials and semiconductor devices. He is a member of TMS and co-organizes a symposium in printed electronics and additive manufacturing.



Kiyo T. Fujimoto serves as the Advanced Manufacturing Laboratory Lead at the Center for Advanced Energy Studies and is a research scientist at Idaho National Laboratory, where she focuses her work on additive manufacturing

of sensors and electronics for harsh service conditions. As a TMS member, she is part of both the Functional Nanomaterials and Energy technical committees, is a mentee in the TMS Leadership Development Initiative, serves on the Public and Governmental Affairs Committee, and is a DEI JOM co-liaison.

The following is an interview conducted by Kiyo T. Fujimoto with David Estrada. Both Fujimoto and Estrada embarked on their educational journeys as non-traditional students, balancing the pursuit of doctoral degrees with the responsibilities of raising a family. Estrada shares insight he developed from his experiences as a non-traditional student and as a Boise State University professor on how accessibility to higher education can be enhanced for non-traditional students.

Kiyo Fujimoto: What motivated you to pursue higher education as a non-traditional student?

David Estrada: I always enjoyed science and math. Early on, I realized that if I wanted to pursue a technical career that leveraged my interests in these topics, I would need to pursue a college degree. As a first-generation college student from a low-income background, I found my route to a college education through U.S. military service. I served as an electronics warfare technician onboard the USS Curtis Wilbur. This further cemented my desire to pursue a college education as I wanted a deeper understanding of electrical engineering and the field of electronics.

Fujimoto: What are some of the most significant obstacles that non-traditional students face when trying to access higher education?

Estrada: Financial roadblocks seem to be the biggest obstacles for non-traditional students pursuing higher education. Many non-traditional students pursue a college education after incurring debt, starting families, or working in industry in well-paying jobs. It can be difficult to navigate the financial aid systems of the university, plan for scholarships, work part time and meet all of one's financial obligations while pursuing a degree.

I would also add that integrating with a cohort of traditional students can be difficult, if not impossible. Study groups form and meet at times that are usually not conducive to non-traditional students with families. It's a major challenge to help integrate non-traditional students into the typical college experience.

"Financial roadblocks seem to be the biggest obstacles for non-traditional students pursuing higher education."

Fujimoto: How do you think colleges and universities could better address the needs of non-traditional students in terms of admissions, financial aid, and support services?

Estrada: Most universities have support services for admissions, financial aid, and student services in general (i.e. advising). However, educating staff in these offices on the special needs of non-traditional students, and connecting staff across these offices, can help them better serve this population of students. Additionally, having transition programs in place to support students to ensure there is not a break in pay when they enroll, advising students on when a transition to full-time status will align them with a cohort of traditional students, and connecting non-traditional students with other campus activities (sports, clubs) etc. can help ensure success.

Fujimoto: What specific changes would you like to see in the higher education system to make it more accessible to non-traditional students?

Estrada: It's hard to say what specific changes are needed for the higher education system, as the system is composed of a wide variety of institutions with varying missions, student compositions, and support structures. I think what could be most beneficial to the students is a consortium of institutions willing to meet non-traditional students where they are and provide a national database of resources available for non-traditional students—sort of a College 101 class that points the students to resources such as the Federal TRIO programs, financial aid information, housing information, etc.

Fujimoto: What kind of financial assistance or other resources do non-traditional students need to succeed in higher education?

Estrada: I think non-traditional students benefit from standard financial aid packages but could use additional support in financial planning as compared to traditional students. Specifically, I'm thinking of non-traditional students who support families, have to pay a home mortgage, care for family members, and/or who may have certain healthcare concerns that typical student insurance may not cover. Connecting these students with resources outside the university is important.

Fujimoto: In your opinion, what are some of the benefits of having a diverse student population in higher education, including non-traditional students?

Estrada: Diverse student populations drive innovation and creativity. It allows students to learn in a complex environment and think beyond their own experiences in how they will apply their knowledge gained to solve major societal challenges. Students who experience diverse educational environments are also better prepared for careers at corporate and government institutions that value diversity, equity, and inclusion.

Fujimoto: How do you see your experience as a non-traditional student shaping your future career goals and aspirations?

Estrada: My experiences shaped the mission of my current research team. My group is devoted to developing material and manufacturing solutions for emerging engineering problems which have no regard for political, socioeconomic, or cultural boundaries. This is a direct outcome of my time in the military and the suffering I witnessed across the globe.

Fujimoto: What advice would you give to other non-traditional students who are considering pursuing higher education?

Estrada: Education can be life changing, not just for the individual, but for future generations of the student's family. I try to encourage students to pursue their passion and always do their best.

Fujimoto: Is there anything else you would like to add about the importance of accessibility to higher education for non-traditional students?

Estrada: TRIO works! When you get to campus, find out if they have any TRIO programs and see if you're eligible to apply. These programs have a long history of supporting non-traditional and underrepresented student populations. They know what it takes to succeed and can help you along your journey.

“Education can be life changing, not just for the individual, but for future generations of the student's family.”

NEXT STEPS

Non-traditional students, despite being a significant and diverse segment of the student population are often overlooked in conversations about DEI in higher education. One reason for oversight in DEI conversations is the prevailing image of a “traditional” student, which typically aligns with the traditional college-age demographic. Non-traditional students bring their own unique perspectives and experiences that contribute to the overall diversity of the campus community. These students face distinct challenges and barriers in accessing and succeeding in higher education.

The metrics used to measure diversity often fail to capture the experiences and contributions of non-traditional students. Enrollment statistics and graduation rates may not adequately reflect the diversity of the student population, leading to a lack of recognition and resources allocated to support their unique challenges.

To address this issue, it is essential to broaden the scope of DEI conversations to include non-traditional students and their specific needs. Enhancing accessibility to higher education for non-traditional students is complex and challenging. However, the incorporation of a few key practices would expand higher education opportunities specifically for this demographic of students. First, institutions should create policies and support services that cater to the specific challenges faced by non-traditional students. Additionally, integrating non-traditional students into the college experience and fostering a supportive environment are crucial. This can be achieved through educating staff on the unique challenges faced by non-traditional students and implementing transition programs that align them with cohorts and campus activities. Lastly, providing tailored financial assistance and connecting students with external resources can address their specific needs.

TMS RESOURCES FOR TRANSITIONING TO A CAREER IN MSE

If you are beginning a career in minerals, metals, and materials science and engineering, TMS offers a number of resources to help you on that path. Here are a few resources you can try today:

- 1) **Join the TMS LinkedIn Community:** Visit www.linkedin.com/company/the-minerals-metals-&-materials-society/ to begin connecting with others in our TMS community.
- 2) **Explore the TMS Career Center:** Visit [www.tms.org/Career Center](https://www.tms.org/CareerCenter) to discover new job opportunities in your chosen field.
- 3) **Catch up on Conversations:** See what topics your TMS community has been discussing in recent years by viewing recorded webinars in the TMS Webinar Library at www.tms.org/WebinarLibrary.

Learn more about available resources and opportunities through your TMS membership; log in to members.tms.org.

TMS FALL 2023

@ MATERIALS SCIENCE & TECHNOLOGY

EXPLORE HIGHLIGHTS AND FEATURES OF THE TMS FALL MEETING 2023 AT MS&T

Megan Enright

"I think the TMS Fall Meeting is really exciting for professionals who are looking to meet people from other related areas and expand their view of their own technical area," said **Tim Rupert**, Program Director on the TMS Board of Directors. "The Fall Meeting is very unique. . . because it brings together different professional societies. You can see the effect of this in the technical content that we have where you bring in new ideas . . . to the larger TMS community. You also see this in the area of collaboration on leadership opportunities, education, and outreach events, where we see that we can bring expertise from different groups of people, different volunteers in many cases, and really accomplish something that's bigger than what a single society can go after by themselves."

The TMS Fall Meeting 2023 will be held at the Materials Science & Technology 2023 technical conference and exhibition (MS&T23) in Columbus, Ohio, USA from October 1–4, 2023. A complement to the TMS Annual Meeting held each spring, the TMS Fall Meeting offers TMS members a chance to connect each year at a second large-scale, multidisciplinary meeting.

TMS presents robust programming, networking and social activities, and professional development events tailored to its members' interests within the broader structure of the MS&T conference series, giving members an opportunity to experience both their TMS community and the resources of all the MS&T partnering societies.

Technical Meeting and Exhibition

MS&T23

MATERIALS SCIENCE & TECHNOLOGY

MS&T23 HIGHLIGHTS

As in previous years, MS&T23 will bring together three leading materials societies—TMS, the American Ceramic Society (ACerS), and the Association for Iron & Steel Technology (AIST). To supplement this long-standing partnership, Event Partners will return with the Advanced Materials Show USA, expanding the exhibition, and the Society for Biomaterials will offer additional programming.

Registration for MS&T23 is now open. You can register for the discounted early registration rate by September 7 at www.matscitech.org/MST23.

KEY DATES

Advance Registration Deadline:
September 7, 2023

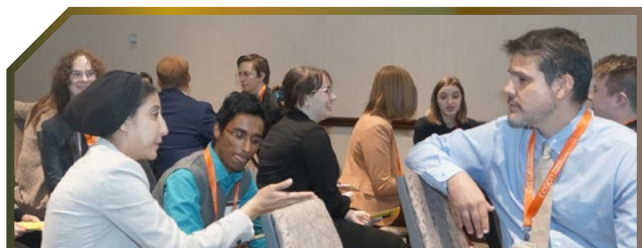
Housing Deadline:
September 7, 2023

Meeting Dates:
October 1–4, 2023



TECHNICAL PROGRAM FEATURES

The TMS Fall Meeting 2023 features a collection of over 20 symposia in interest areas that are related to TMS and its members. It explores the intersections of development, synthesis, and application. This programming complements the MS&T23 technical programming, developed by all three sponsoring societies coordinated by the MS&T23 Program Coordinating Committee. **John Carpenter**, Los Alamos National Laboratory, and **Eric Lass**, the University of Tennessee, Knoxville, are the TMS representatives to the 2023 committee. Read on for some highlights of the TMS Fall Meeting 2023 programming.



Participants practice their networking skills at the Improve Your Networking Skills Workshop hosted by TMS at MS&T22.

The Elizabeth Judson Memorial Symposium

The TMS Fall Meeting 2023 will feature the Curricular Innovations and Continuous Improvement of Academic Programs (and Satisfying ABET along the Way): The Elizabeth Judson Memorial Symposium: Curriculum, Instruction, and Accreditation, on Monday, October 2, 2023. This symposium will provide opportunities to share innovative approaches in curricular development and effective pedagogical approaches in the broad materials science and engineering field, covering all classes of materials. Talks related to new courses or curriculum, accreditation activities, student success, and graduate education will be presented. This symposium is sponsored by the TMS Education and Accreditation Committees.

History of Materials Science and Engineering Symposium

Another highlight of the TMS Fall Meeting 2023 is the History of Materials Science and Engineering Symposium. This symposium focuses on the history of materials science and engineering, particularly in the 20th century when the field evolved out of chemistry, physics, and engineering advances. Specific tales of the discoveries and the evolution of materials structure, properties, processing, and performance will be presented. The development of the institutions of materials science such as journals; professional societies; academic departments; and stakeholders in government, industry, and civil society will be

highlighted. Presentations will also feature those who participated in or who have some connection with these events. This symposium is sponsored by the AIST Metallurgy – Processing, Products & Applications Technology Committee and the TMS Phase Transformations, Shaping & Forming, and Steels Committees.

For a look at more of the specific symposia organized and sponsored by TMS technical committees, visit the Technical Program page at the TMS Fall Meeting website at www.tms.org/TMSFall2023.

LUO TO DELIVER TMS PLenary



Alan Luo, professor of materials science and engineering and integrated systems engineering at The Ohio State University (OSU) and director of the OSU Lightweight Materials and Manufacturing Research Laboratory and Advanced Casting Research Center, will deliver the TMS Plenary Presentation as part of the MS&T23 All-

Conference Plenary session on Tuesday, October 3. He will give the talk, "Lightweight Materials and Sustainable Manufacturing: The Role of Integrated Computational Materials Engineering (ICME)," which will discuss some examples of lightweight material design and development using a CALPHAD-based ICME approach and some of the latest innovations in sustainable casting, extrusion, sheet forming, and multi-material manufacturing processes.

A TMS member since 1999, Luo has served on a multitude of TMS committees including the Magnesium Committee, the Aluminum Committee, the Titanium Committee, and the Solidification Committee. He is also a previous member of the TMS Board of Directors and the Light Metals Division Council. He is a recipient of the 2013 Brimacombe Medal, the 2020 TMS Light Metals Division Distinguished Service Award, the 2021 Bruce Chalmers Award, the 2023 Research to Industrial Practice Award, and a member of the 2023 class of TMS Fellows.



Carolyn Hansson (center), University of Waterloo, looks back on her career in a fireside chat with Joey Kish (left), McMaster University, and Ashley Paz y Puente (right), University of Cincinnati, at a special symposium in her honor at MS&T22.

PROFESSIONAL DEVELOPMENT ACTIVITIES

TMS will present several activities and events to help participants enhance their technical and professional skills during their time at MS&T23. These events are open to all MS&T23 attendees, and some require additional purchases to attend, which can be made through the MS&T23 registration form.



MS&T22 attendees discuss the work on display at the Poster Reception.

Additive Manufacturing Materials and Processes Workshop

To complement the extensive additive manufacturing programming planned for MS&T23, TMS will offer the Additive Manufacturing Materials and Processes Workshop on Sunday, October 1. This workshop will familiarize participants with current additive manufacturing (AM) processes; current AM practices for metals, polymers, and ceramics; modeling of AM processes, microstructural evolutions, and service properties; and current challenges and research opportunities. This workshop is designed for people in the materials community already familiar with AM processes who want to learn more, as well as academics and researchers who will benefit from discussions about current challenges to the full adoption of AM.

An additional purchase is required to attend this event. Participants can register for this workshop through the MS&T23 registration form.

Teaching Tips and Techniques for (New) Instructors

This highly interactive half-day workshop will introduce core instructional skills and practical teaching tips for graduate students, postdocs, and new faculty. Topics include how to actively engage students in class, how to create assessments, and how to plan a syllabus. Short presentations on evidence-based best practices will accompany working sessions where attendees practice these skills in real time with guidance and feedback from workshop leaders. This workshop is primarily aimed at people who are applying to or about to begin academic positions where they will be the primary course instructor for the first time. Senior graduate students, postdocs, and new faculty hires are all welcome to attend.

An additional purchase is required to attend this workshop, planned for Sunday, October 1. Participants can register for this event through the MS&T23 registration form.

Network Like a Pro Panel Discussion

Attendees of the Network Like a Pro Panel Discussion, scheduled for Tuesday, October 3, will benefit from the experiences shared by panelists from a diverse group of professions, followed by a meet-and-greet to apply their learnings. Students and emerging professionals are encouraged to attend. Participants will learn how to grow a personal network, how to leverage events to network, and the do's and don'ts of networking. Panelists will include: 2023 TMS President **Brad Boyce**, Sandia National Laboratories; **Elizabeth Dickey**, Carnegie Mellon University; **Glenn R. Garrett**, Amorphology, Inc.; and more. This event is presented by the TMS Emerging Professionals Committee.

Navigating the Patent Process: Transforming Innovation to Invention

Explore how a materials scientist becomes an inventor in this interactive panel-style workshop. Presented by the TMS Professional Development Committee, this workshop will cover insights into navigating the patent process, with professional and personal perspectives from accomplished inventors and lawyers. More details are available in the Professional Development section of the TMS Fall 2023 website at www.tms.org/TMSFall2023.

"For the future of the TMS Fall Meeting at MS&T, I hope we are able to continue to build the connections between TMS, ACerS, and AIST so that we can really find the synergies between these different complimentary societies," stated Rupert. Make sure you are part of creating and fostering these synergies by attending the TMS Fall Meeting 2023 at MS&T23. Register today at www.matscitech.org/MST23.

Technical Meeting and Exhibition

MS&T24

MATERIALS SCIENCE & TECHNOLOGY

GET READY FOR MS&T24

Plans are now underway for MS&T24, which will be held from October 6–9, 2024, in Pittsburgh, PA. Symposia proposals have been collected and programming plans are being developed. Visit www.matscitech.org/MST24 in October to view programming plans and submit an abstract.

A SHINING EXAMPLE OF SUPPORT TO THE ALUMINUM INDUSTRY AND TO TMS:

HIGHLIGHTS FROM THE TMS2023 LMD SYMPOSIUM IN HONOR OF BARRY WELCH

Alan Tomsett
and Barry Sadler



Barry Welch presented his first aluminum smelting-related paper at the special TMS-AIME (The American Institute of Mining, Metallurgical, and Petroleum Engineers) symposium on aluminum in New York in 1962. The meeting subsequently sowed the seed for the annual Light Metals symposia, now held at the TMS Annual Meeting. After co-authoring or presenting more than 40 additional papers, receiving ten best paper awards, and receiving numerous TMS and AIME Awards in the ensuing years, Welch was honored in a special symposium at the TMS 2023 Annual Meeting & Exhibition (TMS2023) in San Diego, California. (Figure 1.) The symposium celebrated the contribution he has made to the global aluminum industry through technical development, training and mentoring of future leaders, and support for TMS over his 62-year career while based in New Zealand and Australia.



Figure 1. Barry Welch accepts a TMS Certificate of Appreciation from symposium co-organizer Alan Tomsett

This career included significant contributions at the Universities of Auckland and New South Wales (NSW) and more recently as a highly respected industry consultant.

Keynote Session

The keynote session of the symposium brought together Welch's former students, who have become industry and academic leaders in aluminum production, with other industry leaders whose organizations have benefitted from Welch's influence. A strong theme throughout these presentations was the support and mentoring of students provided by Welch and his wife, Pat. They made international students feel very welcome in New Zealand, with many lifelong friendships formed. Welch was ahead of his time with his encouragement and support for female students going right back to his early days at the University of NSW. In her presentation, Jenny Purdie, who has held multiple senior leadership roles at Alcoa and Rio Tinto and is currently asset president of BHP Olympic Dam, gave her personal account of this encouragement. In recognition of his support, numerous other former students and colleagues came forward at the end of the keynote session to provide personal reflections on his work and influence. These included Horst Peters, Nguyen Minh, Daniel Whitfield, Evan Andrews, and Werner Fischer (via Marcus Meier).

The first presentation was from Maria Skyllas-Kazacos, a student who became Barry's successor at the University of NSW, and is now recognised as a global leader in the design of energy storage batteries. She summarized Welch's technical influence at the university and his support for the transfer of knowledge to the aluminium industry through the initiation and organization of the very successful Australasian Aluminium Smelting Technology Conference and Workshops (AASTCW) and industry-focused post-graduate courses. These were strongly supported by the New Zealand and Australian smelters, including the provision of speakers.

Welch has also been an active contributor and supporter of TMS. Jim Robinson, executive director of TMS, summarized the important role Welch played in improving the relevance of *JOM* to the upstream aluminum industry, including the development of the *JOM* Best Paper award. Robinson also highlighted Welch's roles as one of the originators of the TMS Industrial Aluminum Electrolysis Course and founding of the TMS Vittorio de Nora Prize for Environmental Improvements in Metallurgical Industries.

While Welch has been based in New Zealand and Australia for his academic career, his influence is global. Svien Richard Brandtzaeg and Martin Iffert highlighted Welch's influence on their careers as industry leaders and also on them personally. Abdulla Zarooni highlighted Welch's significant contribution to making Emirates Global Aluminium (EGA) a technical leader in the industry. EGA executives and senior technical personnel provided video messages outlining his profound influence.

Several EGA representatives presented Welch with a plaque to honor his contributions (Figure 2). Among them was Nadia Ahli, who, with Welch's encouragement and support from EGA, received the TMS Young Leaders Professional Development Award in 2016. Today she is a technology senior manager, leading projects in the United Arab Emirates and abroad to implement EGA's technology.

As well as recognizing the past, the keynote session also included a forward-looking presentation by Barry Sadler summarizing many of the anode carbon challenges Welch has identified for the industry, with some potential solutions.

Alan Tomsett outlined the significant contribution Ph.D. students supervised by Welch have made to the fundamental understanding of anode carbon topics including pitch level, baking temperature, impurities, anode cover, aggregate fines, and paste rheology. The collaboration Welch initiated between the University of Auckland and R+D Carbon in Switzerland, where several Ph.D. candidates from the university were based, was particularly productive in providing insights that remain relevant today.

This presentation and the one by Barry Sadler highlighted that while well recognized for his



Figure 2. Emirates Global Aluminum representatives present a plaque to Barry Welch. Pictured, from left to right, are Abdulla Alzarooni, Nadia Ahli, Ali Alzarooni, and Barry Welch.

contribution to reduction technology, Welch has also made a significant addition to the science, technology, and application of anodes in aluminum smelting.

Jim Metson from the University of Auckland detailed the history of research programs initiated by Welch at the university from his arrival there in 1981. Features of the programs included a culture of excellence, industry-relevant scale of experimental facilities, strong industry collaboration, and the ability to attract academic researchers to the “growing research powerhouse.”

Technical Presentations

There were a number of other presentations made at the symposium on technical topics pertinent to Barry's influence on the industry. These included the following talks.

Evan Andrews from the Rio Tinto-managed smelter at Boyne Island in Queensland, Australia, explained how a focus on cell operation fundamentals enabled a relatively rapid recovery from a serious excursion in potline performance.

Reflecting the close relationship between Welch, the University of NSW, and EGA, there were several joint EGA/UNSW papers presented at the symposium. They included a presentation by Choon-Jie Wong outlining the plant trial of an individual anode current measurement system. Potential applications and extensions of the technology were also discussed. A later joint paper covered a study of the dissolution of the anode freeze after anode change using the individual anode current measurement system. Wong also presented a paper on behalf of Luning Ma on thermal modelling of the top chamber of electrolytic cells. The model was used to study the relationships between cell parameters such as bath temperature and off-gas temperature/flow rate and has potential applications in better controlling cells during power modulation.

Several presentations focussed on one of Welch's technical passions, alumina dissolution, which has become a critical issue as cell and anode sizes increase. A joint paper from Rio Tinto, Hydro, and the Slovak Academy of Sciences described an analytical technique which has been used to monitor the dissolution rates of different industrial aluminas. Pascal Lavoie from Alcoa co-authored a paper with Mark Taylor, who had followed Welch in leading the research program at the University of Auckland, on the effect of cell conditions on the condition of alumina feeder holes in cells. Maintaining cell conditions that are conducive to good feeder hole condition was found to improve alumina dissolution.

A highlight of the symposium was the presentation made by Welch reflecting on changes made over time to cell design and operations to increase metal

production by Amperage creep. Some of these changes have had a detrimental effect on cell life and operating efficiencies. Welch attributed this to the impact of changes on transfer processes in the cells—the physical phenomena of mass transfer to maintain uniformity in the cell. Welch's observation is that this has been largely ignored to date but must be addressed in an integrated way to improve the efficiency and environmental performance of modern cells as changes are made to increase capacity. In his words, we must do a better job of “... fully respect(ing) the interlink between science, physics, and cell design features.”

Conclusion

The symposium brought together a large global network of people who have been influenced by Welch throughout their careers, including many industry and academic leaders. The outcome from Welch's commitment to sharing knowledge and developing people was on strong display, as was his 62-year contribution to technical developments in the aluminum industry. While there were many heartfelt statements of gratitude from individuals who have received support from Welch, it was also clear that the industry as a whole owes him a vote of thanks for the contribution he has made throughout his illustrious career.

About the Authors



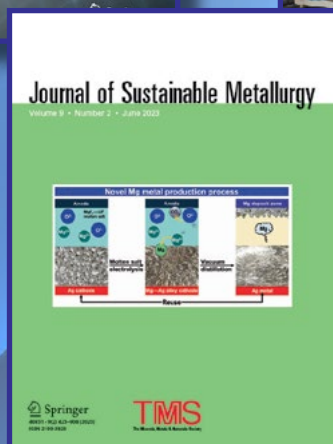
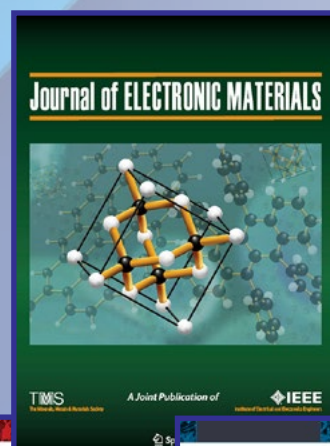
Alan Tomsett is the technical manager at Rio Tinto Pacific Operations. He, along with Mark Dorreen and Barry Sadler, was co-organizer of the Honorary Symposium for Barry Welch. Tomsett is a past Aluminum Committee chair and was editor of *Light Metals 2020* and *Essential Readings in Light Metals, Volume 4, Electrode Technology for Aluminum Production*.



Barry Sadler is the principal of the independent consultancy Net Carbon Consulting that provides industry support to improving the performance of anodes in the aluminium smelting process. Like Tomsett, he is a past Aluminum Committee chair and was the editor of *Light Metals 2013*.

2022 Impact Factors and Key Journal Metrics Announced for TMS Journals

Kelly Zappas



In June, the 2022 Journal Citation Reports (Clarivate Analytics, 2023) released the latest journal Impact Factor numbers, which included rankings for all six TMS journals. The following list shows the 2022 Impact Factors for each TMS journal (with a comparison to 2021 in parentheses):

Integrating Materials and Manufacturing Innovation (IMMI): 3.3 (3.551)

JOM: 2.6 (2.597)

Journal of Electronic Materials (JEM): 2.1 (2.047)

Journal of Sustainable Metallurgy (JSM): 2.4 (3.068)

Metallurgical and Materials Transactions A (MMA): 2.8 (2.762)

Metallurgical and Materials Transactions B (MTB): 3.0 (2.872)

Impact Factor Defined

A journal's Impact Factor is the average number of citations counted in a given Impact Factor year for articles published in the two preceding years. It is based on the number of citations of a journal's content divided by the number of citable articles published by that journal.

Impact Factor is just one of many measures to consider when evaluating journal performance. The information presented on this page provides a more detailed look at TMS journal performance in 2022.

While Impact Factor can vary from year to year for a variety of reasons, TMS journals have generally tracked in a positive direction (see Figure 1) and have also achieved strong placement in Clarivate's ranking by subject categories (see Table I).

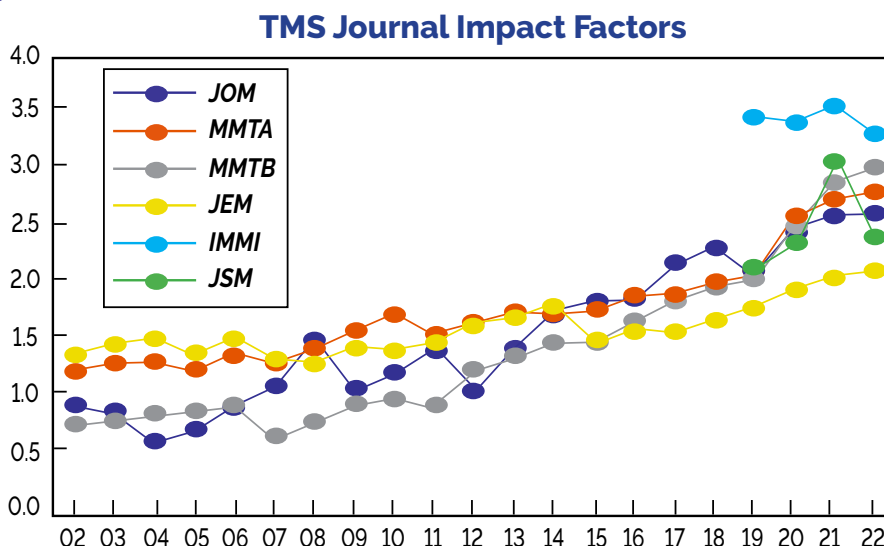


Figure 1. This chart shows 20 years (2002 to 2022) of TMS Journal Impact Factors. *IMMI* and *JSM*, TMS's two newest journals, received their first Impact Factors in 2019.

Journal Rank by Subject Category

Category Name	Total Journals 2022	JOM	MMTA	MMTB	JEM	JSM	IMMI
Materials Science, Multidisciplinary	342	220	200	195	248	-	181
Metallurgy & Metallurgical Engineering	78	26	25	23	-	29	-
Mineralogy	29	11	-	-	-	-	-
Mining & Mineral Processing	20	7	-	-	-	-	-
Engineering, Electrical & Electronic	275	-	-	-	179	-	-
Physics, Applied	159	-	-	-	98	-	-
Green & Sustainable Science & Technology	46	-	-	-	-	43	-
Engineering, Manufacturing	50	-	-	-	-	-	28

Table I. This table presents the subject categories assigned to TMS journals and the 2022 rank of the journals within these categories.

Overview of 2022 Key Metrics for all TMS Journals

Journal	2022 Impact Factor	5-year Impact Factor	Total Cites 2022	Total Downloads 2022
<i>IMMI</i>	3.3	3.7	1,007	105,445
<i>JOM</i>	2.6	2.8	15,773	959,936
<i>JEM</i>	2.1	1.8	15,612	595,598
<i>JSM</i>	2.4	3.0	1,588	203,799
<i>MMTA</i>	2.8	2.8	36,285	1,238,792
<i>MMTB</i>	3.0	2.9	13,214	604,728

Table II. This table shows 2022 key metrics—five-year Impact Factor, total citations, and total downloads—for TMS journals in addition to their most recent Impact Factors.

Table II shows a more comprehensive overview of 2022 key metrics across the entire TMS journal portfolio. *Metallurgical and Materials Transactions A* had the most total citations (36,285) and the most total downloads (1,238,792) among TMS journals in 2022, followed by *JOM* with 15,773 citations and 959,936 downloads.

To access TMS's entire library of journals, visit the Journals section of the TMS website at www.tms.org/Journals. TMS members should log in to the TMS website before clicking on the individual journal links to ensure full access to content.

Visit the journal home pages on the Springer website (accessible through the TMS Journals website) to view a range of 2022 key metrics including Impact Factors.

Editorial Changes for *Journal of Sustainable Metallurgy*

Kelly Zappas



Bart Blanpain

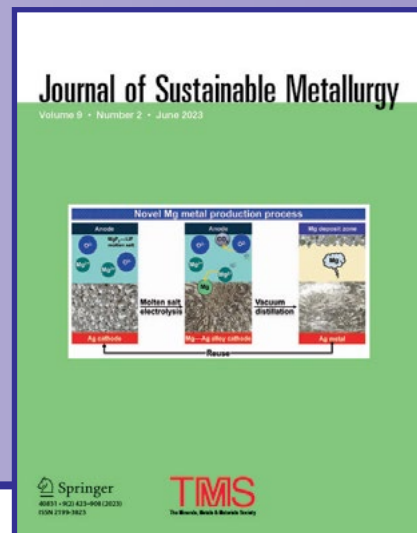


Akbar Rhamdhani

When **Bart Blanpain** stepped down as co-editor-in-chief of the *Journal of Sustainable Metallurgy* in July, it marked the end of an era for the journal. The first issue of this TMS journal was published in March 2015 and led by a team of three editors-in-chief: Blanpain, KU Leuven, Belgium; **Diran Apelian**, Worcester Polytechnic Institute, United States; and **Shin-ya Kitamura**, Tohoku University, Japan. **Yiannis Pontikes**, KU Leuven, Belgium, served as managing editor.

"We started the journal from the perspective that metallurgy as both a motor for sustainability and a sustainability challenge in itself deserved a specific place, where academic research and industrial impact would meet for the advancement of metallurgy into a direction that supports the urgent transition of our global system," Blanpain said. "With the journal we thought we could help provide such a platform. We were able to surpass the different activation energies thanks to the efforts, vision, and networks of Diran Apelian and Shin-ya Kitamura and the boundless energy and drive of Yiannis Pontikes, who came up with the idea in the first place after a discussion with Dimitrios Panias. In the first years, it was essential that the initiative was carried by a number of colleagues that liked the concept and were willing to send in good manuscripts and be members of our editorial board. Today I am proud to see that the journal is receiving a steady influx of manuscripts and that metallurgy and sustainability have become inseparable, also in industry. Much more work needs to be done, and the journal is there to serve this change."

Blanpain was the last of the original editorial team still serving on the journal. Now **Akbar Rhamdhani**, Swinburne University of Technology, Australia, has moved into Blanpain's role, joining **Kazuki Morita**, The University of Tokyo, Japan, and **Uday Pal**, Boston



University, United States, as co-editors-in-chief of the journal.

"I am excited and keen to join the editorial team for the *Journal of Sustainable Metallurgy* as I will be working alongside international leaders and respected scientists/researchers in the area of sustainable metallurgy," Rhamdhani said. "I am hoping that I can contribute to attracting more high-quality papers into the journal and to making the journal into the first choice for authors in the field to submit their papers."

Rhamdhani previously served as one of the journal's associate editors and was part of the team awarded the 2023 *Journal of Sustainable Metallurgy* Best Paper Award.

"I think one of the insights that I get from being a contributor," he said, "is that there is high-quality work that may need some exposure to a broader audience. The editorial team can have a positive role in identifying these high-quality papers."

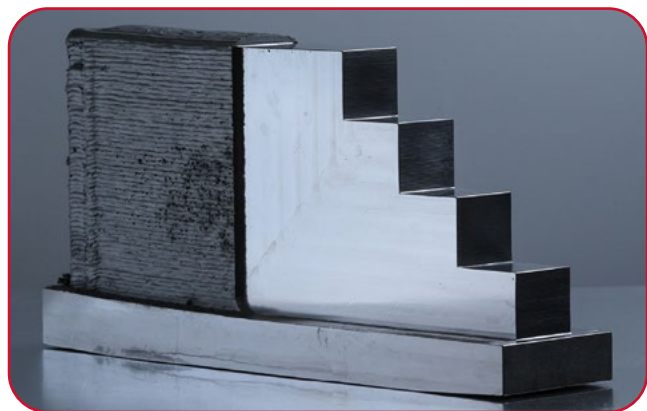
Rhamdhani looks forward to the role that he will play in shaping the future of the journal with his co-editors-in-chief. "The *Journal of Sustainable Metallurgy* has a unique position as a journal that specifically combines metallurgical aspects with sustainability as the focus," he said. "Considering the important area of sustainable metallurgy in supporting our future green society, there is much important work/research being carried out."

Topics where Rhamdhani specifically would like to see paper submissions include decarbonization, hydrogenation, green metal processing, circular economy, recycling, and resource efficiency—not just the technical aspects, but also the broader context of economic impacts, policy, value chains, etc.

You can learn more about the journal at www.springer.com/journal/40831. TMS members can access current and past issues of the *Journal of Sustainable Metallurgy* and other TMS journals by logging in to the TMS website at www.tms.org/Journals.

In Case You Missed It:

BUSINESS NEWS FROM THE FIELD



Hannover, Germany: Laser Zentrum Hannover e.V. (LZH) has jointly developed a 3D printer that can produce steel components weighing several tons. The printer, which is used as a prototype for research and development purposes only, is located at the marine gearbox manufacturer REINTJES in Hameln. It uses laser-assisted arc deposition welding, a high-performance additive process method for metals that achieves high mass throughput. The consortium can apply up to 3.2 kilograms of steel per hour with the printer. *(Pictured is a sample component produced by deposition welding with a mass of around 18 kilograms applied. Photo Credit: LZH)*

Glencore and Li-Cycle Announce Joint Study to Develop a European Recycling Hub

Baar, Switzerland: Glencore International AG, a producer, recycler, and marketer of nickel and cobalt for the production of electric vehicle batteries, and Li-Cycle Holdings Corp., a lithium-ion battery resource recovery and recycling company, have signed a letter of intent to jointly study the feasibility of and develop a Hub facility (a hydrometallurgical facility that processes black mass from lithium-ion batteries) in Portovesme, Italy. The Portovesme Hub would produce critical battery materials, including nickel, cobalt, and lithium from recycled battery content.

Hydro Produces Aluminum Using Hydrogen

Navarra, Spain: Hydro announced that it has produced its first successful batch of aluminum using green hydrogen. In a test carried out at a casthouse in Hydro's extrusion plant in Navarra, hydrogen replaced natural gas as fuel for the recycling of aluminum. The test was conducted and led by hydrogen experts from Hydro Havrand, Hydro's green hydrogen company, in partnership with Fives, an industrial engineering group with expertise in hydrogen burner technology and solutions for the aluminium industry. Fives has contributed with design and supplying of key components and controls needed to operate safely and effectively.

Do you have business or industry news of interest to the minerals, metals, and materials community?

JOM
THE MAGAZINE

Submit your announcement or press release to Kelly Zappas at kzappas@tms.org.



Victoria, British Columbia, Canada: Aluula Composites announced a partnership with French sailmaker Incidence Sails to introduce a new generation of ultra-light, strong, and recycle-ready composite material for use in sailmaking. The new sails were introduced aboard the Biotherm race boat in The Ocean Race, an around-the-world racing challenge. *(Photo Credit: The Ocean Race)*

Imerys and British Lithium Announce Partnership to Accelerate Development of UK's Largest Lithium Deposit

Paris, France: Imerys and British Lithium have formed a joint venture with the objective of creating the United Kingdom's first integrated producer of battery-grade lithium carbonate. Imerys contributes its lithium mineral resources, land, and infrastructure for an 80% stake in the joint venture. British Lithium provides its lithium processing technology, technical team, and lithium pilot plant for the remaining 20%.

Materials Processing Institute Launches Hydrogen Research Agreement with Trent Refractories and Kanthal

Middlesbrough, United Kingdom: The U.K.'s Materials Processing Institute has announced a three-year research partnership with Trent Refractories, a U.K.-based manufacturer and supplier of refractory solutions, and Kanthal, a Swedish company specializing in industrial electric heating technology and resistance materials, to examine the potential impact on industrial processes of using hydrogen as an alternative fuel source. The agreement will focus on the effect of hydrogen on refractories, the heat-resistant materials that form the linings for high-temperature furnaces, crucibles, ladles, and kilns, primarily used in the iron and steel industry.

TMS MEETING HEADLINES

Meeting dates and locations are current as of June 29, 2023.
 For the most recent updates on TMS-sponsored events, visit www.tms.org/Meetings.



TMS Fall Meeting 2023 @ Materials Science & Technology (MS&T23)

October 1–4, 2023
 Columbus, Ohio, USA

Discount Registration Deadline:

September 7, 2023

Housing Deadline:
September 7, 2023

The MS&T23 Plenary Session will feature lectures by Alan A. Luo, The Ohio State University; Sergei V. Kalinin, University of Tennessee, Knoxville; and Keith Allen Taylor, SSAM Americas.

www.tms.org/TMSFall2023



3rd World Congress on High Entropy Alloys (HEA 2023)

November 12–15, 2023
 Pittsburgh, Pennsylvania, USA

Discount Registration Deadline:

September 27, 2023

HEA 2023 will provide a platform to explore the latest research advances in single-phase and multiphase metallic, intermetallic, and ceramic high entropy materials for functional or structural applications.

www.tms.org/HEA2023



TMS 2024 Annual Meeting & Exhibition (TMS2024)

March 3–7, 2024
 Orlando, Florida, USA

Housing Deadline:
February 6, 2024

Join your colleagues at TMS2024 where you can learn about the latest advances, share your research, and develop personal connections with visionaries and thought leaders in the field.

www.tms.org/TMS2024



TMS Specialty Congress 2024

June 16–20, 2024
 Cleveland, Ohio, USA

Abstract Submission Deadline:
October 30, 2023

The TMS Specialty Congress will allow attendees to explore their technical interest in a focused, small event environment, while also having access to cross-disciplinary learning and collaboration opportunities with aligned materials communities.

www.tms.org/SpecialtyCongress/2024

Other Meetings of Note



The 15th International Symposium on Superalloys (Superalloys 2024)

September 8–12, 2024
 Champion, Pennsylvania, USA

www.tms.org/Superalloys2024



TMS 2025 Annual Meeting & Exhibition (TMS2025)

March 23–27, 2025
 Las Vegas, Nevada, USA

www.tms.org/TMS2025



TMS Specialty Congress 2025

June 15–19, 2025
 Anaheim, California, USA

www.tms.org/SpecialtyCongress/2025



Extraction 2025 Meeting & Exhibition (Extraction 2025)

November 16–20, 2025
 Phoenix, Arizona, USA

www.extractionmeeting.org/Extraction2025

10th International Symposium on Lead and Zinc Processing (PbZn2023)

October 18–20, 2023
 Changsha, China

Co-sponsored by TMS

OTC Brasil 2023

October 24–26, 2023
 Rio de Janeiro, Brazil

Co-sponsored by TMS

11th Pacific Rim International Conference on Advanced Materials and Processing

November 19–23, 2023
 Jeju, South Korea

Co-sponsored by TMS

Materials in Nuclear Energy Systems (MiNES 2023)

December 10–14, 2023
 New Orleans, Louisiana, USA

Co-sponsored by TMS

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programming and events. Plan to stay at the headquarters hotel for easy access to
activities, five on-site restaurants, and a number of additional amenities.

MARK YOUR CALENDAR WITH THESE KEY DATES

October 2023: Registration Opens | **February 6, 2024:** Housing Deadline
March 3–7, 2024: Conference Dates

SEE YOU IN ORLANDO!

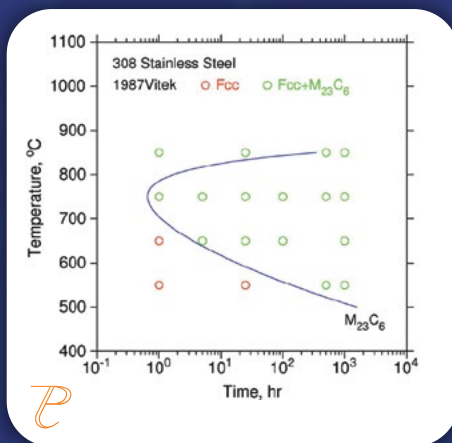
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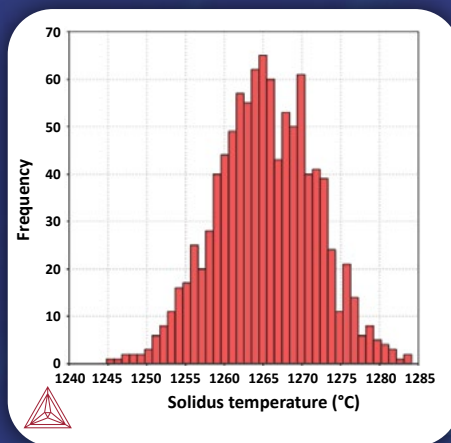
Gain insight into materials processing

Precipitation



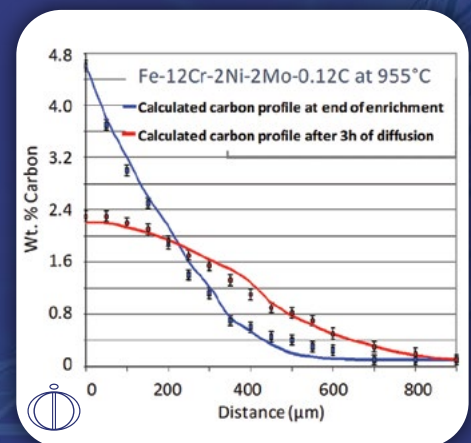
Time temperature precipitation of $M_{23}C_6$ in 308 stainless steel

Solidification



Solidus variation within Alloy 718 specification (Gaussian, $n=1000$)

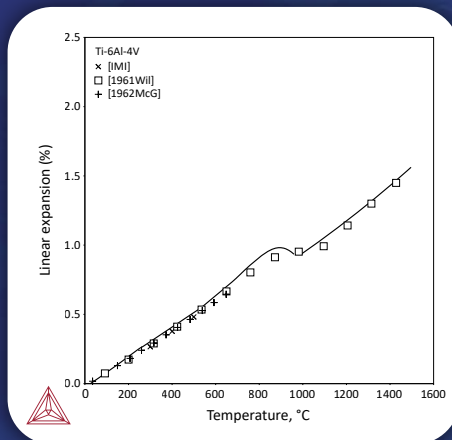
Diffusion



Carbon diffusion profile near surface during carburization of a martensitic stainless steel

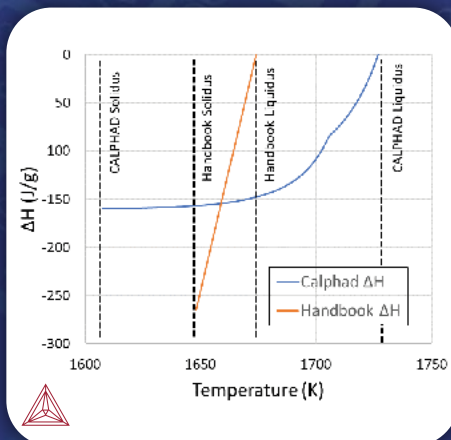
Predict a wide range of materials property data

Thermophysical Data



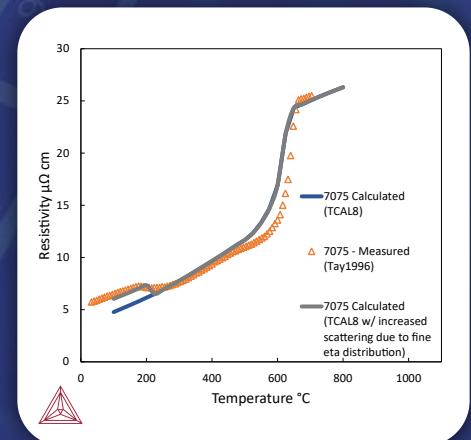
Linear expansion vs temperature for Ti-6Al-4V

Thermodynamic Properties



Calculated latent heat compared to handbook values for a specific 316L stainless steel chemistry

Electrical Resistivity



Calculated electrical resistivity of aluminum alloy 7075