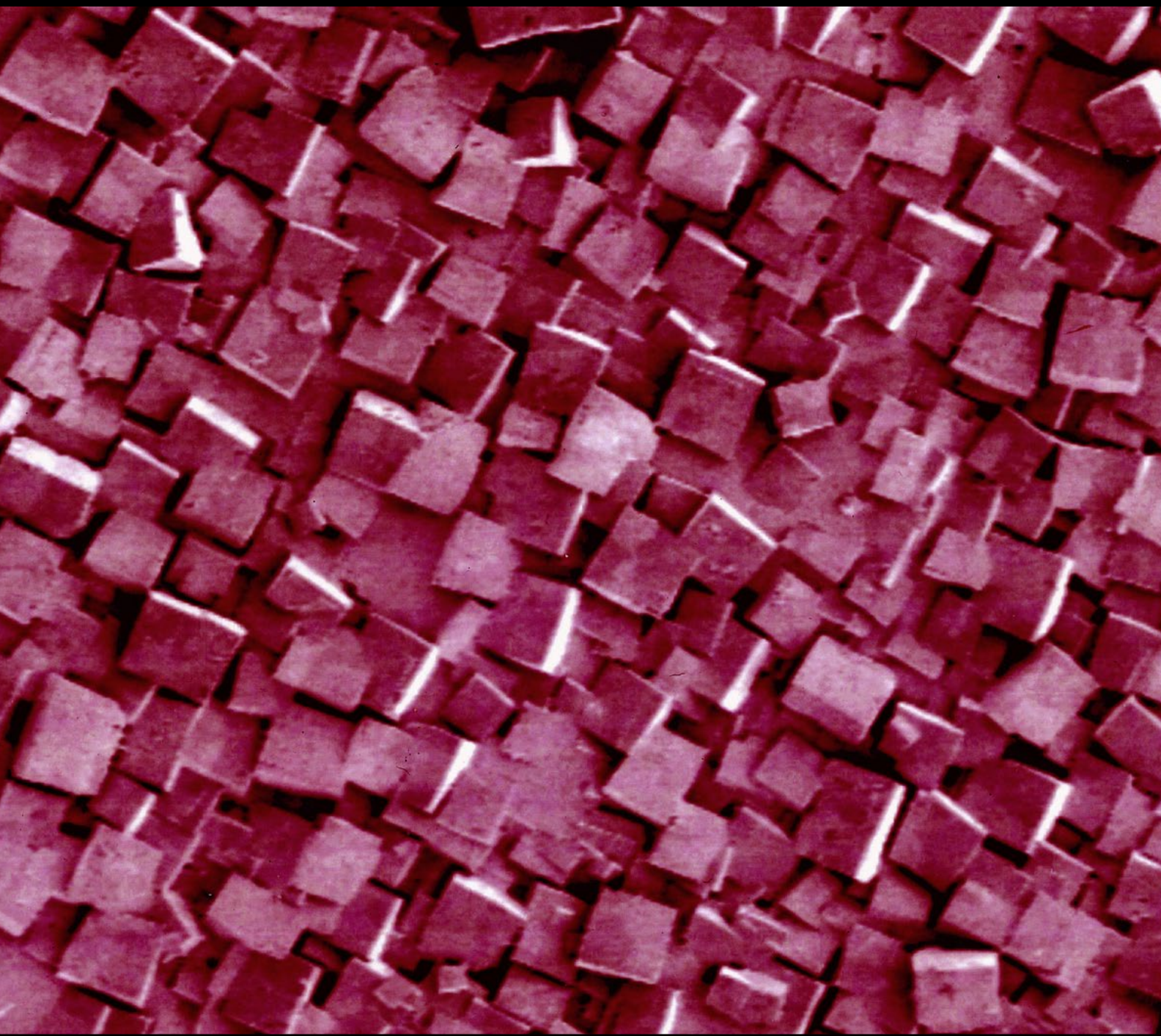
JOM

SEPTEMBER 2021
jom.tms.org

An official publication of The Minerals, Metals & Materials Society

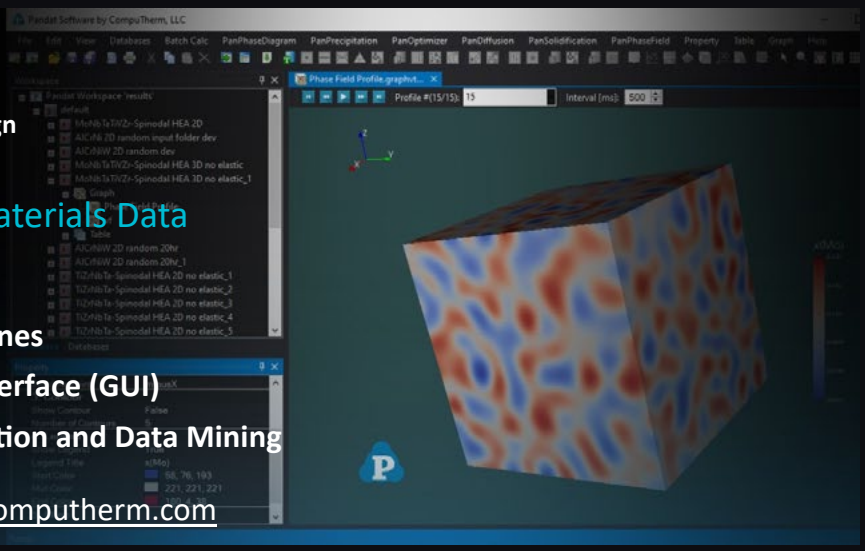


COMING BACK TOGETHER: Preview MS&T21 Programming and Events

TMS Springer

Pandat Software

An Integrated Modeling Platform for Materials Design



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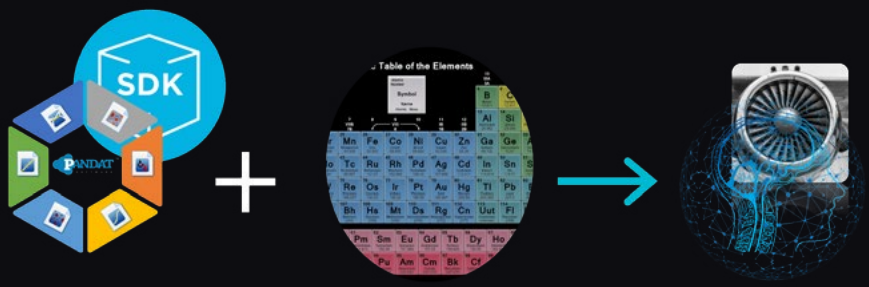
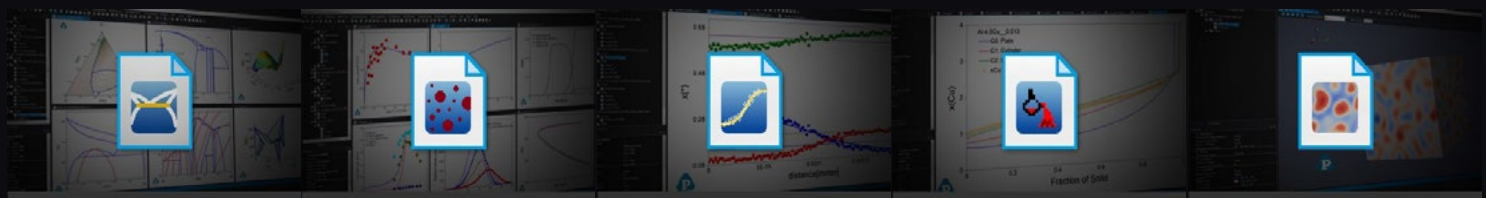


Pandat Software + PanDatabases → ICME & MGI Applications

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

Pandat Software Modules

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



PanPhaseDiagram

- stable and meta-stable diagrams
- property contour diagrams
- thermodynamic properties
- chemical driving force

PanPrecipitation

- concurrent nucle-ation, growth and coarsening
- particle size and size distribution
- multi-phase co-precipitation

PanDiffusion

- diffusion couple
- homogenization
- carburization and decarburization
- particle dissolu-tion

PanSolidification

- solidification path
- back-diffusion in the solid
- dendrite arm coarsening
- micro-segregation

PanPhaseField

- direct coupling with CALPHAD
- feasible for multi-component alloys
- open architecture for user's model plugin

JOM

5700 Corporate Drive
Suite 750
Pittsburgh, PA 15237
USA

Phone: 1-724-776-9000
Web: jom.tms.org
E-Mail: membership@tms.org

About the Cover

From "Microwave Hydrothermal Growth of Epitaxial Lead Zirconate Titanate Thick Films," by Pascal Pinceloup et al., the figure shows an FESEM image of PZT thick films grown after 3 experiments in 3 m KOH on (111) $SrTiO_3$.

September 2021 Guest Editors

Computational Modeling in Pyrometallurgy
Pyrometallurgy Committee
Quinn Reynolds, Mintek
M Akbar Rhamdhani,
Swinburne University of Technology

Nanomaterials and Composites for Energy Conversion and Storage
Energy Committee; Energy Conversion and Storage Committee
Yulin Zhong, Griffith University
Soumendra Basu, Boston University
Ziqi Sun, Queensland University of Technology

Recovery, Sorting, and Processing of Secondary Aluminum
Aluminum Committee; Recycling and Environmental Technologies Committee
Anne Kvithyld, SINTEF

About JOM:

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

About TMS:

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

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Nanomaterials and Composites for Energy Conversion and Storage

Corrections

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WHERE MATERIALS INNOVATIONS HAPPENS

JOM, Vol. 73, No. 9, 2021
https://doi.org/10.1007/s11837-021-04821-9

in the final analysis

"For perhaps the first time, the humans inside a spacecraft will—in a strict financial sense—be worth more than the vehicle itself, as billionaires take to the skies this month in a pair of historic suborbital spaceflights that mark a dramatic change in what it takes to become an astronaut."

—"As space billionaires take flight, 'the right stuff' for space travel enters a new era" by Meghan Bartels for Space.com

JOM
Volume 73
Number 9
September 2021

James J. Robinson
Executive Director
@JJRofTMS

As I write in mid-July, the current news cycle is obsessed with the race to space by Amazon founder Jeff Bezos and Virgin founder Sir Richard Branson. Attention magnets, they are entrepreneurial, innovative, and quite wealthy. Akin to Laika (the first animal into space aboard *Sputnik 2*), Sir Richard earned the first-billionaire-into-space bragging rights on July 11th, as he crossed the Kármán line (the boundary between the Earth's atmosphere and outer space) more than a week before Bezos's planned ascension. The means for the pair to achieve not orbit but a few weightless moments and spectacular views are spacecraft developed by the two billionaires' competing space companies: Blue Origin building *New Shepard* for Bezos, and Virgin Galactic building *VSS Unity* for Sir Richard. Good wishes to them . . . and to one other billionaire and sure-to-be space traveler: Elon Musk, who has set his fancy on a more ambitious destination beyond the Kármán line: Mars. Recall that he launched his Tesla Roadster in that general direction a few years ago, perhaps to await his arrival.

While it is hard to work up a lot of affection for the billionaire class with their otherworldly worth, excesses, and eccentricities, I do admit a partiality to Elon Musk. He clearly has an engineer's mind and is leveraging his background in materials science at both SpaceX and Tesla. He is part of a continuum of progress that again and again reminds us that advances in materials technology are endlessly necessary to enable and improve terrestrial and extraterrestrial vehicles alike. You know the mantra: lighter, farther, faster, higher, etc., etc. And while a tremendous amount of work has gone into improving all manner of vehicles to help us reach hitherto fore unreachable heights (actual and metaphorical), we should not overlook the research into materials themselves that these vehicles enable us to perform.

Without relentless gravity exerting its pull, one can conduct some very interesting research in space, and many TMS members have a history of designing space-based materials experiments, presenting their findings at TMS meetings and in our publications. So, it was with some interest that I read that the National Academies of Sciences, Engineering, and Medicine have issued a call for members of the science community to help them develop the *Decadal Survey on Biological and Physical Sciences (BPS) Research in Space 2023–2032 (BPS2023)*. Submissions in the form of white papers will help inform U.S. priorities for research in space. According to the invitation to participate, "BPS2023 will review the state of knowledge in the current and emerging areas of the field and generate consensus recommendations for a comprehensive vision and strategy for a decade of transformative science at the frontiers of biological and physical sciences research in space. The study report will help NASA define and align biological and physical sciences research to uniquely advance scientific knowledge, meet human and robotic exploration mission needs, and provide terrestrial benefits." I'm sure that some TMS members will have interesting ideas on this.

"Without relentless gravity exerting its pull, one can conduct some very interesting research in space, and many TMS members have a history of designing space-based materials experiments."

The form of participation is to submit white papers that identify research areas, concepts, methods, tools, techniques, and new ideas that could advance knowledge on the effects of the spaceflight environment on biological and biophysical systems and processes; physical systems and processes (including materials, combustion, fluid behavior, and fundamental physics); and physical and biological processes involved in the functioning of space exploration technologies. Research conditions can encompass zero or partial gravity, low-Earth orbit, terrestrial analogs of spaceflight or space conditions, deep space, the Moon, and even Mars itself (attention: Elon). Depending on the type of white paper submitted, the deadline is either October or December of this year.

If interested, Google "Committee on Biological and Physical Sciences in Space" to get to the launching pad. Just be careful that you don't trip over a billionaire in the process!

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JOM themagazine

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

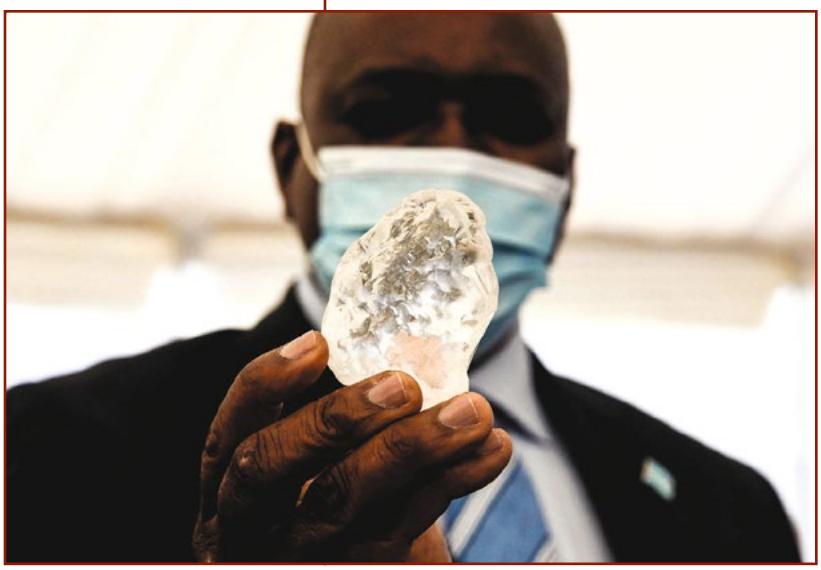
In Case You Missed It:
Business News from the Field

First Cobalt Explores Iron Creek

Toronto, Canada: First Cobalt Corporation began a $2.5 million exploration program at its Iron Creek cobalt-copper project in the U.S. Located in the Idaho Cobalt Belt, the Iron Creek Project is one of the few primary cobalt deposits in the world. The company intends to double the size of its resource over the next two drill seasons as interest grows in a U.S. domestic cobalt supply to support a growing electric vehicle market.

Hydrogen to Heat Ovako's Steel

Stockholm, Sweden: A group of Swedish and Norwegian companies are building a 17-MW fossil-free hydrogen facility at Ovako AB's steel mill in Hofors, Sweden. The effort brings together Ovako, Nel Hydrogen Electrolyser AB, Volvo, Hitachi ABB Power Grids Sweden, and H2 Green Steel. Ovako will be the first in the world to heat steel with hydrogen prior to rolling. Expected to be completed by the end of 2022, the facility will reduce Ovako's carbon dioxide emissions for steel production in Hofors by 50%.



Gaborone, Botswana: Botswana President Mokgweetsi Masisi holds a 1,098.3-carat diamond found in June 2021 in the Jwaneng mine by Debswana Diamond Company Limited, the mining company jointly owned by the nation's government and the De Beers Group. Weeks later, Lucara Diamond Corporation unearthed a 1,174.76-carat gem from Botswana's Karowe Diamond Mine, the third diamond over 1,000 carats recovered since 2015. Botswana is Africa's leading diamond producer. (Photo credit: Monirul Bhuiyan/AFP/Getty Images)

Wabtec Opens 3D Printing Facility

Pittsburgh, Pennsylvania, USA: Wabtec Corporation opened an 11,000-square-foot additive manufacturing (AM) facility in the Pittsburgh area. The company announced the construction of the facility last fall and began operations there in June 2021. Wabtec participates in Neighborhood 91, an AM and 3D-printing supply chain hub in the region. With an SLM®800 printer, Wabtec will produce brake parts for transit applications and heat sinks for freight locomotives, among other components. The company plans to use additive technologies to produce more than 25,000 parts by 2025.

Royal Gold Acquires Gold Stream

Denver, Colorado, USA: Royal Gold Inc. agreed to purchase gold produced from the NX Gold Mine in Brazil with Ero Gold Corporation. Royal Gold will pay $100 million at closing, and up to an additional $10 million of further payments depending on meeting success-based targets related to regional exploration and resource additions, in return for 25% of the gold produced from the NX Gold Mine until the delivery of 93,000 ounces, and 10% thereafter. Royal Gold will pay 20% of the spot gold price for each ounce delivered until the delivery of 49,000 ounces, and 40% of the spot gold price thereafter.

Indonesian Government Plans Bullion Bank

Jakarta, Indonesia: As the home to one of the world's largest gold mines, the Indonesian government will set up a bullion bank to spur trading of the precious metal domestically. The central bank, the mining industry, and others are consulting with the government to start operating the bank in 2024. The country is leading a broad effort to climb up the commodities value chain. That drive has included forcing copper and nickel miners to invest in domestic refining, allowing the country to profit from higher-value products rather than just raw materials exports.

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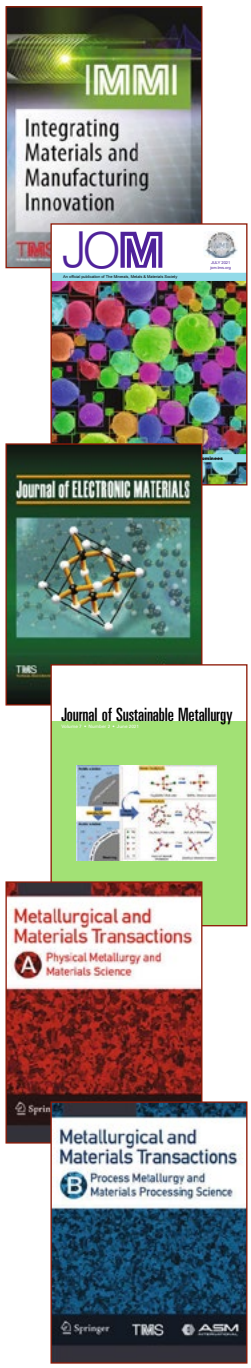
A Look at 2020 Impact Factors and Other Key Metrics for TMS Journals

Kelly Zappas



TMS JOURNALS

The 2020 Journal Citation Reports (Clarivate Analytics, 2021) were released in June and included positive news for all six TMS journals. The following list shows the 2020 Impact Factors for each TMS journal (with a comparison to 2019 in parentheses):

- *Integrating Materials and Manufacturing Innovation* (*IMMI*): 3.404 (3.447)
- *JOM*: 2.471 (2.054)
- *Journal of Electronic Materials* (*JEM*): 1.938 (1.774)
- *Journal of Sustainable Metallurgy* (*JSM*): 2.347 (2.109)
- *Metallurgical and Materials Transactions A* (*MMTA*): 2.556 (2.05)
- *Metallurgical and Materials Transactions B* (*MMTB*): 2.47 (2.035)

"The TMS family of journals continues to represent high-quality publications as indicated by their Impact Factors," said Judy Schneider, TMS Director/Chair, Content Development & Dissemination, and Professor, University of Alabama at Huntsville. "The impact of almost all continue to increase annually. In glancing over the list of journals, it is clear they represent a wide picture of the materials community interests. The family of journals and the research captured continue to highlight the relevance of materials science with cutting-edge technology."

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 factors to consider when evaluating journal performance.

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 on the following page).

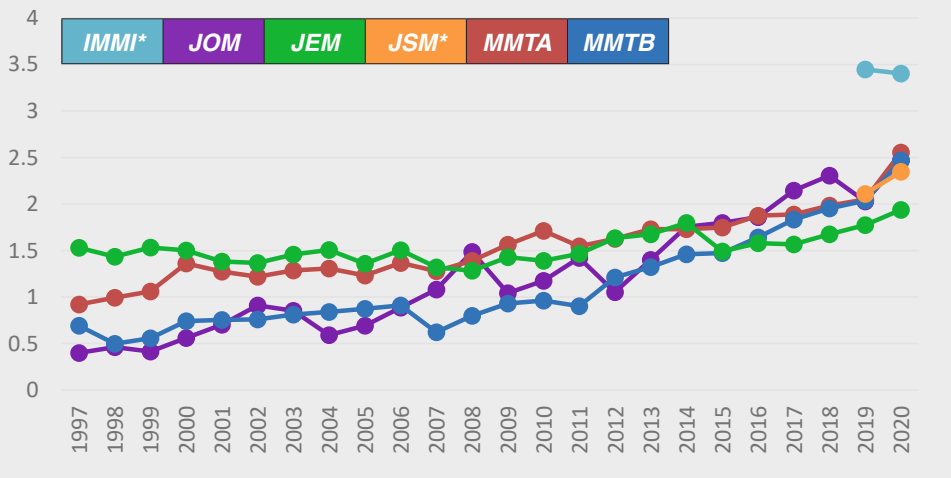


Figure 1. Impact Factors for TMS journals since 1997.
**These journals received their first Impact Factors for 2019.*

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

Category Name	2020 Total Journals	IMMI	JOM	JEM	JSM	MMTA	MMTB
Materials Science, Multidisciplinary	335	164	216	249	-	209	217
Metallurgy & Metallurgical Engineering	80	-	21	-	25	20	22
Mineralogy	30	-	12	-	-	-	-
Mining & Mineral Processing	21	-	10	-	-	-	-
Engineering, Electrical & Electronic	273	-	-	174	-	-	-
Physics, Applied	160	-	-	102	-	-	-
Green & Sustainable Science & Technology	44	-	-	-	39	-	-
Engineering, Manufacturing	50	22	-	-	-	-	-

Table II shows a more comprehensive overview of 2020 key metrics across the entire TMS journal portfolio. *Metallurgical and Materials Transactions A* had the most total citations (34,499) and the most total downloads (1,026,350) among TMS journals in 2020, compared to 30,270 citations and 934,975 for this journal in 2019.

Table II. This table shows 2020 key metrics—five-year Impact Factor, total citations, and total downloads—for TMS journals in addition to their most recent Impact Factors.

Key Metrics	IMMI	JOM	JEM	JSM	MMTA	MMTB
2020 Impact Factor	3.404	2.471	1.938	2.347	2.556	2.47
Five-Year Impact Factor	4.423	2.988	1.746	3.428	2.602	2.57
Total Citations 2020	674	13,389	14,352	839	34,499	11,572
Total Downloads 2020	71,854	716,940	290,293	115,924	1,026,350	421,857

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 2020 key metrics including Impact Factors.

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A (Zoom) Call to Public Service: My Year as a Congressional Fellow

Megan Malara

Megan Malara

"Our life experiences shape who we are, and I likely could never put on paper all the ways I have grown through this fellowship."

For the past year, I have had the privilege to serve as the 2020–2021 TMS/MRS Congressional Science and Engineering Fellow in the office of U.S. Senator Sherrod Brown of Ohio. While I experienced most of my fellowship virtually, it was still eventful to say the least. When I accepted this position in March 2020, COVID-19 closures had just begun, and I never imagined what all would unfold. During my fellowship, I had a front row seat to a change in administration, a flip in Senate control, the sprint to fill the seat of the late Supreme Court Justice Ruth Bader Ginsburg, a global pandemic, an economic crisis, and a violent insurrection on our Capitol. Unprecedented—the word of the year.

Our life experiences shape who we are, and I likely could never put on paper all the ways I have grown through this fellowship. In my placement office, I have been fortunate to serve alongside a staff, both in D.C. and in Ohio, who are among the most dedicated, giving, and effective people I have met. Working with staff, outside experts, and constituents on health and education issues during a public health emergency that will have lasting repercussions on both made for a highly rewarding fellowship, and I hope that I have made a difference.

From the Bench to the Hill

I knew I wanted to be an engineer at 15. I was good at math and science, I had people who believed in me, and I wanted to use my skills to help others. I went into biomaterials and tissue engineering and then began exploring science policy in graduate school.

While in graduate school I suffered a back injury. I refused to go to the emergency room—I didn't want to figure out how to pay the bills on a grad student stipend. I suffered for days. And then I lost feeling in my leg and foot.

I still ended up at the emergency room, in surgery, and in physical therapy for the better part of a year. If I wasn't worried about the cost, could this have been avoided? If I had sought treatment sooner, would I still be able to feel all my limbs? Maybe.

I had spent years at the bench and in surgical suites conducting translational biomedical research dedicated to improving the lives of patients, but it became all too personal that the barriers to real people getting real care are often limiting well before we are limited by medical advancement.

I decided there was more I could do.

When I started my fellowship year in fall 2020, the pandemic was surging, and a comprehensive, federal strategy was lacking. I worked to track the pandemic—rates, demographics, emerging variants—and met with those on the ground to assess their needs and determine how, through oversight and policy, we could get them the help they needed.

As late-stage vaccine trial data came out showing safe and highly efficacious profiles and vaccines began earning emergency use authorization, there was a sense of hope. With my background, I was able to help interpret the vaccine technology and data surrounding the vaccine trials. Pushing for effective and equitable vaccine distribution, access, and uptake became my next big focus.

In a legislative push to support significant federal investment in research for national security and global competitiveness, I was able to leverage my experience as a first-generation college graduate and female engineer in meetings with stakeholders, committees, and agencies to help develop and push for provisions to expand

Malara takes the Senate train to file an amendment at the Capitol.

"As scientists we have not just a role, but a responsibility, to work towards a better future."

and diversify the science, engineering, technology, and math (STEM) pipeline and to make STEM a more inclusive environment.

We are in a state of overlapping crises, and the need is more far-reaching than the public health emergency. Some of the most important government work does not always make the headlines. Policy gives you the tools and the venue to affect change in people's everyday lives. I have watched my colleagues give their all, all the while handling their own lives during a pandemic. Their commitment to one another, to the constituents they serve, to this country, and to justice is something that will stick with me always. I was blessed to learn from my colleagues and honored to serve alongside them.

"In generosity and helping others, be like a river" —Rumi

In record time we have seen safe and highly effective COVID-19 vaccines developed, tested, administered, and enter the forefront of our strategy to fight back against the pandemic. This, along with innovation and global competitiveness legislation moving through Congress and the director of the Office of Science and Technology Policy being elevated to a Cabinet-level position, show that now is the perfect time to get involved in science policy. Weigh in with your elected officials, collaborate with other experts and disseminate your knowledge to policymakers, or consider a run for office yourself. Beyond federal, state, and local science policy, I encourage you to take a look at your university, your workplace, your field. What can you do to help others? How can you push for change?

My time on the Hill, while experienced mostly from home, has been more than I had pictured. More challenging and more rewarding, and I am more inspired than ever that change is coming. As scientists we have not just a role, but a responsibility, to work towards a better future.

TMS Returns to D.C., Virtually

TMS leaders participated in virtual Congressional visits to discuss key legislative priorities for the Society and its members on May 26 and June 3, 2021. Participants included Ellen Cerreta, 2021 TMS President; Tom Battle, 2020 TMS President; Eric Brown, TMS Public and Governmental Affairs Director; and James Robinson, TMS Executive Director. These delegates met virtually with staffers from the offices of Representative Don Beyer (D-VA), Senator Richard Blumenthal (D-CT), Representative Jamaal Bowman (D-NY), Senator Raphael Warnock (D-GA), and Patrick Looney, Deputy Director of the U.S. Office of Science and Technology Policy (OSTP) for Physical Sciences and Engineering, as well as with staff leads of subcommittees of the U.S. House of Representatives Committee on Science, Space, & Technology.

The groups discussed TMS legislative priorities, including:

- **Endless Frontier Act (Now U.S. Innovation and Competition Act):** TMS supports the main portions of the Endless Frontier Act, which would increase U.S. investments in science and technology innovation and strengthen the economy and competitiveness. TMS stresses the need to retain the proposed significant investments in the National Science Foundation and establish a new Directorate for Technology and Innovation. TMS also emphasizes retention to extend the STEM workforce pipeline and have workers educated and work ready to realize the aspirations of the Endless Frontier Act. Note, however, that TMS does not support some of the more recently added pieces of the legislation that pertain to public access to federal research.
- **Materials Research and Development and Hard Infrastructure:** TMS supports strengthening materials R&D because investing in the next generation of physical infrastructure will enhance the American quality of life, increase public safety, and promote the public welfare. Increased investment in materials technology is critical to national security, American economic competitiveness on the global stage, and our response to climate change. Investing in infrastructure and materials technology includes ongoing protection of our economic prosperity and security. Innovations in infrastructure safety and reliability, including the non-destructive evaluation of roads and bridges and embedded structural health monitoring technology, should be part of America's infrastructure plan.

To learn more about current legislative priorities for TMS, visit the Current Issues section of the Public & Governmental Affairs website at www.tms.org/CurrentIssues. And for added perspective on the 2021 Congressional visits, read Jim Robinson's "In the Final Analysis" in the August 2021 issue of *JOM*.

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COMING TOGETHER IN COLUMBUS FOR MS&T21

Kelly Zappas

After an out-of-the-ordinary year and a virtual meeting in 2020, the Materials Science & Technology (MS&T) Technical Meeting and Exhibition returns to a traditional in-person format in a traditional location for MS&T21. This 19th installment in the conference series will be held October 17–21 in Columbus, Ohio, making this the fourth time MS&T will be held in Ohio's state capital since 2011.

While the full conference experience—including networking and social activities—is designed primarily as an in-person event, the MS&T21 + On Demand registration option will give those who are unable to travel the chance to both present their work at the conference and view others' recorded presentations. The recordings will be available through November 30, 2021. More information on this option is available through the MS&T21 registration web page at www.matscitech.org/MST21.

Three Meetings in One

MS&T21 will once again bring together members from TMS, The American Ceramic Society (ACerS), and the Association for Iron & Steel Technology (AIST) for an event that comprises three meetings in one: the TMS Fall Meeting, ACerS 123rd Annual Meeting, and the AIST Steel Properties & Applications event.

The overall conference technical program is developed by an MS&T21 Program Coordinating Committee, which is chaired this year by TMS representative Saryu Fensin, Los Alamos National Laboratory. The committee also includes ACerS Representative Taylor Sparks, University of Utah, and AIST Representative Daniel Baker, General Motors.

IMPORTANT DATES TO REMEMBER:

Housing Deadline: September 23
Meeting Dates: October 17–21
On-Demand Presentations Available Until: November 30
Visit **www.matscitech.org/MST21** for access and details.

Tresa Pollock

The MS&T21 technical program will feature 75 symposia in the following technical tracks:

- Additive Manufacturing
- Artificial Intelligence
- Biomaterials
- Ceramic and Glass Materials
- Electronic and Magnetic Materials
- Energy
- Fundamentals and Characterization
- Iron and Steel (Ferrous Alloys)
- Materials-Environment Interactions
- Modeling
- Nanomaterials
- Processing and Manufacturing
- Special Topics

Within this broader technical program, nearly 30 symposia in 11 topic areas will make up the TMS Fall Meeting at MS&T21. TMS's programming contributions explore the intersections of development, synthesis, and application and focus on topics of interest to TMS and its members.

For the most up-to-date information on technical programming plans, visit the Technical Program and TMS Fall Meeting sections of the MS&T21 website at www.matscitech.org/MST21.

THE EXHIBIT HALL IS BACK!

The return of an in-person MS&T also means the return of the Exhibit Hall! Attendees are welcome to browse products and services by a variety of companies on Monday, October 18, through Wednesday, October 20. All in-person attendees are invited to join their fellow attendees and exhibitors alike at the Exhibit Networking Reception on Tuesday, October 19. Visit the Exhibit page at www.matscitech.org/MST21 for exhibit hours and more details.

Tresa Pollock to Deliver TMS Plenary

Tresa Pollock will deliver the TMS plenary presentation as part of the MS&T21 plenary session on Tuesday morning, October 19. Pollock is Alcoa Professor of Materials at the University of California, Santa Barbara; a TMS Fellow; a former TMS President; and the current editor-in-chief of the *Metallurgical and Materials Transactions* family of journals published by TMS and ASM International

"Additive manufacturing promises a major transformation of the production of high economic value metallic materials, enabling innovative, geometrically complex designs with minimal material waste," Pollock's abstract reads. Her talk, "New Superalloys in the Co-Ni Design Space for 3D Printing," will identify the overarching challenge to design alloys that are compatible with the unique additive processing conditions while maintaining material properties sufficient for the challenging environments encountered in energy, space, and nuclear applications.

Superalloys with approximately equal parts of nickel and cobalt offer new design pathways, enabling improved control of solidification and phase transformations that are critical to 3D printing, according to her abstract. The presentation will discuss the role of new experimental, computational, and data-centric design tools in discovering new alloys in this domain; the unique properties of Co-Ni alloys; and future challenges for the exploration of the Co-Ni design space.

Pollock will be joined at the MS&T21 plenary by speakers from AIST and ACerS. AIST's presenter, Anil K. Sachdev of General Motors Global Research & Development, will discuss "Iron – The Ubiquitous Element." The ACerS plenary speaker, Clive Randall, is the director of the Materials Research Institute at The Pennsylvania State University and will talk about "Turning Down the Heat in Sintering to Enable the Unification of all Materials."

New Diversity, Equity, and Inclusion Event Introduced

The first in a series of annual diversity, equity, and inclusion engagement events at MS&T is scheduled for Sunday, October 17, at MS&T21. The Wikipedia Edit-a-Thon for Diversity in Materials Science and Engineering is a collaborative event designed to increase the visibility of underrepresented scientists and engineers in the disciplines served by the MS&T partner societies.

Because the contributions of the broad diversity of materials scientists and engineers are often buried or overlooked on Wikipedia resources, attendees are invited to combat these biases by helping to make the achievements of underrepresented materials scientists and engineers more readily discoverable.

Representatives from 500 Women Scientists, the organization that pioneered the concept of Wikipedia Edit-a-Thons to advance diversity, equity, and inclusion in STEMM (science, technology, engineering, math, and medicine), will lead a tutorial on Wikipedia as a useful tool and an editing demonstration. Facilitators will guide participants through their first edits at their own pace, using biographies, resources, and examples that will be provided as part of the workshop. Participants are encouraged to use these newfound skills to continue the work after the event has ended.

To participate, sign up in advance through the MS&T21 website to reserve your spot, and bring a charged laptop to the event. This program is co-organized by ACerS, AIST, and TMS, and the event organizing committee is chaired by Natasha Vermaak, Lehigh University and TMS Diversity, Equity, and Inclusion Committee chair.

Planning for MS&T21 and Beyond

Registration and hotel reservations are now available through the MS&T21 website. TMS members are encouraged to book housing at the Hyatt Regency Columbus, the TMS headquarters hotel for MS&T21 and the site of various TMS networking and social activities. For the best rates, be sure to book through the MS&T21 website by September 23.

For more information, visit the Registration & Travel section of www.matscitech.org/MST21.

As preparations continue for the 2021 conference, plans are also moving forward for MS&T22, which is scheduled for October 9–13, 2022, in Pittsburgh, Pennsylvania. Symposium proposals have been collected for MS&T22, and the MS&T Program Coordinating Committee is currently working on finalizing program plans. MS&T22 will open its call for abstracts this fall.

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Highlighting Best Practices in Promoting Diversity, Inclusion, and Civility in STEM: Part II

Jenifer S. (Warner) Locke

Jenifer S. (Warner) Locke

"Highlighting Best Practices in Promoting Diversity, Inclusion, and Civility in STEM: Part II" serves as an introduction to a thematic group of articles in the September 2021 issue of JOM, covering diversity and inclusion topics. The article package is a feature series developed by the TMS Diversity, Equity, and Inclusion Committee. For additional information, contact Kaitlin Calva, JOM Magazine Managing Editor, at kcalva@tms.org.

The 2021 special section of *JOM* from the TMS Diversity, Equity, and Inclusion (DEI) Committee seeks to continue themes first presented last year (see the September 2020 issue of *JOM*). These themes center around sharing best practices toward increasing retention and participation of underrepresented peoples in TMS and materials science in general. Hopefully, all reading this acknowledge that bias, oftentimes implicit in nature, exists and creates systemic issues around representation, level of involvement, and equity. While our 2020 section focused on visible areas of diversity, this 2021 section focuses on areas of diversity that can often remain hidden, but can nonetheless push people to leave our science, technology, engineering, and math (STEM) community.

I hope that this special section creates more awareness around the fact that most of a person's identity is unseen; just because we can't see it doesn't mean our cultural norms make one feel accepted, nor does it mean they are not hindered by bias-related roadblocks. I also hope it propels *JOM* readers' voices and helps them enact change in their workplaces and communities so we can one day fully realize each person's full potential.

The first article presents the findings and recommendations of the Ad Hoc Committee on Potential Biases within the TMS Culture to create a more engaged membership for all regardless of gender, race, ethnicity, visual/auditory/physical diversity, international status, etc. It is the hope that this article can be a call for action to us all and lead to improvements in our Society.

The next article focuses on just one area of the many areas of neurodiversity, autism, in an interview about Stairway to STEM, an organization that helps autistic students transition to college and eventually STEM careers. While not every reader may be an educator focusing on college, this article can inform us and provide resources on ensuring that our autistic colleagues at all levels can bring their diverse and unique ideas and perspectives forward.

The third article provides goals and recommendations for moving towards equity in STEM for those LGBTQIA+ (lesbian, gay, bisexual, transgender, queer, intersex, asexual, and more). The authors highlight why focusing on LGBTQIA+ individuals remains essential and provide critically important items that both institutions and individuals can do toward equitable ends.

Finally, the last article focuses on one of the biggest best practices a person with a privileged vantage point can do: become an ally for those without your set of privileges. This article discusses the benefits of growing awareness and receiving education toward allyship from the perspective of a person who engaged in an ally course in college. While this effort focused largely on gender-based bias, these principles can be taken to help each reader become an ally for any marginalized group.

These articles highlight just a sliver of the best practices to help create a more inclusive and equitable STEM community and Society. Let these articles provide a platform for more education, conversation, and change, particularly in areas of diversity that often are overlooked. Also, while these articles, and those in 2020, each have a specific identity focus, it does not mean they are isolated and intersectionality should be considered in any DEI effort.

Jenifer S. Locke (she/her) is an assistant professor at The Ohio State University. As a TMS member, she is the *JOM* advisor for the DEI Committee. **Locke would like to thank the DEI Committee members and the authors featured in this series for their work and time in putting together this special topic and helping to create change for a more equitable future.**

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Recommendations to Mitigate and Reduce Perceived Implicit Bias at TMS

Megan J. Cordill

Megan J. Cordill

In 2019 the TMS Board of Directors created an ad hoc committee to look into whether or not there are actual or perceived biases within the TMS community and make recommendations to address the findings. This ad hoc committee was formed in direct response to the fulfilment of the TMS Aspires strategic goal "to be a highly inclusive society where all materials students and professionals feel welcome and diversity is celebrated." (**Editor's note:** see www.tms.org/TMSAspires for more.) Formally named the Ad Hoc Committee on Potential Biases within the TMS Culture and led by 2020 TMS President Thomas Battle, the group was gender and racially diverse and included U.S. and non-U.S. members representing academia, government, and industry.

The committee used a variety of information and data resources to develop

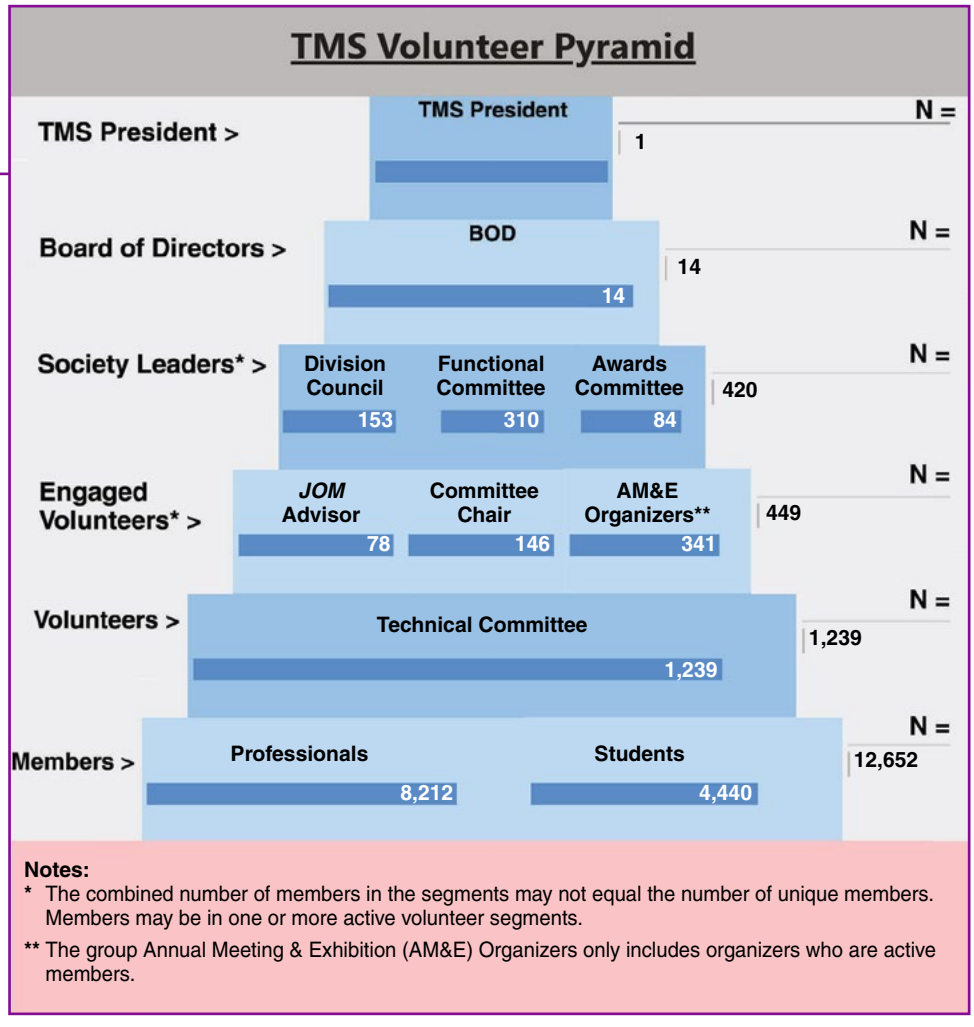

Figure 1: The TMS Volunteer Leadership Pyramid (VLP) provides a model for tracking TMS members through progressively more involved levels of volunteer engagement on the assumption that this progression serves as a pathway to Society leadership roles. The data shown in the VLP, generated in June 2021 and representative of 2020 membership data, is further organized by the following demographic information for the purposes of tracking progress over time and identifying potential barriers to leadership for specific groups or members: Employment Sector; Geographic Area; Age; Gender; Ethnicity (U.S. Only); and Highest Attained Degree. While this project was done concurrently and independently from the Ad Hoc Committee on Potential Bias's work, the Committee recommends using this as a resource to measure progress in expanding participation and inclusion to groups that are currently underrepresented in leadership roles.

its recommendations, including the 2020 TMS member survey, a separate survey of non-U.S. members, a review of the recommendations from the Ad Hoc Committee on Best Practices for Technical Committees, and a compilation of the committee members' own observations and experiences. A concurrent activity was the development of baseline data to measure progress in volunteer and leadership engagement. This led to the creation of the Volunteer Leadership Pyramid (VLP), shown in Figure 1 on the previous page. The VLP is organized according to progressively more involved levels of volunteer leadership and tracks the representation of key TMS demographics within these levels.

Key Findings and Recommendations

To provide a framework for their analysis and recommendations, the committee identified and adopted the following definitions:

- **Bias:** a prejudice in favor of or against one thing, person, or group compared with another usually in a way that is considered to be unfair. Biases may be held by an individual, group, or institution and can have negative or positive consequences.
- **Unconscious Bias** (also known as Implicit Bias): subconscious attitudes, perceptions and stereotypes that influence our understanding, actions, and behavior when interacting with various identities.
- **Conscious Bias** (also known as Explicit Bias): the person is very clear about their feelings and attitudes, and related behaviors are conducted with intent.

Based on its research and analysis, the committee determined that explicit bias toward any particular group within TMS was not found. However, there was indication of implicit, unconscious bias that may be interfering with some TMS members' full engagement in Society activities. Additionally, a perceived theme surfaced in all aspects of the committee's research and analysis: namely, that long-standing processes and cultural norms are posing significant barriers to member engagement, especially for members who did not belong to established groups. A common feedback identified that it was unclear or difficult to attend or further engage in a meeting or pursue more active participation within TMS.

To address these findings, the committee developed five recommendations with the goal of mitigating the consequences of bias, reducing its impact, and laying the groundwork to eliminate it in the long term.

Recommendation 1:

Committees and other volunteer groups should commit to having at least one all-virtual meeting per year, scheduled to reasonably accommodate a variety of time zones and, in general, incorporate virtual options for all meetings and ongoing interactions.

Volunteer leadership should receive training on conducting effective virtual meetings that encourage engagement of all members, while considering potential communication and accessibility barriers. In addition, TMS will explore structured, intentional use of online tools to foster discussion and interaction between meetings.

Among other inputs, this recommendation was developed to address the survey results of non-U.S. members in which 46% of respondents cited, "It is difficult for me to participate in in-person meetings outside my own country," as well as 80% of these respondents indicating "yes" to the question, "Would you be more involved with TMS if you could participate virtually?"

Recommendation 2:

Technical Division Councils and Functional Committees should systematically address the factors leading to a strong perception of gatekeeping and preferential treatment for those with established or traditional ties.

Within this recommendation, it is planned to incorporate unconscious bias training elements in technical and functional committees and TMS Board of Directors leadership training. The implementation of a structured mentorship program focused on including new voices in volunteer and leadership roles is also encouraged. A possible model has already

been developed by the Race and Ethnicity Working Group of the Diversity, Equity, and Inclusion Committee (DEI), which after only one year has demonstrated quantifiable success in minority member engagement on technical and functional committees. In addition, guidance and training should also be provided to symposium organizers on reaching out to appropriate invited speakers outside of their personal sphere that also reflect the demographic range of TMS membership. The sidebar feature accompanying this article demonstrates impact of diversity of technical committee membership on the diversity of invited speakers at TMS annual meetings.

This recommendation was developed to specifically address feedback from both U.S. and non-U.S. members regarding challenges they have encountered in joining technical committees and becoming more involved with TMS activities. For instance, non-U.S. survey respondents (32%) noted, "It is difficult to participate when you are not part of the established TMS groups," while other members shared written comments similar to this: "There is a hidden structure that makes it hard to get involved with TMS." All TMS members should work to change these experiences.

Recommendation 3:

Develop, implement, and market a comprehensive, consistent, structured orientation program with both online and in-person components.

This includes:

1) Defining volunteer opportunities available to members and place these within the context of the total organization;
2) Clearly delineating the available pathways and processes for engagement;
3) Refining and highlighting volunteer opportunities, when possible, that can serve as an onboarding program for new members and/or those with limited time and resources; and
4) Addressing potential communication challenges.

It is recommended that the orientation begin before the member attends an annual meeting. In addition, technical committees are encouraged to implement a peer-to-peer recruitment program with symposium organizers. Using the baseline data gathered through the VLP project, TMS should also formally measure and report progress.

The context for this recommendation comes from survey results that the second-most-cited reason for not participating in TMS volunteer activities by non-U.S. members was, "I am not aware of TMS volunteer activities (43%)." A number of members also provided feedback that they did not have the bandwith to devote to volunteer activities. Based on these and other comments received, it is further recommended to clearly define activities with a time commitment, so that members can choose ways to become involved that best fits their time constraints.

Recommendation 4:

Implement a Society-wide policy and practice of using gender-neutral language in all TMS documents, forms, and communications and adopt a consistent practice of removing courtesy titles as a potential barrier to participation, either by phasing them out and/or making courtesy titles a clear opt-in choice.

As a leader in implementing diversity, equity, and inclusion initiatives, it is necessary that TMS embrace this straightforward, but very meaningful, recommendation to be inclusive to all through our Society.

Recommendation 5:

Extrapolate the Ad Hoc Committee's findings and recommendations to all aspects of membership engagement.

Within this recommendation, it is envisioned to have the Technical Division Councils make a diversity, equity, and inclusion update a routine agenda item that would be reported by the Membership & Student Development Committee representatives. Other suggestions include: developing and implementing a uniform process for identifying a more diverse pool of award nominees; developing consistent ally and active bystander training and support for members as a cohesive, common-goal ongoing effort; and potentially conducting a climate survey of TMS membership in the future.

"…the next time you are in your technical committee meeting or at a networking event, if you see someone you don't know or perceive that they are looking for a way to engage, introduce yourself."
—Megan J. Cordill

Next Steps—And What You Can Do

The TMS Board of Directors received, discussed, and approved the Ad Hoc Committee's recommendations at its March 12, 2021, meeting and are on track to develop a plan for implementation before the close of the year. The Board has made acting upon these recommendations in early 2022 as one of its highest priorites.

While much data reviewed by the committee focused on TMS members outside of the United States, the total volume of research and comments reviewed and analyzed indicated that barriers to inclusivity and engagement of the full TMS membership exist in other TMS aspects. TMS leadership should represent the diversity of our members, and this can only occur when we break down perceived barriers to volunteering.

With this article, the TMS DEI Committee and the Ad Hoc Committee on Potential Biases within the TMS Culture are joining forces to directly report the recommendations to the TMS membership at large. A take-home message for all TMS members is that while bias was reported, it was implicit bias. This means, the next time you are in your technical committee meeting or at a networking event, if you see someone you don't know or perceive that they are looking for a way to engage, introduce yourself. You would be helping to reduce gatekeeping and may find a new collaborator or colleague in the process.

Megan Cordill (she/her) is the vice director at the Erich Schmid Institute for Materials Science, Austrian Academy of Sciences. She is the past chair of the TMS DEI Committee and was a member of the TMS Ad Hoc Committee on Potential Biases within the TMS Culture.

Correlations Between Organizing Committee and Invited Speaker Diversity

Dana Zöllner

An analysis of keynote and invited speakers of recent TMS Annual Meeting & Exhibitions brings attention to clear imbalances.

While the 79 keynote lecturers for the TMS 2020 Annual Meeting & Exhibition (TMS2020) mirrored the demographics of U.S. and non-U.S. TMS members, only 8.5% of the U.S. keynote lecturers were women. In contrast, among the non-US keynote lecturers, 28.1% were women. It was found that the composition of the organizing committees had a potentially crucial impact on these results. For male-only organizing committees, women made up only 4.8% of their keynote speakers. In contrast, whenever at least one woman was part of the committee, the percentage of women being invited for a keynote lecture increased by an approximate factor of four, up to 20.0%. Of course, due to the limited number of keynotes those values tend to fluctuate from year to year.

A similar discrepancy can be observed regarding the origin of the organizing committees. In cases in which symposium organizers were all U.S.-based, more than 70% of the keynote lecturers worked also at an U.S. institution. In contrast, international organizing teams were much more likely to invite international speakers.

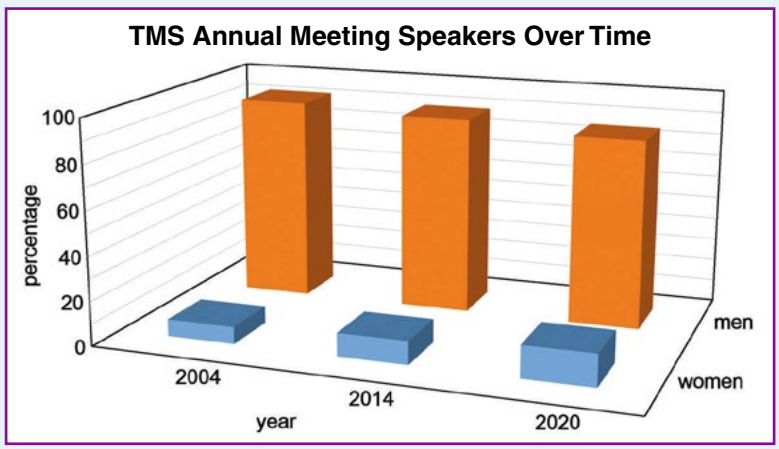

Figure 2: Percentage of male and female invited speakers at TMS annual meetings since 2004.

It is noteworthy that of the large number invited lectures for TMS2020—943 in total—women made up 14.5% of the speakers, while the percentage of TMS members who identify as female was 20% in 2019. A positive development is clearly going on: The percentage of women being invited has basically doubled within the last 16 years (Figure 2).

All in all, mixed organizing committees—in terms of country of origin and gender—tended to represent TMS member diversity more accurately with their invited and keynote speakers.

Dana Zöllner is scientific coordinator of the Graduate Academy, Otto von Guericke University Magdeburg.

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Stairway to STEM: Providing Resources for Autistic Students/ Students on the Autism Spectrum

Natasha Vermaak and Mary Ellen Gardiner

Natasha Vermaak

Mary Ellen Gardiner

Stairway to STEM (STS) is a nonprofit organization with a mission to help autistic students realize their capacity for success as they transition to college environments and beyond, particularly in STEM fields.[1] The goal of STS is to be a one-stop online resource for students on the autism spectrum, their parents, and post-secondary STEM instructors. Following the STS Identifying Language Policy, throughout this article the use of identity-first and person-first language will be alternated.[2] A lot of autistic people like identity-first language, however it is a matter of personal choice, and the best thing to do is to ask individuals which they prefer (person-first or identity-first language).

Some may be familiar with the American Psychiatric Association's Diagnostic and Statistical Manual's (DSM) description of autism in the form of deficits and the severity of social-emotional reciprocity, nonverbal communicative behaviors, and the management of relationships, marked by restrictive, repetitive patterns of behavior, interests, or activities, and/or sensory sensitivities.[3] However, viewing autism from this medical or deficit model can lead to attitudes of "fixing" students—to molding them into typical behaviors and interactions.[4] In contrast, the social justice or neurodiversity model of autism emphasizes that autism is not at its core a communication deficit but instead a communication difference—one that should be honored and respected.[4]

Stairway to STEM supports student confidence, resiliency, and self-advocacy through the production of tools and events designed to: (i) build awareness of academic and employer-based STEM programs among autistic individuals; and (ii) promote existing evidence-based practices to an expanded community of educational institutions, students on the autism spectrum, and their families and employers. The online resources span podcasts, forums, e-books, newsletters, and posts geared towards students, families, and educators. Stairway to STEM was developed, produced, and is maintained by Pellet Media Inc., an award-winning media production company. Below some questions and answers are presented about STS with Mary Ellen Gardiner, chief of staff for Pellet Media.[5]

Vermaak: What are the most popular autism resources for collegiate success that you provide and why do you think that is?

Gardiner: The videos are the most popular resource on the STS website. They are created by autistic students for autistic students; they are genuine and speak directly to the students. For example, some recent videos include:

- **"Tips for Autistic Students: Attending Academic and Scholarly Conferences,"** by STEM graduate student Laura Gilmour[6]
- **"How To Use Your Phone, Calendar & Daily Planner to Master Your College Schedule,"** by STEM student Elinore Alms[7]
- **"How Examining Autism and the Immigrant Experience Together Can Benefit Communities,"** by STEM graduate student Laura Gilmour[8]

"The better we understand the challenges facing autistic students who also belong to other minority populations, the better we can recognize and support their particular needs."
—Arianne Garcia, Stairway to STEM

Blog posts written by STS content creators are also popular. For example, students, families, and educators really enjoyed a post, "Intersectionality, Autism & STEM College Outcomes," written by STS editorial board member Arianne Garcia.[9] In this article, Garcia considers the way various forms of discrimination can compound negative STEM college outcomes for autistic students in relation to race, gender, and sexuality. She begins by exploring the term "intersectionality" and then shows how it has serious consequences for many current and aspiring STEM students. Garcia writes, "The better we understand the challenges facing autistic students who also belong to other minority populations, the better we can recognize and support their particular needs."[9]

Vermaak: Since STS started publishing in 2018, what do you consider as one of your major accomplishments?

Gardiner: One of our highlights was our 2019 conference Imagine Your Future in STEM, in partnership with the RISE Learning Institute, STEM to Stern, and Neurodiversity Navigators at Bellevue College in Bellevue, Washington. At this conference over 100 high school students and families came together to share exciting and relevant content for autistic high school students and the transition to college and a STEM career. The conference explored the skills and resources needed for collegiate and workplace success, including considerations such as self-advocacy, internal motivation, and organizational and executive functioning abilities. Environmental resources for educational and workplace professionals, including understanding autistic culture and communication, and the value of a neurodiverse workplace were discussed, with Bellevue College STEM faculty sharing best practices and students sharing their college experiences. In addition, a professional panel from Microsoft's Neurodiversity Community (formerly Autism Community) presented on career experiences.[10,11] Many of the resources and best practices shared can be found in STS' free e-books:

- ***Autism 101: An Introduction to Academic Success***: This is a collection of STS material curated with an eye toward educators and the students they instruct. The first section provides an overview of academic autistic culture and first-hand accounts of common challenges that autistic students face. The second section includes tips and strategies from autistic students and academic and support professionals around time management, organization, and interacting with professors.[4]
- ***Imagine Your Future in STEM: College Transition, Achievement, and Further Educational and Professional Advancement***: This e-book is geared toward students and families. It pulls together extensive STS material on the college transition, college success, and preparing for graduate school or the workforce. Each section supports students and families at crucial points as students develop their self-advocacy and manage increased independence.[12]

Vermaak: Finally, what message would you like to share with the student and professional members of TMS and the *JOM* readership about addressing the needs of autistic students/students on the autism spectrum who are transitioning from high school to college in the STEM fields?

Gardiner: The importance of self-advocacy cannot be overstated. There are many advocacy resources and starting points outlined for autistic students in the STS materials online. Another resource is the Autistic Self Advocacy Network (ASAN).[13] This organization seeks to advance the principles of the global disability rights movement with regard to autism. Allies are encouraged to continue to educate themselves in order to support autistic people. In addition to STS materials for students, families, and educators, the ASAN also provides general resources for allies through its website, Welcome to the Autistic Community.[14]

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Natasha Vermaak is an associate professor of mechanical engineering and mechanics at Lehigh University. She is currently chair of the TMS DEI Committee.

Mary Ellen Gardiner is chief of staff at Pellet Media Inc.

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Material Goals Towards Equity Along the STEM and LGBTQIA+ Spectra

Ben Britton, Jennifer Carter, Matthew Korey, and Liz Roccoforte


Ben Britton


Matthew Korey


Jennifer Carter


Liz Roccoforte

"Legal steps forward are just one fragment of needs for inclusion and belonging."

In materials science and engineering (MSE) we champion materials, but advances come from the people "behind" the research and applications. This mandates us to assess whether equal access and support to participate exists. Here, we focus on exploring and addressing disparities for members of the LGBTQIA+ (lesbian, gay, bisexual, transgender, queer, intersex, asexual, and more) community, to create a sense of inclusion, belonging, and power-sharing amongst LGBTQIA+ and non-LGBTQIA+ identifying individuals.

With wider societal progress towards LGBTQIA+ equality, like the right of same-gender couples to marry, some question the need to discuss the role of sexuality and gender on participation in MSE.[1] Legal steps forward are just one fragment of needs for inclusion and belonging.

The co-correlation of LGBTQ identity, lack of inclusion and belonging, and poor experiences in STEM is highlighted by Cech and Waidzunas and is worth a read (n.b., this may trigger memories for those impacted).[2] The study explores 25,000 individuals employed in STEM in the United States, with 4% self-identifying as LGBTQ, revealing that LGBTQ people are:

- less likely to have adequate career resources/ opportunities;
- less comfortable whistleblowing;
- experience devaluation of their professional expertise;
- experience social exclusion and harassment in their workplace;
- experience health and wellness difficulties; and
- more likely to leave their current jobs, or to leave STEM entirely.

Typical approaches frame this regarding equity (fairness), diversity (representation), and inclusion and belonging (e.g., in decision-making processes); often this centers on legally protected classes/characteristics (which, depending on location, may include sexuality and gender) and can be encouraged by individual interest groups or recent events. It is critically important to also consider intersectionality, where individuals who belong to multiple marginalized groups face extra barriers to participation and experience marginalization within groups (e.g., a Black lesbian can be marginalized within a queer-friendly space due to misogyny from gay or bisexual men and racism from white people).[3]

The near monoculture of MSE, especially as reflected by those in positions of power, further accentuates imbalances. Materials science and engineering originates within a traditionally heteronormative[a] and cis-masculine[b] basis, being coalesced from engineering, chemistry, and physics. The lack of diverse representation is often only considered in terms of visible minority status, as indicated by perceived gender presentation, age, physical disability, and skin color. Membership of the LGBTQIA+ community may be invisible, as individuals can "pass" or "code-switch" to hide their minority status (e.g., for safety). This is not anecdote, as according to a recent survey of LGBT+ physical scientists from across the U.K., only 40% of lesbian and gay individuals are out to their coworkers, reducing to 15% for bi-/pansexual, and 21% for queer/questioning.[4] These results hide local discrepancies, both in terms of geography, culture, and type of work, additionally within the LGBTQIA+ spectra there is evidence of discrepancies of experience, especially of transgender and post-secondary students in STEM.[5]

Moving Towards LGBTQIA+ Equality

We quote the U.K.-based charitable trust, Pride in STEM, on the annual International Day Against Biphobia, Homophobia, and Transphobia: "Every LGBTQIA person across the world deserves to live their life to the fullest with no fear of discrimination and persecution."

Cultural change towards equity must be conducted within the context of "nothing about us without us," so supporting LGBTQIA+ individuals means bringing them on board, fostering a sense of belonging for all, and deferring to members of the LGBTQIA+ community for advice. Everyone must recognize and challenge "deficit models," as LGBTQIA+ individuals are not there "to be fixed." Together we must navigate the "minority tax" that many members of current and historically marginalized communities face, where they feel required to contribute service towards equity rather than be free to do what they need to do to succeed and thrive in their place of work on their own terms.

Here we introduce recommendations and work for institutions and allies, as they must do the "heavy lifting." As we are not the first to make recommendations, and our list is not exhaustive, we encourage further reading.[4]

Institutions should:

- Create a safe, inclusive, and supportive environment that retains and respects individuals. Start with basic workplace protections that respect LGBTQIA+ status, including anti-bullying and anti-harassment policies that address the needs of the most marginalized. This should not be the responsibility of those who have already been marginalized by the status quo (also known as, minority tax) and often will require dedicated resources (staff time, specific budgets, etc.), to facilitate a change.
- Create/support queer-friendly spaces, such as establishing a monthly queer-friendly coffee, celebrating LGBTQ+ STEM Day, or starting a chapter of oSTEM (Out in STEM).
- Create and maintain codes of conduct and workplace policies. These are tools (with permanence) to sustain change but require cultural buy-in and enforcement. Refresh these regularly, with input from those who have been marginalized by the status quo, to reflect the changing needs of the communities.
- Upturn heteronormative and (cis-) gendered assumptions (and the static nature of sexuality and gender identity). This can start with a simple audit of policies, considering whether terms need to be gendered, and how the protection or policy should apply equally to all people (and how to

"…supporting LGBTQIA+ individuals means bringing them on board, fostering a sense of belonging for all, and deferring to members of the LGBTQIA+ community for advice."

[a] Heteronomative is the assumption that it is normal to be, or to want to be, in a heterosexual relationship, e.g., in assuming that someone is dating or married to someone of the opposite gender.
[b] Cis-masculine is the assumption that professionals (in STEM) identify with the same gender they were identified at birth (cis) and male-presenting ("are men") or have male-like traits as inferred by societal norms.

actively frame it as anti-homophobic/transphobic).
- Include equity, diversity, and inclusion (EDI) as an active item within all decision-making processes, and support people asking about the LGBTQIA+-focused EDI implications of policy changes. There is risk that people asking for more inclusion are seen as "troublemakers," but the status quo is demonstrably broken.

Given the hostile nature of STEM, we suggest that at-risk individuals explore the safety of the work environment prior to agreeing to career changes. The Human Rights Campaign website provides resources that are helpful for seeking out safe employment opportunities in the United States.[6]

Allies should:
- Speak up when witnessing derogatory and/or dismissive behavior about members of the LGBTQIA+ community. It is exhausting for a member of an underrepresented minority to have to survive these daily micro- and macro-aggressions.
- Create a group code of conduct as a lab group leader/member that includes statements that support the need for an inclusive work environment (e.g., the code of conduct developed for Bahlai Lab at Kent State University).[7]
- Consider how the status quo favors cisgendered and heteronormative assumptions. "Stick to the science" statements are often made by those who have survived and are established in positions of power. Remind your peers that individuals in opposite-gender relationships often bring their sexuality and gender identity up at work, typically in most casual inferences like when introducing their wife (or husband) or children.[c] Thus in the face of inequality, it is never possible to "stick to the science" because the science is done by individuals.
- Avoid attending or engaging with events, activities, and organizations that are passively or actively hostile to LGBTQIA+ individuals. Ask about EDI policies when you start your discussions. This is important when accepting awards, conference invitations, and your participation in significant events or activities.

What TMS and TMS PRIDE Are Doing

TMS states on its website and within conference and event programs the expected code of conduct during meetings, committee participation, and after-hours events.

In 2015, the Women in Materials Science and Engineering Committee was renamed the Diversity Committee, and then the Diversity, Equity, and Inclusion (DEI) Committee in 2020, to reflect a broader mission statement. The TMS Pride working group was formed in 2018 to advise the DEI Committee, and leverages committee resources to advocate for and facilitate the inclusion, recognition, and networking of LGBTQIA+ individuals in the field.

Specific TMS Pride programming and current issues include:
- Broadening normalization of LGBTQIA+ identity within TMS by hosting EDI online webinars and in-person symposia at annual meetings through the Diversity in the Minerals, Metals, and Materials Summit series.
- Working with other MSE-related societies to increase LGBTQIA+ and intersectional identity visibility in all communities within our discipline.
- Hosting networking events at TMS annual meetings to enable LGBTQIA+ individuals (and their partners) to connect in safe, semi-closed, non-hetero-/cis-normative spaces.
- Combating existing and unique challenges for people of transgender,

[c] We stress that many members of the LGBTQIA+ community have, and are actively considering having, children through a variety of means. Furthermore, while childcare and other matters correlated with heterosexual relationships may be supported and/or discussed professionally, we often see male-bias in representation and participation in STEM often due to the unequal support of men and women (and in many places legal provision with regards to identity with a non-binary gender is not considered at all).

agender, and genderqueer identity at annual meetings by:
  - Working with TMS staff in identifying, labeling, and/or creating gender-neutral bathrooms and inclusion on site maps.
  - Buying and distributing pronoun stickers for name tags at the annual meeting for LGBTQIA+ members and allies.
  - Advocating for more inclusive honorifics for registration and nametags at meetings (i.e., gender-neutral alternatives for "Mr." and "Miss/Mrs./Ms.").
- Developing lists of LGBTQIA+ inclusive restaurants for annual meetings located in areas without legal protection for LGBTQIA+ identities or with bathroom bills in place.
- Advocating with TMS staff and leadership for local LGBTQIA+ protections to be considered when choosing future annual meeting locations.
- Fundraising for TMS-related programming for LGBTQIA+ individuals.
- Authoring articles for *JOM* focusing on LGBTQIA+ and intersectional identity.
- Addressing existing and ongoing exclusion of LGBTQIA+ individuals from positions of leadership within TMS.

The work with TMS Pride is ongoing and the team is always open to new members willing to help host, plan, and attend future events. If you have questions, please e-mail tmspride@tms.org.

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Ben Britton (he/him) is an associate professor in the Department of Materials Engineering at the University of British Columbia and a visiting reader at Imperial College London. He is a member of the TMS DEI Committee and recipient of the 2021 TMS Frank Crossley Diversity Award.

Jennifer L.W. Carter (she/her) is an associate professor in the Department of Materials Science and Engineering at Case Western Reserve University. She is a past chair and current member of the TMS DEI Committee.

Matthew Korey (he/him) is a postdoctoral researcher at the Manufacturing Demonstration Facility at Oak Ridge National Laboratory. He is the current chair of the TMS Pride working group and an active member of the TMS DEI Committee.

Liz Roccoforte (she/her) is the inaugural director of the LGBT Center at Case Western Reserve University.

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Reflections from a Male Engineering Student Ally, His Professor, and His Advisor

Jenifer (Warner) Locke, Jackson Pope, and Lisa M. Abrams

Jenifer (Warner) Locke

Jackson Pope

Lisa M. Abrams

Background (From A Professor)

Most are aware that the majority of students pursuing undergraduate engineering degrees are men. Much has been made of the "chilly climate," or unwelcoming environment for women in higher education, particularly those in science, technology, engineering, or math (STEM) fields.[1] Elements of this chilly climate include both overt and covert behaviors by faculty, administrators, and students (e.g., sexist humor, stereotypical comments of women's abilities), and institutional policies and practices. These behaviors can have a lasting impact on the desire to persist in the engineering field. Studies have shown that this chilly climate can have a negative impact on cognitive development and can also influence women's desire to stay and persist within STEM fields.[2]

While awareness of gender barriers for women in engineering programs is increasing, related work in the field designed to remove such obstacles is still evolving. In STEM departments, men constitute the dominant group and as such, they play a vital role in working toward gender equity.[3] From a social justice perspective, having allies, i.e., those from the dominant social group who understand the inequity placed on those in the minority, is critical in addressing issues with climate and improving the experiences for all.[4]

The notion of creating allies has been utilized in academic settings particularly at the faculty level with North Dakota State University's Advocates and Allies program. Evidence suggests that these programs for faculty have a positive impact on the men who attend the trainings and thus the climate for all. The same principle can also be applied at the student level. Undergraduate and graduate men who are devoted to promoting gender equity in STEM fields can serve as peer mentors for other students. Having allies within the environment can help change the culture of the chilly climate that women face and contribute to the strategies to retain women in engineering programs.

Approach (From A Professor)

The work started out as a cohort of men consisting of 11 undergraduate and graduate students who were trained as allies for gender equity in the college of engineering (COE). Through participation in a one-year informal program focused on gender inequality, implicit bias, and micro-aggressions, these individuals gained awareness and skills to act as allies for underrepresented groups in the COE, specifically women. The success of this initiative led to a leadership course being developed and offered every semester since autumn 2016. This course is focused on gender equity and the practice of inclusive

> *"Having allies within the environment can help change the culture of the chilly climate that women face and contribute to the strategies to retain women in engineering programs.*
> —Lisa M. Abrams, the professor

leadership in engineering. It leverages evidence-based models that include student engagement across three stages:

- information gathering to develop awareness of gender equity challenges in engineering;
- meaning making to examine personal biases; and
- contextual application of strategies that promote inclusive engineering climates.

In the first four weeks of the course, students have the opportunity to discuss and explore different components of social identities. They watch videos, get input from industry (who reinforce these concepts), and partake in a workshop exploring their own identities. Next comes the concept of power and privilege, and its connection to gender, race, and socioeconomic status. From weeks 8 to 10, students are introduced to implicit bias through case studies and group discussions. They are then introduced to micro-aggressions, and the impact that they can have on women and other minorities. Although the primary focus of the course is gender, the experience of other marginalized groups is also included in the curriculum.

The students were asked to self-report on the efficacy of the course objectives at the start and end of the course. In both the pre- and post-course survey, the students answered the same set of multiple-choice questions, which was scored using Likert-type scales. The results show an increase in self-reported efficacy over all the semesters the course has been offered.

This course will be offered on a regular basis. It would be desired to look for trends and/or differences in students in different engineering majors and different stages of academic career. Student behavior changes as a result of this course are currently be measured. A similar workshop for new engineering hires at a prominent company located within the state has also been offered.

Reflections (From A Male Engineering Student Ally)

In my experience, it is the community that the cohort created that made this course so effective. Working in such a close-knit group helped build layers of trust that made it possible to break down stigmas around topics that are traditionally hard to talk about. It became much easier to offer my own thoughts and opinions and come to a deeper understanding of how my actions really impacted the people around me.

I can vividly recall one exercise where the men read aloud specific examples of harassment collected from women in our engineering college. To hear, in their

"I always knew that engineering was male dominated, but I never imagined that misogyny in the field could be as pervasive as their stories had shown it to be."
—Jackson Pope, the male engineering student ally

Table I

Weeks	Module	Development Stage/Activities
1–4	Social Identities	Common Ground activity, social identity definition discussion *The Mask You Live In* film and discussion Industry/men's panel discussion, social identity workshop (gender/race/socioeconomic status, etc.)
5–7	Privilege	Power and privilege definition discussion Privilege workshop (gender/race/socioeconomic status, etc.) Tactics of Power and Control workshop
8–10	Implicit Bias	Implicit bias definition and discussion Ohio State University and engineering workplace case studies Implicit Association Test review and discussion
11–13	Microaggressions	Microaggressions definition and I-Statement activity 8 Dumb Things diversity workshop Women's panel; case studies
14	Wrap-up	Course reflection, discussion, and evaluation

Table I. This table shows the modules, activities, and skills that students participate in and develop over 14 weeks in this course to train male allies in gender equity and inclusive leadership in the STEM fields.

"…Pope's participation in a course that educated and gave him tools to become an ally positively benefited the culture of his work group and demonstrated the impact one ally can make."
—Jenifer Locke, the research advisor

own words, what was happening to the students that I sat next to was eye-opening. Their stories showed that this abuse was happening at all levels—from senior directors, managers, professors, teammates, and other students—and that it was ongoing. I always knew that engineering was male dominated, but I never imagined that misogyny in the field could be as pervasive as their stories had shown it to be.

Imagine for a moment that you have just figured out that the sky is blue, and you want to discuss it with a group of your friends. The tone of that conversation would be eerily similar to the one I had with some female friends from my major shortly after the exercise took place. Each of them had their own experiences to offer up, and any time this subject has come up since then, my female peers have always had more stories to add. From these candid, and at times very personal, conversations it became clear the impact that this environment can have on someone.

Lessons Learned (From A Male Engineering Student Ally)

My time in the cohort helped me develop the skills and mindset needed to make these types of difficult discussions more productive. Likewise, it has given me the tools needed to identify the various kinds of situations that contribute to a hostile environment and how to better diffuse them. It can be difficult to call out problematic behavior, but I am able to find ways to do so tactfully and without assigning blame. Ultimately, this helps lower tensions and makes people more receptive to hearing out what they could do, or say, differently. This is a valuable skill, and it has proven to be an enormous asset to both my personal and professional life in the years since I joined the cohort. It is hard for me to imagine I would have this same skillset without this experience.

Impact on Culture (From A Research Advisor)

Jackson Pope, who offered the above perspective, was an undergraduate research assistant in my lab while he was enrolled in Abrams' course. With his involvement, I noticed a change in his ability to support and understand my experiences as a female in STEM, as well as a change in nearly all the male students in my research group. Specifically, an increased level of intellectual respect and diminished need to convince male group members, members who had never taken the course, to listen to my recommendations. This enhanced supportive environment was also noticed by female group members. A postdoc who had previously had interactions with a male graduate student who left her feeling "less-than" on several occasions, reported improvements in this persons' behavior after Pope's involvement in the course and subsequent positive influences in the group culture. It became clear to me that Pope's participation in a course that educated and gave him tools to become an ally positively benefited the culture of his work group and demonstrated the impact one ally can make.

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Jenifer Locke (she/her; the research advisor) is an assistant professor in the Department of Materials Science and Engineering and the Fontana Corrosion Center at The Ohio State University (OSU). As a TMS member, she is the *JOM* advisor and an officer in the Diversity, Equity, and Inclusion Committee.

Jackson Pope (the male engineering student ally) is a graduate student in mechanical engineering at the University of Colorado Boulder and received his bachelor's degree in materials science and engineering at OSU in December 2016.

Lisa M. Abrams (the professor) is the associate chair and Professor of Practice in Engineering Education at OSU.

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TMS meeting headlines

TMS is committed to your safety during the pandemic. Meeting dates and locations are current as of July 26, 2021. For the most recent updates on TMS-sponsored events, visit www.tms.org/Meetings.

Other Meetings of Note

Congress on Safety in Engineering and Industry 2021 (Safety Congress 2021)
November 1–3, 2021
Fort Worth, Texas, USA

Materials in Nuclear Energy Systems (MiNES 2021)
November 8–12, 2021
Pittsburgh, Pennsylvania, USA

TMS Materials Innovation Briefing: Focus on Pittsburgh
November 10, 2021
Cranberry Township, Pennsylvania, USA

World Congress on Artificial Intelligence in Materials and Manufacturing (AIM 2022)
April 3–6, 2022
Pittsburgh, Pennsylvania, USA

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

Additive Manufacturing Benchmarks (AM-Bench 2022)
August 15–18, 2022
Bethesda, Maryland, USA

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

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- This year, Materials Science & Technology (MS&T) is offering two registration options: **MS&T21 Full-Conference Registration**, for those who wish to participate in the onsite meeting; and **MS&T21 + On Demand**, for those who are unable to travel but still wish to present their work and view other presentations. Both options include access to on-demand presentations. There's still time, so register today!
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- Visit the ICME 2021 website to learn more about the technical program and plenary speakers, and to register today before rates increase.

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- The 2nd World Congress on High Entropy Alloys (HEA 2021) will feature highly focused technical talks on topics that include, but are not limited to, fundamental theory of alloy design, computational modeling and simulation, properties, processing, and applications of high entropy alloys.
- The plenary speakers are *Amy Clarke*, Colorado School of Mines, USA; *Maryam Ghazisaeidi*, The Ohio State University, USA; and *Elsa Olivetti*, Massachusetts Institute of Technology, USA.

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call for papers

***JOM* is seeking contributions on the following topics for 2022. For the full Editorial Calendar, along with author instructions, visit www.tms.org/EditorialCalendar.**

March 2022
Manuscript Deadline: October 1, 2021

Topic: Additive Manufacturing with Light Alloys

Scope: Additive manufacturing (AM) with light alloys, especially Al-based alloys, is both desirable and challenging. This is a rapidly growing research field with a clear impact on future manufacturing. Papers are invited on the development and adaptation of AM Al-based alloys, development of an AM process for mitigating technological issues such as hot and cold cracking, porosity, grain growth texture and compositional segregation, post-processing of AM parts, and advanced characterization and testing of AM parts.
Editor: Dmitry Eskin
Sponsor: Aluminum Committee

Topic: Decarbonization of Pyrometallurgical Processes

Scope: Pyrometallurgical processes require energy to heat the feed material up to the temperature required for reactions and phase separation to occur. Additionally, pyrometallurgical processes can also require reductants for the desired reactions to proceed. This energy and reductant can be derived from a variety of sources, with hydrocarbons commonly used. This topic focuses on techniques and technology to prevent or significantly reduce CO_2 emissions.
Editors: Stuart Nicol and Akbar Rhamdhani
Sponsor: Pyrometallurgy Committee

Topic: Environmental Degradation of Additively Manufactured Alloys

Scope: Given the significantly different microstructures of additively produced materials as compared with traditional materials, evaluation of their environmental degradation is essential for the prediction of performance and life in harsh environments. This special topic welcomes papers focused on how additively produced materials degrade in: (i) corrosive environments; (ii) high-temperature, oxidizing environments; (iii) harsh environments while under mechanical stress; and (iv) high-radiation environments.
Editors: Kinga Unocic, Bai Cui, and Wenjun Cai
Sponsor: Corrosion and Environmental Effects Committee

Topic: Low-temperature Technology for Electronic Packaging and Interconnects

Scope: This special topic focuses on low-temperature technology for electronic packaging and interconnects.
Editors: Albert T. Wu and Babak Arfaei
Sponsor: Electronic Packaging and Interconnection Materials Committee

Topic: Powder Metallurgy of Non-Ferrous Metals: Striving Toward Technology Advancement

Scope: Papers are invited exploring all aspects of powder metallurgy of non-ferrous metals. Example topics include: (i) powder processing of light and reactive metals, high entropy alloys, and functionally graded materials and composites; (ii) advances in powder consolidation processes, e.g., spark plasma and microwave sintering, powder forging and extrusion, and cold spray forming; (iii) novel process development, and robustness; and (iv) modelling and simulation.
Editors: David Yan and Kathy Lu
Sponsor: Powder Materials Committee

Topic: Recovery of Rare Earth and Critical Metals from Unconventional Sources

Scope: This topic invites submissions on science discoveries and emerging technologies that enable sustainable extraction, processing, and separation of rare earths and other co-product metals from unconventional sources, including to mine tailings, acid drainage, coal ash, and oil field brines. Manuscripts that address advances in separations science, metals refining, process intensification, and technology scale-up are a good fit.
Editors: Chukwunwike Iloeje, Joseph Hamuyuni, Fiseha Tesfaye, and Alexandra Anderson
Sponsors: Process Technology and Modeling Committee, Energy Committee, and Recycling and Environmental Technologies Committee

April 2022

Manuscript Deadline: November 1, 2021

Topic: Computational Design of Alloys for Energy Technologies

Scope: This special topic covers design, development, and lifetime modeling of materials for extreme operating conditions in energy technologies. Advanced materials that resist elevated temperatures, corrosive environments, and a range of static and dynamic stresses are needed to improve the efficiency and reduce the environmental impact of energy technologies. Articles will cover the use of computational modeling using techniques including machine learning and experiments to close the design loop and accelerate materials discovery and advanced manufacturing.
Editors: Ram Devanathan, Jeff Hawk, and Laurent Capolungo
Sponsor: ICME Committee

Topic: Computational Modeling of Metallurgical Furnaces

Scope: Computational modeling continues to play an increasingly important role for evaluating and improving metallurgical furnace design and operation. Metallurgical furnaces typically involve complex transport phenomena, multi-phase chemical reactions and phase transformations, which make modeling efforts challenging. This special topic invites original research on high-fidelity simulations of industrial metallurgical furnaces. Papers that address gas, liquid, and solid phase interactions are encouraged.
Editors: Alexandra Anderson, Fiseha Tesfaye, Chukwunwike Iloeje, and Stuart Nicol
Sponsors: Process Technology and Modeling Committee and Pyrometallurgy Committee

Topic: Energy Efficiency and Low Carbon Footprint in Metals Processing

Scope: Metal production technologies are carbon and energy intensive, but it can be argued that the bulk of carbon footprint of metal processes comes from energy sources and reductants. In this case, decarbonizing is closely intertwined with energy consumption of processes. This special topic covers energy efficiency in relation to decarbonization of metal production. Manuscripts should address energy efficiency, carbon capture and reducing the carbon footprint of metals processing, as well as life cycle assessment.
Editors: Joseph Hamuyuni, Fiseha Tesfaye, Chukwunwike Iloeje, and Alexandra Anderson
Sponsors: Energy Committee, Recycling and Environmental Technologies Committee, and Process Technology and Modeling Committee

Topic: Phenomena and Scales Influencing Alloy Solidification Microstructures

Scope: This topic focuses on numerical predictions and experimental observations of the coupling/interaction of processes that occur across varying length and time scales simultaneously during solidification. Examples include microstructure simulations to characterize macroscopic properties such as permeability or experiments such as bulk stirring that influence solidification.
Editor: Andrew Kao
Sponsor: Solidification Committee

May 2022

Manuscript Deadline: December 1, 2021

Topic: Advances in Characterization of Functional Composite Materials

Scope: Papers are invited on the latest developments and applications of functional composite materials with advanced engineering uses, from initial conception to obsolescence. Of particular interest are original papers and reviews focusing on characterization and non-destructive evaluation of metal-matrix composites, ceramic-matrix composites, polymer-matrix composites, and coatings at the nano- and microscales.
Editors: Zhiwei Peng, Rajiv Soman, Yunus Eren Kalay, and Ramasis Goswami
Sponsor: Materials Characterization Committee

Topic: Progress on Recovery of Critical Raw Materials

Scope: For a sustainable economy, many countries have published their Critical Raw Materials (CRM) list. Over time, extensive research and developmental activities have led to the emergence of new methods and engineering processes for the recovery of CRM from mineral ores or tailings, extractive waste and metallurgy slags. Authors are welcome to contribute manuscripts on recovery of CRM from various feeds ranged from ore to metallurgical slag using hydrometallurgical and electrometallurgical extraction processes.
Editors: Hong Peng and Kerstin Forsberg
Sponsors: Hydrometallurgy and Electrometallurgy Committee and Recycling and Environmental Technologies Committee

Topic: Sustainable Composite Materials

Scope: This special topic covers composite materials that are derived from renewable sources and/or can be used in renewable energy-based applications such as wind energy, and solar, among others. Fundamental and applied research in this area is welcome. This call invites scientists from diverse groups such as early career, graduate students, academics, industry, and national labs to submit their research.
Editors: Simona Hunyadi Murph and Surojit Gupta
Sponsors: Composite Materials Committee, and Energy Conversion and Storage Committee

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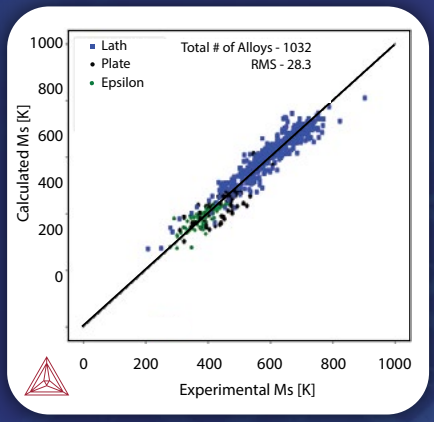
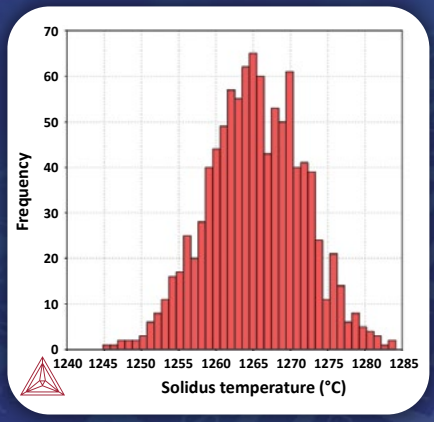


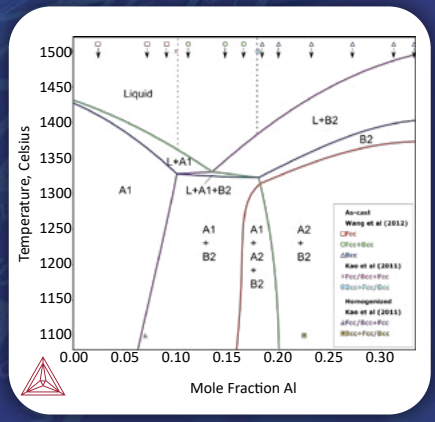
Comparison of calculated and experimental Ms temperatures for a wide range of steels

Nickel



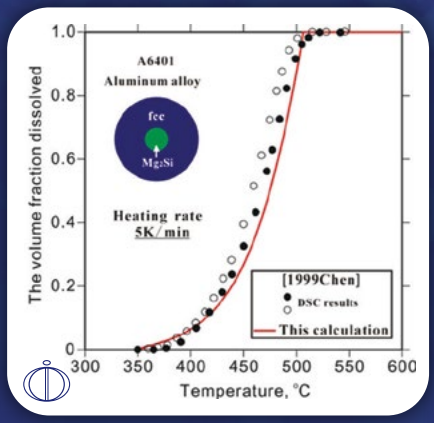
Variation in solidus temperature over 1000 compositions within alloy 718 specification

High Entropy Alloys



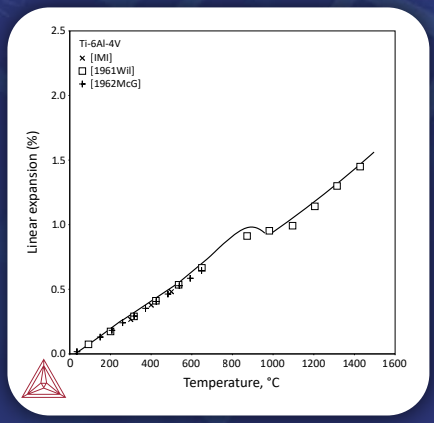
Calculated phase diagram along the composition line of CoCrFeNi-Al

Al Alloys



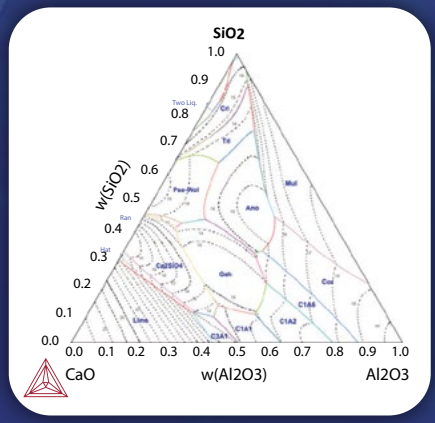
Dissolution of Mg2Si precipitate in Alloy A6401

Ti and TiAl Alloys



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

Oxides



Ternary liquidus projection in oxide systems

www.thermocalc.com

info@thermocalc.com