JOM THE MAGAZINE

JULY 2023
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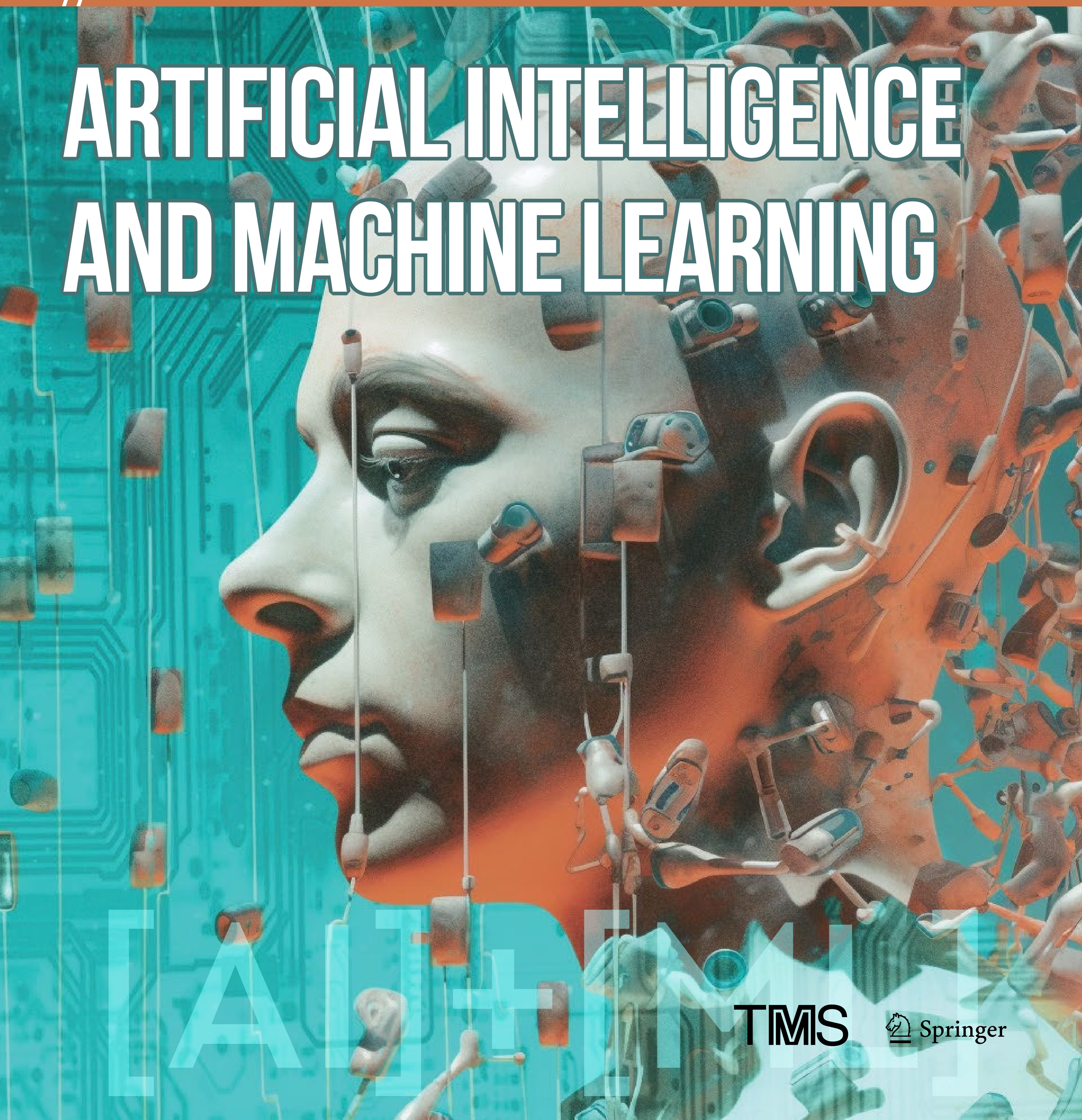
News and insights about TMS, its members, and the professions it serves

ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING



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ABOUT THE COVER

The role of artificial intelligence and machine learning in materials education is the subject of a series of four articles organized by the TMS Education Committee in this month's issue. Fittingly, the cover artwork was developed using an artificial intelligence bot called MidJourney and Adobe Photoshop to depict the interaction between human and machine intelligence. The cover was designed by TMS Head of Visual Communications David Rasel and was inspired by the illustrations of science fiction book covers such as Isaac Asimov's *I Robot*.

Access Technical Journal Articles

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

About *JOM: The Magazine*:

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

About TMS:

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

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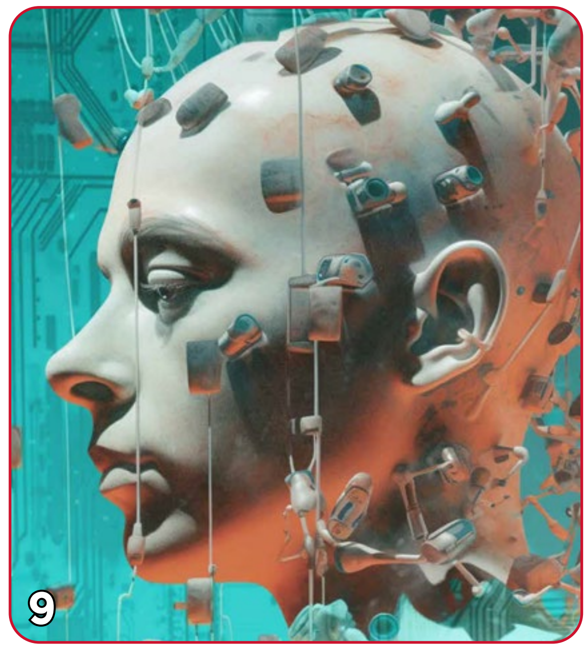

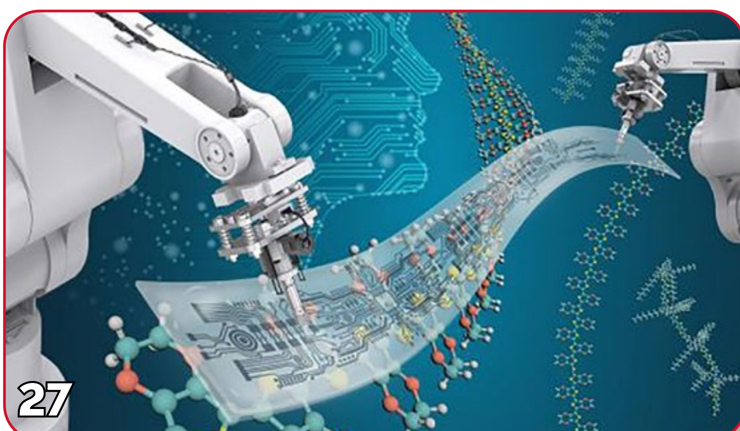

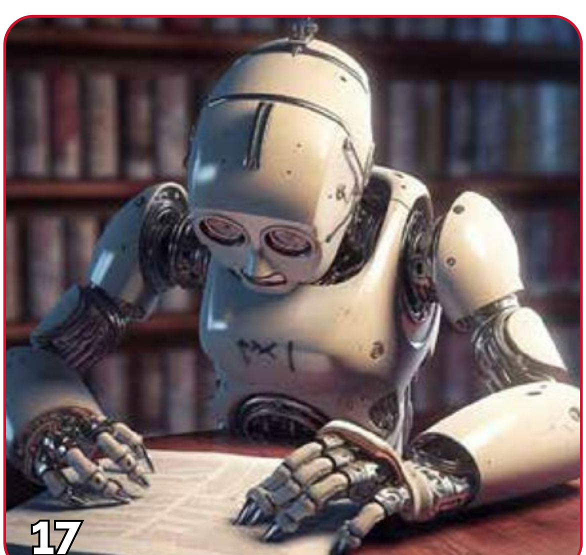

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IN THE FINAL ANALYSIS

JOM
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> *"I've been thinking a lot about Pandora's boxes lately, because we Homo sapiens [sic] are doing something we've never done before: lifting the lids on two giant Pandora's boxes at the same time, without any idea of what could come flying out."*
>
> *—Thomas Friedman*

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James J. Robinson
Executive Director
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For almost three millennia, the notion of opening Pandora's Box has resided within our collective imagination. The idea is simple and relatable: Satisfy your curiosity and inadvertently expose the world to untold dangers. It is a favorite metaphor of editorialists, so it is no surprise that three-time Pulitzer Prize recipient Thomas Friedman gave us two boxes to consider in a recent *The New York Times* column. One box was for artificial intelligence and the other for climate change. Each box gives humankind godlike powers to modify the planet and affect all living things. Friedman's message: We must quickly devise and adopt wise policies to manage these powerful forces lest we aimlessly bumble our way to inevitable ruination.

In a synchronistic way, I found the column meaningful for not only its general timeliness but as both climate change and artificial intelligence are the focus of TMS attention and activities.

Consider climate change. TMS has a long pedigree in sustainability and even publishes the *Journal of Sustainable Metallurgy.* This is not by happenstance as the TMS Bylaws specify that the Society encourages "professionalism, ethical behavior, and concern for the environment." Perhaps belatedly, that encouragement has never directly addressed climate change itself. Not so anymore as the TMS Board of Directors recently adopted the TMS Position Statement on Climate Change. The statement begins, "Climate change is a critical global challenge that poses an existential threat to humanity and the planet," and it concedes that the TMS community "has had a role in legacy extraction, processing, and manufacturing methods that directly and indirectly contributed to historical greenhouse gas emissions." That same profession can nonetheless be part of the solution as the TMS community "continues to pursue more sustainable methods that can be implemented today and in the future." You can read the full statement at the TMS web site. My take: TMS is a community of problem solvers that can and will help ameliorate the impacts of climate change.

One of the ways that the TMS community is solving problems is with a heavy lean toward the development and implementation of artificial intelligence and companionable technologies. Such topics are proliferating through TMS symposia, continuing education, technology accelerator studies, publications, and volunteer opportunities. It is an understatement to say that artificial intelligence is rapidly infusing the TMS community. One example of this quickening: You have likely read that TMS will soon begin housing most of its specialty meetings within an annual midyear event: "TMS Specialty Congress." The meetings within the Specialty Congress will vary from year to year, but one year-over-year constant will be the presence of the TMS World Congress on Artificial Intelligence in Materials and Manufacturing. The propagation of artificial intelligence in every field will be pervasive and rapid, and the TMS Specialty Congress will help us keep pace with these rapid developments.

"One of the ways that the TMS community is solving problems is with a heavy lean toward the development and implementation of artificial intelligence and companionable technologies."

Thomas Friedman conjectures that we may be able to use artificial intelligence to solve the challenge of climate change. An interesting idea and one that I decided to test with an expert. So, I went to ChatGPT and asked, "Can AI solve climate change?"

Here's what it said in its best eighth grader's essay voice: "While AI has the potential to contribute to solutions for climate change, it is not a silver bullet, and its effectiveness depends on how it is developed, deployed, and integrated with other technologies and policies. Ultimately, addressing climate change requires a holistic approach that involves a range of actors, including governments, businesses, civil society organizations, and individuals, working together towards a common goal."

We don't need ChatGPT to tell us that TMS will be among the "range of actors."

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JOM TECHNICAL TOPICS

JOM THE MAGAZINE

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

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

JULY 2023

Biological Translation: Biological Materials Science and Bioinspired Design

Scope: The interconnected fields of biological materials science and bioinspired design offer the potential to better understand and harness lessons learned from nature. Biological materials science employs the tools and techniques of chemistry, physics, and engineering to understand how biological organisms thrive in their natural environments. Bioinspired design employs this information with advanced manufacturing techniques to fabricate advanced materials and structures. This special topic of *JOM* is focused on these two interconnected fields as well as the related fields of biomaterials, biomimetics, and experimental biology.
Editors: **Steven Naleway,** University of Utah; **David Restrepo,** University of Texas at San Antonio; **Kalpana Katti,** North Dakota State University; **Ling Li,** Virginia Tech; and **Dhruv Bhate,** Arizona State University
Sponsor: Biomaterials Committee

Design, Production, and Applications of Steels for a Sustainable Future

Scope: This special topic focuses on the latest advances in designing steel compositions to enable lower carbon emissions or lower energy consumption during production; steel production methods that reduce environmental impacts; and applications of steels to enable lower emissions or energy savings in power generation.
Editors: **Jonah Klemm-Toole,** Colorado School of Mines, and **Kester Clarke,** Colorado School of Mines
Sponsor: Steels Committee

Influence of Processing on Microstructure and Properties of Magnesium Alloys

Scope: Magnesium and its alloys are gaining increasing interest in structural and biomedical applications. The processing route has a pivotal effect on the microstructure and, in turn, the properties and the overall performance of the material during service. Therefore, elucidating the relationship between the processing and the property profile has a great impact on the application of magnesium-based materials.
Editors: **Domonkos Tolnai,** Helmholtz-Zentrum Geesthacht, and **Tracy Berman,** University of Michigan
Sponsor: Magnesium Committee

Instrumentation for Process Modeling and Validation

Scope: Accurate numerical modeling of operational systems requires proper validation, which is typically accomplished by comparing process measurements with calculated results. High-quality process data can be difficult to obtain, especially in systems that operate under hazardous conditions or use legacy equipment where implementation of modern instrumentation can be difficult. This special topic is intended to showcase proven methodologies for instrumenting processes, collecting data and actionably using it to validate and improve process models.
Editors: **Matthew Zappulla,** Los Alamos National Laboratory, and **Alexandra Anderson,** Los Alamos National Laboratory
Sponsor: Process Technology and Modeling Committee

Mesoscale Materials Science: Experiments and Modeling

Scope: This topic focuses on advanced mechanical testing, advanced characterization, enhancements in computational approaches, and integration of experiments and modeling for engineering the evolution of mesoscopic structures.
Editors: **Saurabh Puri,** Vulcan Forms Inc., and **Amit Pandey,** Lockheed Martin Space
Sponsor: Advanced Characterization, Testing, and Simulation Committee

Microstructural Evolution in Powder Processing

Scope: This special topic focuses on characterization of microstructural evolution during powder processing using single or combined methods involving classification, blending, thermal treatment, compaction, etc.
Editor: **Zhiwei Peng,** Central South University
Sponsor: Materials Characterization Committee

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TMS MEMBER NEWS

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Share the Good News!

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

Viola L. Acoff Named Dean at Ole Miss

Following a national search, **Viola L. Acoff** has been named the dean of the University of Mississippi (Ole Miss) School of Engineering beginning July 1, 2023. Acoff is the first female and first African American to serve in this position. Prior to this, Acoff was the associate dean for undergraduate and graduate programs at the University of Alabama. She also previously led the Department of Metallurgical and Materials Engineering at the University of Alabama, in addition to serving as a full professor.

Her areas of expertise are additive manufacturing, welding metallurgy, physical metallurgy, and materials characterization. Acoff has been awarded more than $13 million in research grants, including a National Science Foundation (NSF) CAREER Award. She has over 25 years of experience in increasing the number of STEM degrees awarded to students from underrepresented groups. Since 2015, she has led the Alabama Louis Stokes Alliance for Minority Participation Program, a statewide effort funded by a $5 million grant from the NSF.

A TMS member since 1993, she has served for more than 25 years in various volunteer aspects of TMS, including organizing symposia for technical and functional committees, serving on the Nominating Committee and on the TMS Foundation Board of Trustees, and serving as chair of the ad hoc Public & Governmental Affairs Sub-committee on Racial Justice. She was the inaugural recipient of the TMS Ellen Swallow Richards Diversity Award. Currently, she is the director/chair for Membership Diversity and Development on the TMS Board of Directors.

Valentino Cooper Appointed to DOE Advisory Committee

TMS member **Valentino "Tino" Cooper** was appointed to a three-year term on the Department of Energy's (DOE) Basic Energy Sciences Advisory Committee (BESAC). Cooper is a scientist at the DOE's Oak Ridge National Laboratory and the director of Fast and Cooperative Ion Transport in Polymer Electrolytes (FaCT), a DOE Energy Frontier Research Center. His research informs the fundamental understanding of advanced materials for next-generation energy and information technology. The BESAC issues advice and recommendations on complex scientific, technical, and programmatic issues related to the Basic Energy Science program, which supports scientific research for new energy technologies and advances the DOE's missions.

Cooper has been a TMS member since 2017. He has served on a variety of TMS committees, including the Content Development and Dissemination Committee, the Computational Materials Science and Engineering Committee, and the Public & Governmental Affairs Sub-committee on Racial Justice. In 2013, he received a DOE Early Career award. Cooper also co-authored the article "Bettye Washington Greene: An Industrial Chemist and Inventor Who Lit a Path for Innovation," in *JOM: The Magazine*'s February 2022 issue, as part of the Black History Month special series.

Amit Pandey Honored as Lockheed Martin Technical Fellow

Through the Technical Fellows program, Lockheed Martin honors technical excellence and leadership which drives innovation across the corporation. **Amit Pandey** was named an associate fellow to honor his technical achievements and his dedication to the ideals of the Lockheed Martin Technical Fellow program.

Pandey has been a TMS member since 2007 and has served on several TMS committees, including the Advanced Characterization, Testing, and Simulation Committee; the Thin Films and Interfaces Committee; and the Energy Conversion and Storage Committee. He is a recipient of the 2014 Functional Materials Division (FMD) Young Leaders Professional Development award. Currently, Pandey is the chair of the TMS Industrial Advisory Committee.

Edward Herderick Joins NSL Analytical

TMS Member **Edward Herderick** has been named Vice President of Science and Technology Development at NSL Analytical Services, a materials and analytical testing company, where he will focus on expanding NSL's testing capabilities. He will also join the Executive Resource Group of May River Capital to assist May River's portfolio companies (including NSL) with opportunities and initiatives in material science and additive manufacturing.

Herderick has extensive experience testing and implementing complex manufacturing technology solutions for clients in the aerospace, power generation, transportation, healthcare, and other diversified industrial sectors. He has held leadership roles at The Ohio State University, General Electric, Ohio-based startup rp+m, and the Edison Welding Institute.

A TMS member since 2008, Herderick has served on the TMS Board of Directors, as a TMS Foundation Trustee, and on several technical and functional committees. In 2022, he was named a TMS Brimacombe Medalist for demonstrating sustained excellence and achievement in his field.

Somnath Ghosh and Tony Rollett Co-Direct New NASA STRI

Somnath Ghosh

Tony Rollett

In a partnership between Carnegie Mellon University (CMU) and Johns Hopkins University (JHU), two TMS members will co-direct one of NASA's new Space Technology Research Institutes (STRI). **Somnath Ghosh,** JHU, is the co-primary investigator, and **Tony Rollett,** CMU, is the primary investigator. The main focus of this institute is to ensure that additively manufactured metal parts are capable of withstanding the stress of NASA's ambitious exploration missions. This team will also work to ensure the rapid certification of additively manufactured metal parts.

Ghosh, a TMS member since 2006, is a member of the 2021 class of TMS Fellows, the recipient of the 2017 Structural Materials Division (SMD) Distinguished Scientist/Engineer Award, and the recipient of the 2023 Materials Processing & Manufacturing Division Distinguished Scientist/ Engineer Award. He has served on the Integrated Computational Materials Engineering Committee and the Titanium Committee. He was also a workshop participant for the TMS accelerator study, *Advanced Computation and Data in Materials and Manufacturing: Core Knowledge Gaps and Opportunities*.

Rollett, a TMS member since 1986, is a member of the 2011 class of TMS Fellows and is the recipient of the 2014 Cyril Stanley Smith Award and the 2022 SMD *JOM* Best Paper Award. He has previously served on several TMS committees, including the Shaping and Forming Committee and the Computational Materials Science and Engineering Committee. He also served as an instructor for the TMS online course, Verification, Validation, and Uncertainty Quantification in the Computational Modeling of Materials and Structures.

Gopher Resource Awarded 2023 BCI Innovation Award

Gopher Resource was named the recipient of the 2023 Battery Council International (BCI) Innovation Award for their patent-pending Slag Cleaning and Recovery of Useful Metals (SCRUM) process. This award is presented annually to honor innovation in equipment, processes, services, and products that advance the lead battery industry. Utilizing furnace fuming technology to separate tin and lead into a fume form, the SCRUM process produces a "cleaned" bulk iron sodium-silicate "SCRUM Slag." **Joe Grogan,** Chief Technology Officer at Gopher Resource, was among the team that accepted this award.

Grogan, a TMS member since 2018, is a member of the TMS Industrial Advisory Committee and is currently serving on the Extraction & Processing Division (EPD) Council. Previously, he has served as a member of the Pyrometallurgy Committee.

The Gopher Resource team accepts the 2023 BCI Innovation Award. *Photo Credit: Gopher Resource.*

TMS Members Meet at OTC 2023

Members of the TMS OTC programming subcommittee meet at OTC 2023. Pictured from left to right: **Jeffrey O'Donnell,** Material Energies LLC; **Indranil Roy,** DAMORPHE Inc.; **Greg Kusinski,** Chevron; **Joseph Gomes,** Offshore Operations Committee; and **Steve Louis,** Promethean Decommissioning Company.

The Offshore Technology Conference 2023 (OTC 2023) took place from May 1-4, 2023, in Houston, Texas. OTC 2023 featured executive-level speakers and technical experts on what innovations can be expected over the next 50 years. More than 300 technical presentations, many of which were sponsored by the TMS OTC programming subcommittee, were held and covered topics relevant to materials scientists and engineers. Over 24,000 energy professionals attended and took advantage of all the valuable networking opportunities with industry leaders, exhibitors, and peers.

TMS is one of the 13 nonprofit organizations who work cooperatively to develop the technical program at OTC. At OTC 2023, members of the TMS OTC programming subcommittee met to discuss future events and programming relevant to TMS members in this sphere.

Photo Credit: OTC 2023

Ting Roy, DAMORPHE Inc., was honored as a member of the 2023 class of OTC Emerging Leaders at OTC 2023. The OTC Emerging Leaders are individuals from each of the sponsoring organizations of OTC who make key contributions to the offshore energy sector. Roy is also a member of the TMS OTC programming subcommittee.

Interested in joining the TMS OTC programming subcommittee? Contact TMS Marketing Manager Ashley-Anne Bohnert at abohnert@tms.org for more details.

Honoring 50 Years of TMS Membership

Nineteen TMS members join the Legion of Honor, celebrating 50 years of membership, in 2022. These members first joined TMS in 1972, when it was still a constituent society of the American Institute of Mining, Metallurgical, and Petroleum Engineers (AIME). These members have been active in Society events and activities over the past five decades. We salute their dedication and contributions to TMS and to the fields of minerals, metals, and materials science and engineering. Congratulations to the following members!

John Bradley
Robert Caligiuri
Dhanesh Chandra
Ravindra Chhatre
Oscar Christopherson
C. Eckert
George Eltringham
Ivan Falleiros
John Green
Lindell Hurst
M. Ashraf Imam
Lionel Kimerling
Martin Kopchak
Sydney Leavitt
Thor Pedersen
Alton Romig
Jack Schuh
Jeffery Stember
Raymond Symens

In Memoriam

Walter Gretz, a TMS member since 1957, passed away in April 2023. TMS offers condolences to his family, friends, and colleagues.

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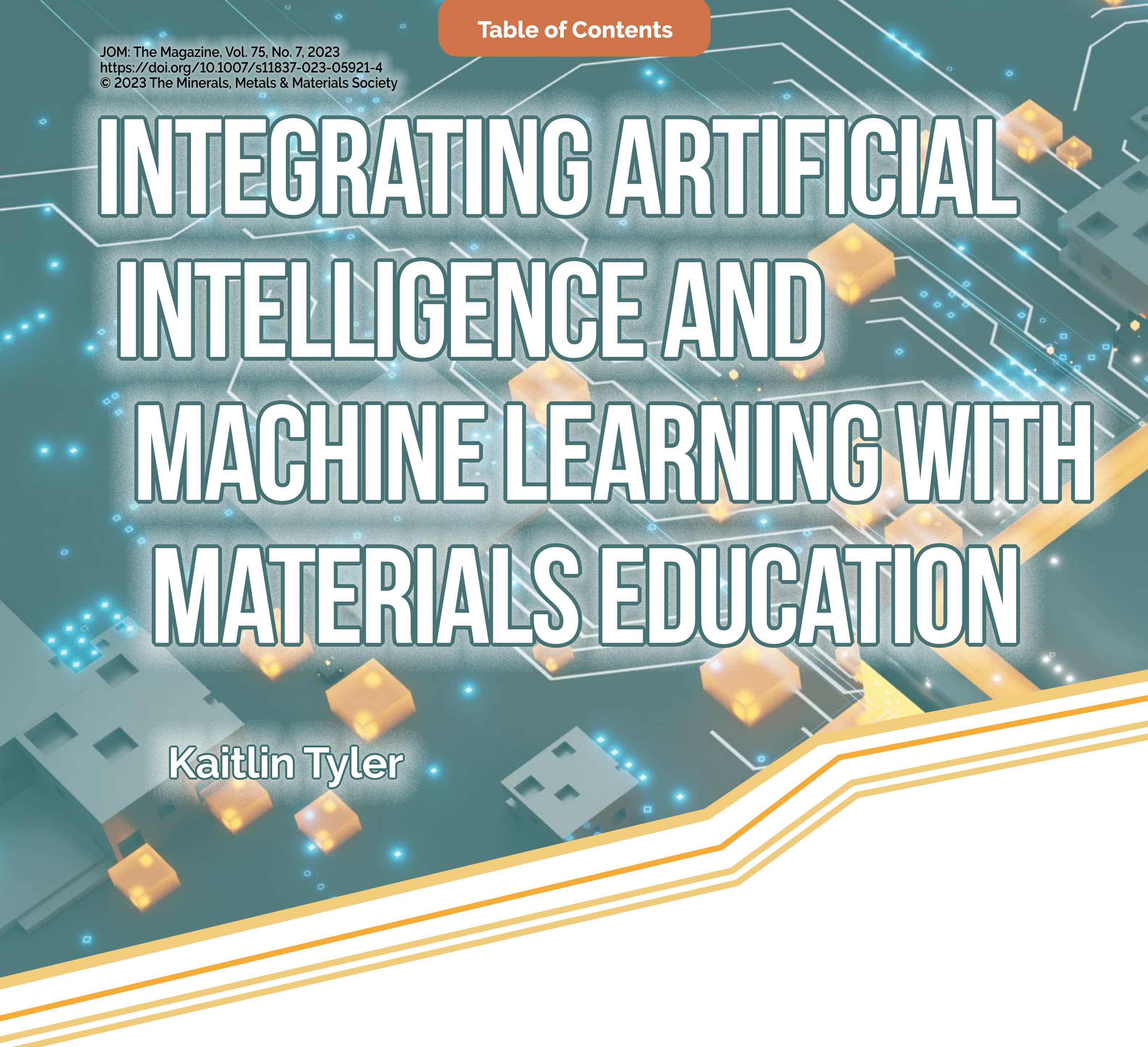
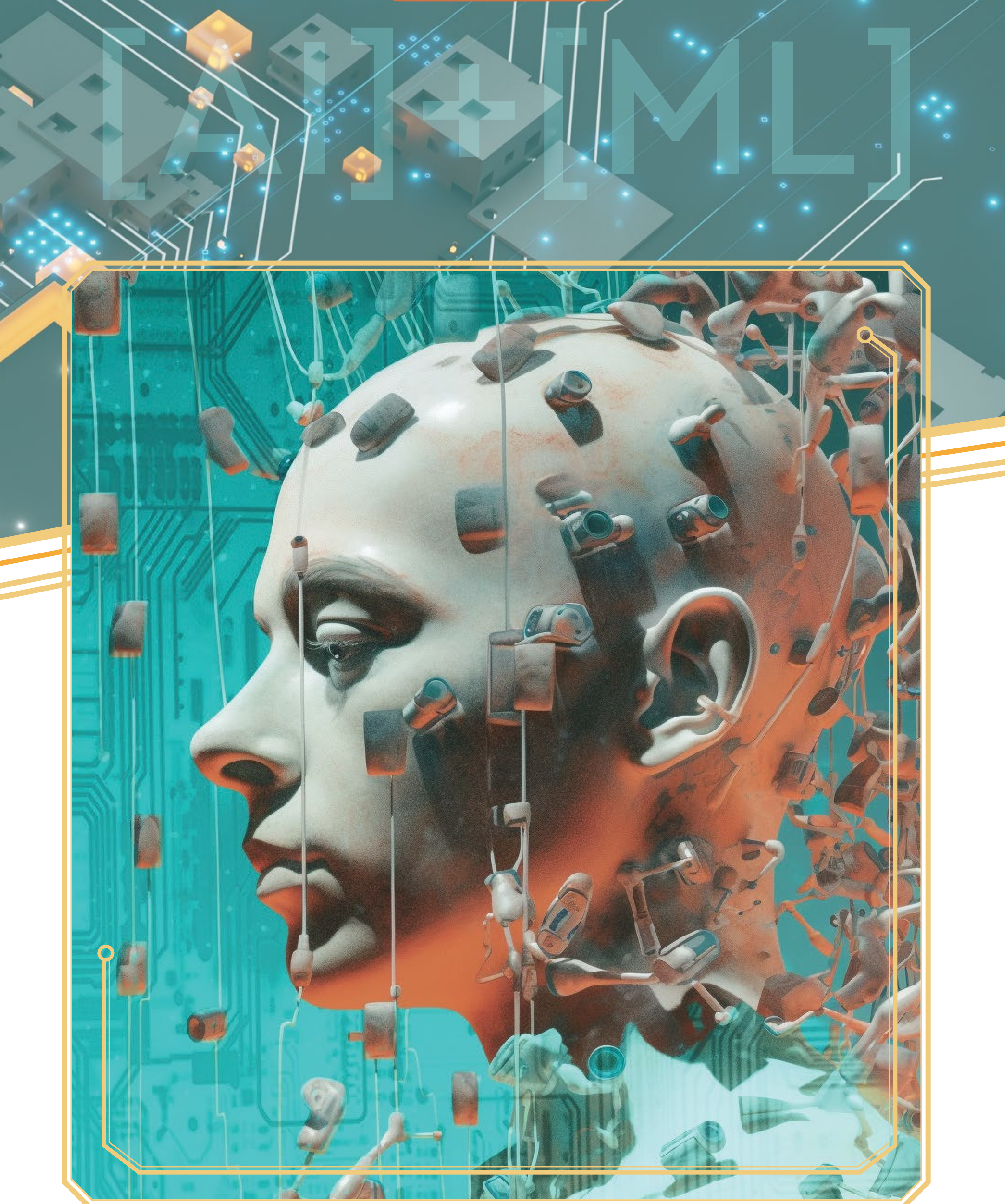


INTEGRATING ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING WITH MATERIALS EDUCATION

Kaitlin Tyler

Artificial Intelligence (AI) and Machine Learning (ML). What may have sounded like terms better suited for a science fiction novel decades ago are now commonplace in industry.


[AI]+[ML]

This is certainly my experience, anyway, as an employee of a large simulation software company. Add in the recent launch of ChatGPT, and you find the buzzwords on everyone's mind. But what does this mean for the materials community?

In particular, what does this mean for our classrooms and the next generation of material scientists and engineers?

New tools like this, I find, lead to more questions when first implemented than answers. How do we assess our students now, when ChatGPT can just write their essays for them? How exactly do I incorporate yet another tool into my already packed curriculum? What is industry expecting students to know about AI and ML when they get to the work force?

To help shed some light on this topic, I wanted to get opinions from members of the materials community using these tools in education. Our first article in this series is an interview with a professor (**Taylor Sparks** from University of Utah), a Ph.D. candidate (**Enze Chen** from University of California Berkeley), and a consultant (**Bryce Meredig**) about the role that AI and machine learning can play in materials and how these tools can be incorporated into the classroom.

The second article goes into the classrooms at University of Michigan, where TMS Education Committee Member **Tim Chambers,** along with his colleagues **Wenhao Sun** and **Katsuyo Thornton,** are teaching computational methods in a variety of ways.

NEW TOOLS LIKE THIS, I FIND, LEAD TO MORE QUESTIONS WHEN FIRST IMPLEMENTED THAN ANSWERS.

Finally, TMS Education Committee Member **Alison Polasik** from Campbell University shares here responses to some questions she tasked her students to ask ChatGPT and how she has pivoted to using this new tool to support her classroom learning goals.

I hope this set of articles illustrates how AI and machine learning can be an asset to the materials community, particularly in the education space. As someone whose job straddles the line between industry and academia, I see both sides. There are so many opportunities that utilizing computational tools like AI can help us advance. Therefore, our students need to not only know about the tools but also how to use them.

THERE ARE SO MANY OPPORTUNITIES THAT UTILIZING COMPUTATIONAL TOOLS LIKE AI CAN HELP US ADVANCE. THEREFORE, OUR STUDENTS NEED TO NOT ONLY KNOW ABOUT THE TOOLS BUT ALSO HOW TO USE THEM.

I understand that AI tools like ChatGPT can be intimidating, especially with their ability to possibly outsmart plagiarism detection software. Something I like to remind myself of when I get bogged down with the negatives of these new technologies is that at one point in time, people were skeptical of digital calculators over slide rules and computer-aided drawing (CAD) programs over traditional paper and pencil drafting. AI and ML are tools, just like our calculators and CAD programs. They will certainly take some time to adjust to, especially when it comes to how we assess our students. But I certainly think, and so do our peers who contributed to this article series, that the positives outweigh the negatives. We simply need to understand the potential, educate both ourselves and our students, and watch the next generation flourish.

Kaitlin Tyler

Kaitlin Tyler is currently an academic content development program manager at Ansys, with an emphasis on materials-related topics. Her role focuses on supporting academics using Ansys software in the classroom through engaging educational resources. She received her Ph.D. at the University of Illinois Urbana-Champaign in 2018. She is currently the *JOM* liaison for the TMS Education Committee and a member of the TMS Diversity, Equity, and Inclusion Committee.

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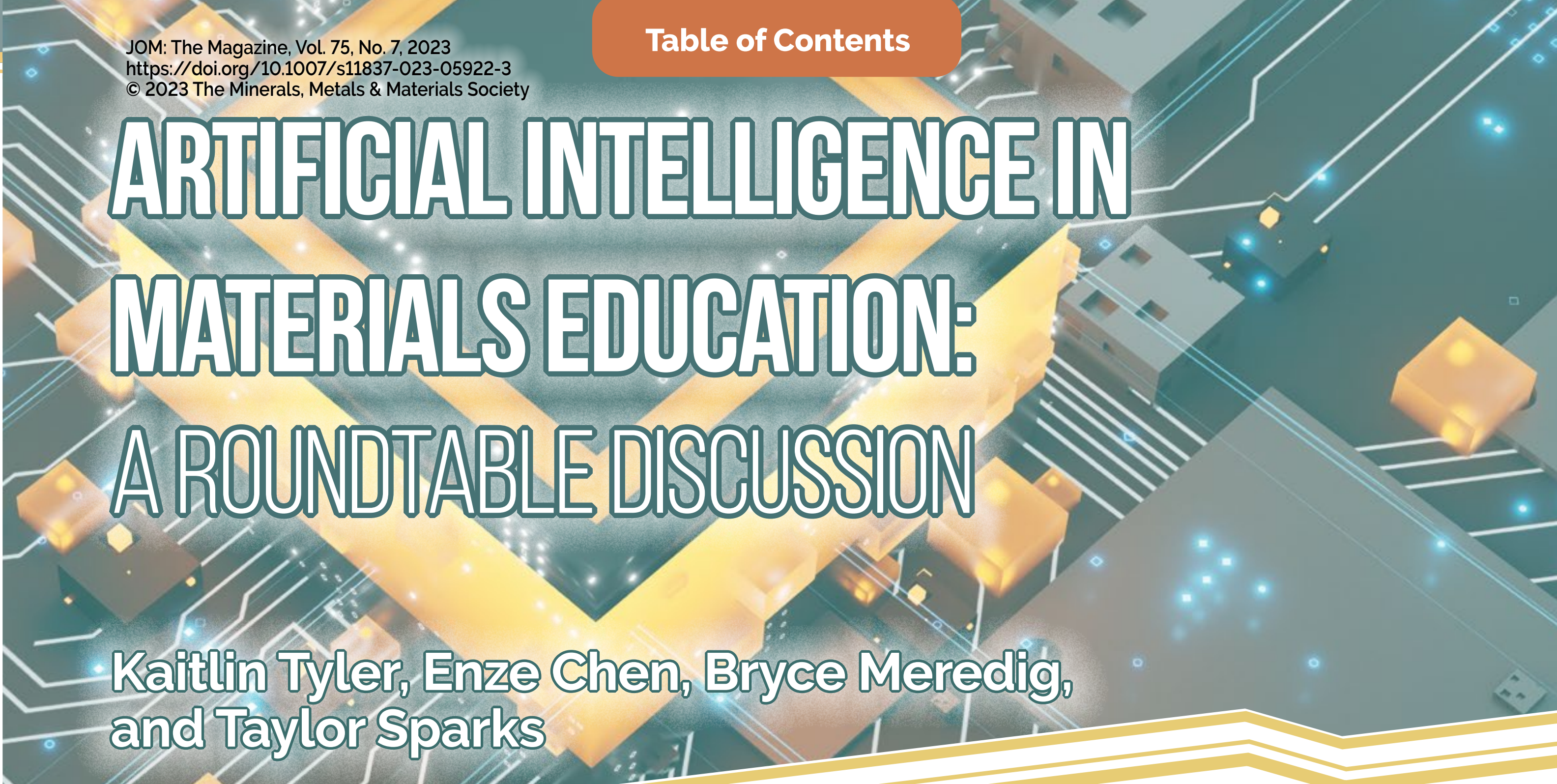

ARTIFICIAL INTELLIGENCE IN MATERIALS EDUCATION: A ROUNDTABLE DISCUSSION

Kaitlin Tyler, Enze Chen, Bryce Meredig, and Taylor Sparks

Editor's Note: In this roundtable conversation, *Kaitlin Tyler*, *JOM* liaison for the TMS Education Committee, poses questions about the role that artificial intelligence (AI) and machine learning can play in materials and how these tools can be incorporated into the classroom. Respondents are *Enze Chen*, a Ph.D. candidate at the University of California, Berkeley; *Bryce Meredig*, independent consultant; and *Taylor Sparks*, associate professor of materials science and engineering at the University of Utah.

Kaitlin Tyler: How do you currently use AI and machine learning in your job?

Bryce Meredig: I help science and engineering organizations use AI, and computation more broadly, to reach their goals more efficiently.

Taylor Sparks: My research group is founded on the use of AI and machine learning as tools to aid in materials discovery. We use these tools to help us narrow the search space for new alloys, compounds, and formulations.

Enze Chen: For my thesis, I use atomistic simulations and machine learning to study planar defects in structural alloys, where I have built machine learning models to predict the antiphase boundary energy in nickel-based superalloys and other interfacial properties in α-titanium alloys. Here, the overarching goal is to use machine learning to capture the complex relationships between structure and properties to accelerate materials design, which is exciting. Additionally, I have adapted these workflows and tools to create a summer internship curriculum for undergraduates from traditionally underrepresented backgrounds in engineering. It has been a joy to work with them in data-driven design of high-κ dielectrics as they learn about how advanced machine learning tools are used to drive materials R&D.

Tyler: In a few words, how would you describe AI and how it relates to materials?

Chen: AI is a clever tool for solving materials challenges.

Meredig: AI is a powerful tool that helps us focus our limited resources where they are most likely to pay off. In materials development, for example, we can use AI to identify the most promising candidates and avoid investing in dead ends.

Sparks: Material science as a discipline is built on this idea of capturing and exploiting relationships between materials processing, properties, and structure. AI allows us to find and exploit much more subtle nuanced relationships or higher order ones where humans really struggle.

Tyler: What value do you see AI providing the materials community?

Sparks: Artificial intelligence and machine learning can drastically reduce the number of experiments necessary before we find materials with desired properties. We can reduce the cost and time to innovation and even deployment. These tools can also help us construct valuable surrogate models for predicting properties that were otherwise really difficult for us to build empirical models for.

FUNDAMENTALLY, I SEE AI AS ANOTHER TOOL—ALBEIT A NOVEL AND POWERFUL ONE—TO ADD TO OUR TOOLBOX FOR DESIGNING NEW MATERIALS.

Chen: Fundamentally, I see AI as another tool—albeit a novel and powerful one—to add to our toolbox for designing new materials. I've seen its value in automating tasks and identifying multidimensional relationships across materials domains, and this mostly stems from the fresh perspectives AI provides from disparate fields of engineering. In a world where knowledge feels increasingly siloed, it's uplifting to see the productive synergy between AI and materials. We should be tactful about its use as it often produces specious results, but I believe advancements in AI will ultimately enable us to excel at what we do best: identifying processing, structure, properties, and performance relationships across scales to design new materials to benefit society.

Tyler: When you talk about AI with other materials scientists and materials educators, what reaction do you get most often?

Meredig: A mixture of excitement and some skepticism. People are always eager to have a new tool that makes their job easier, but they also are cautious of the hype surrounding AI. That's why it's important to be realistic when describing what AI is and is not good for in materials science.

Chen: I would say skepticism, which makes sense. Five years ago, there was skepticism and fear about AI taking over our jobs due to uncertainties around the new technology. Now, people are no less skeptical, but it's about building trust in the results of AI. I'm a big fan of healthy skepticism that kindles further conversation and progress, but it seems that many people who want to learn more about AI are unsure where to start. This is why I am committed to working at the intersection of AI, materials, and education, and to developing domain-specific educational resources to help move the field forward.

Sparks: The reaction from other material scientists has really changed over time. Ten years ago, when I was starting as a new faculty member and proposing the use of materials and informatics as a tool, there was much more skepticism. There were some that did not even consider it as a part of material science. That has really changed. There have been some high-profile success stories, and people are becoming more familiar with the limitations but also the capabilities of machine learning tools as well. Nowadays, people see it as a useful tool, but there is less surprise about what it is capable of doing.

Tyler: What skills related to AI/machine learning does the next generation of engineers need to know?

Chen: I think about this question a lot, and it's hard to answer because AI and machine learning change so quickly. I believe all engineers could benefit from standard proficiency in AI discourse placed in the context of materials. Regardless of one's role, they'll likely interface with people who work with AI/machine learning, and this fluency will facilitate the collaboration/interactions. More importantly, I view the current AI race as a fervid chase for better answers, and it's unclear to me if we're spending enough time asking better questions. As great as the resulting AI tools may be, they're useless if we're answering the wrong questions. I would like to help the next generation of engineers develop the ability to ask meaningful questions to guide the strategic use of AI solutions in materials.

Sparks: For material scientists to really leverage the power of machine learning and materials informatics, it is critical that they improve their coding ability and their fundamental knowledge of statistics. There is no substitute for learning the fundamentals of linear algebra and probability if you're going to be developing new tools. If you're going to be using existing tools, I think that the barrier to entry is dropping every day. It's getting fairly routine.

Meredig: The next generation of materials scientists should definitely learn how to use AI in their day-to-day activities. The nature of every role in our field, not just computational work, will be transformed at least to some extent by AI. Related skills in coding, statistics, and data science will continue to grow in importance in materials science.

INDUSTRY IS DEMANDING THIS SKILL SET FROM OUR STUDENTS. WE NEED TO BE TRAINING THEM SO THAT THEY ARE RESPONSIVE TO THE NEEDS OF FUTURE CAREERS.

Tyler: To those who are nervous about including AI in their classroom, do you have any words of encouragement?

Sparks: Whether we are nervous or not is sort of irrelevant at this point. Industry is demanding this skill set from our students. We need to be training them so that they are responsive to the needs of future careers. For those that are worried that they don't have the right skill set themselves to teach it, I would point out that there have never been more awesome resources for learning these tools. There are great best practices articles, example notebooks, powerful libraries and open source packages, hackathons and workshops, and even YouTube tutorials.

Meredig: I encourage educators to embrace this opportunity and help students channel their excitement for AI toward challenges in materials science. Society is counting on our field for solutions to urgent problems, such as climate change, and AI can help us deliver those solutions faster.

Chen: AI is cool, and so are you! As educators, one of the best ways to serve our students is to help them navigate the volatile world of AI by focusing on the course learning goals and what students need to be successful. Sometimes AI is the answer, but in many cases it's not, and your course will be better off without it. If I choose to include AI, I know that it will not replace the students' creativity, but rather give them more freedom to exercise it. And if AI has already found its way in, don't let it replace you; rather, let it work for you. Use AI-written assignments as teachable moments or exercises in fact-checking to continue cultivating a classroom culture of trust and authenticity.

MEET THE PANELISTS

Enze Chen

Enze Chen is a Ph.D. candidate in Materials Science and Engineering (MSE) at the University of California, Berkeley. As a National Science Foundation Fellow, he works at the intersection of materials, computing, and education, where he pursues parallel research tracks studying planar defects in structural alloys and the integration of computational tools in MSE education. He is passionate about teaching and mentoring and is a recipient of the UC Berkeley Outstanding Graduate Student Instructor Award and MSE Graduate Student Equity and Inclusion Award.

Taylor Sparks

Taylor Sparks is an associate professor of materials science and engineering at the University of Utah and currently a Royal Society Wolfson Visiting Fellow on sabbatical at the University of Liverpool. He holds a B.S. in materials science and engineering from the University of Utah, M.S. in materials from the University of California Santa Barbara, and Ph.D. in applied physics from Harvard University. He was a recipient of the National Science Foundation CAREER Award and a speaker for TEDxSaltLakeCity.

Bryce Meredig

Bryce Meredig is a consultant, researcher, and entrepreneur in the field of materials AI and computation. He co-founded Citrine Informatics in 2013, serving as chief executive officer and later chief science officer, helping to grow the company over nearly a decade into a leading provider of enterprise materials informatics software. Meredig earned his BAS and MBA at Stanford University, and his Ph.D. in materials science and engineering at Northwestern University.

Kaitlin Tyler

Kaitlin Tyler is currently an academic content development program manager at Ansys, with an emphasis on materials-related topics. Her role focuses on supporting academics using Ansys software in the classroom through engaging educational resources. She received her Ph.D. at the University of Illinois Urbana-Champaign in 2018. She is currently the *JOM* liaison for the TMS Education Committee and a member of the TMS Diversity, Equity, and Inclusion Committee.

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TEACHING COMPUTATIONAL METHODS FOR MATERIALS DISCOVERY AND DESIGN

Timothy Chambers, Katsuyo Thornton, and Wenhao Sun

The discovery and application of new materials is core to the advancement of materials science and engineering as a discipline. Computational methods at all length scales, from density-functional theory (DFT) to finite element analysis, are increasingly important to the creation and deployment of novel materials. Recently, there is emerging interest in the role of data science and machine-learning in computational materials discovery and design. Future leaders in materials innovation will need to be proficient with computational methods in addition to physical experiments and professional workplace skills.

Integrated computational materials engineering (ICME) plays a critical role in modern materials science and engineering (MSE), with theoretical advances working alongside novel experimental methods to enable engineering workflows that are more efficient, effective, and sustainable than traditional methods. The 2021 Materials Genome Initiative (MGI) strategic plan places a heavy emphasis on the use of ICME and other integrated techniques as a key strategy for the future of our field [1]. One of the three main goals of the MGI is workforce development.

Workforce development spans K-12 through post-graduate education, both academic and industrial. Accordingly, university courses must prepare students to excel in an integrated physical-and-computational work environment. These courses should engage students in performing meaningful computational tasks to develop skills, and not merely expose students to information. While most students will specialize in either physical or computational work, they must still be able to collaborate effectively with "the other half" on solving complex problems. We argue that the best way to support development of these collaborative skills is to give students hands-on experience with both physical and computational experiments.

The MSE department at the University of Michigan (U-M) has therefore revised existing courses and added new courses to better help students develop fluency with computational methods, and to give them opportunities to engage in ICME-style work so they will be prepared for their future careers. Here, we outline key elements of this curriculum as well as lessons learned from developing and teaching these courses.

Implementation of Computation in U-M MSE Curriculum

At U-M, computational work begins early for all engineering students. Freshmen in the MSE section of Introduction to Engineering conduct simulation projects including finite element modeling of statistics problems and Python coding of an Ising model to investigate ferromagnetic materials. While these introductory experiences are very scripted, our goal at this level is to develop student appreciation of the power of computational methods for understanding material behavior and properties; any proficiency gained with the actual development and implementation of such tools is an ancillary benefit.

All freshmen also take an introductory MATLAB® and/or Python coding class to learn basic programming skills.

In the sophomore year, students taking Physics of Materials use Quantum Espresso on nanoHUB, employing DFT models to calculate the band structures of semiconductors. For most students, this is their first experience as an MSE major modifying, theoretically or experimentally, the structure of a material and examining its consequences within a structure-properties paradigm. Such activities can be very helpful for developing conceptual understanding, and so replacing some lecture time with such work avoids the constraint of limited class time while also leading to deeper understanding. These initial forays into first-principles investigations on known materials are reinforced later in the curriculum when their applications to *new* materials, within the role of computational materials discovery and design, is explored.

AT U-M, COMPUTATIONAL WORK BEGINS EARLY FOR ALL ENGINEERING STUDENTS.

In junior year, students conduct ICME-style work in their year-long junior laboratory sequence in addition to programming thermodynamic and kinetic models in their core MSE courses using MATLAB or Python. In their first semester of the lab sequence, students conduct an alloy design project that integrates physical synthesis of aluminum alloys with computational prediction and analysis of their microstructure using commercial software, Thermo-Calc. They also use commercial software, COMSOL Multiphysics®, for finite element analysis of thermal and mechanical behavior of their novel synthesized alloys. In the second semester of the junior lab sequence, students perform electrochemical simulations of liquid-electrolyte batteries also with COMSOL. The course concludes with a project in which the students integrate simulations and experimental measurements of consumer products to conduct a reverse engineering analysis. The students must design, plan, and execute self-directed physical experiments and computational activities in teams in an intentional and coordinated manner.

In senior year, students gain access to multiple high-level computational courses. Approximately one-half of MSE seniors take a survey course on computational approaches in materials science and engineering. The course is partially flipped; approximately one third of the classes are traditional lectures, while one third of the course requires preparation (videos, readings, and brief quizzes), freeing up class time to solve challenging problems with real-time instructor guidance. The remaining one third is used for the course project and presentations. The in-class activities include deriving the weak form of partial differential equations for finite element methods, learning and applying software tools (such as the open-source PRISMS software), and writing MATLAB code to solve MSE problems. Early in the course, students learn about the finite difference method and write their own codes to solve the diffusion equation, which is then modified to simulate phase transformation during spinodal decomposition, as well as nucleation and growth. The students develop their plans for the course project in teams during the first half of the course. Their achievements are evaluated through the quizzes, homework assignments, in-class work, an exam, a final presentation, and a final report. The students benefit from in-depth discussions on methods that have been covered in their sophomore- and junior-level courses in addition to learning about new methodologies.

We also have a new senior-to-graduate-level elective with a focus on data-driven materials informatics and computational materials science, and their role in the Materials Genome Initiative. Students in the course use Python to access big-data from existing materials databases, conduct simulations, and design and execute a data-driven research project in MSE. State-of-the-art methods in computational materials science (DFT, phase field modeling, computational mechanics, etc.), statistical analysis, supervised and unsupervised machine-learning, and data visualization are taught in computational labs to help students develop proficiency with these methods. One project has students reproduce materials data-science figures from high-impact papers, using free Python packages and the Materials Project API. In addition, students learn about state-of-the-art materials informatics packages such as Pymatgen and Matminer. Open-source PRISMS software is used to teach students how to modify and run open-source codes, and to integrate two different computational methods. The course further explores the MGI paradigm of merging computation, experiment, and characterization by studying examples of MGI efforts in the design of lithium ion batteries and structural alloys. The capstone project has a team of four students write a National Science Foundation/Department of Energy-style proposal, replete with 'preliminary data' produced using the materials informatics methods learned in the course.

Lessons Learned

At the introductory level, our focus has been on improving student attitudes and beliefs, rather than learning of technical content knowledge—the curriculum is intentionally structured to "hook" students first and then really teach the content in subsequent experiences. Many MSE students seem to have anxiety around computational work and coding, and so there is a significant risk of losing students whom we don't get through the activation barrier caused by this anxiety. The lesson learned is: *Start students with an early, easy success that helps them believe computational MSE is worth doing and that they can do it*.

With juniors, with computational work integrated into lab courses, we see a wide disparity in attitudes and abilities between students with and without coding experience and research experience, so it can be quite a challenge to maintain high-quality equitable instruction across such a diverse student population. Fortunately, in a team-based, project-based course, more differentiated instruction is both possible and effective. Our lesson learned for an intermediate course is: *Combine directed "training" projects where all students can learn some fundamentals with more complex, open-ended team projects where advanced students can take a technical leadership role.*

Some trends seem to apply across all levels. Mathematical reasoning in a computational context is challenging, and students can struggle to connect principles from their "pure math" courses to their implementation in computational models, and so reviewing the math situated in context is recommended. Challenging assignments require in-class, real-time guidance for getting started, as many students struggle to take productive first steps on their own but then become more independent. Finally, students generally respond very positively to opportunities for practicing real workplace skills in a class context, such as presenting a business-style project post-mortem in an undergraduate lab or writing a scientific grant proposal as part of a graduate course. MGI-style courses particularly excel here; the integration of physical and computational approaches gives individual students the opportunity to become technical leaders in different areas of a complex project, enhancing their knowledge, skills, and self-confidence to become more prepared for their careers ahead.

Reference

1. Materials Genome Initiative, National Science and Technology Council (USA), 2021. https://www.mgi.gov/sites/default/files/documents/MGI-2021-Strategic-Plan.pdf.

ABOUT THE AUTHORS:

Tim Chambers

Tim Chambers is a lecturer in MSE at the University of Michigan and has served on the TMS Education Committee for three years. He conducts research on STEM education, currently investigating the effects of MSE students' attitudes & beliefs around computational work in engineering.

Katsuyo Thornton

Katsuyo Thornton is the Van Vlack Professor of MSE at the University of Michigan. Her research harnesses high-performance-computing resources to elucidate the complex interplay between thermodynamics, kinetics, mechanics, and electrochemistry of materials and how they influence materials performance. She has served on the TMS Materials Innovations Committee.

Wenhao Sun

Wenhao Sun is the Dow Corning Assistant Professor of MSE at the University of Michigan. His research uses high-throughput density functional theory, applied thermodynamics, and materials informatics to deepen our fundamental understanding of synthesis–structure–property relationships, while exploring new chemical spaces for functional materials.

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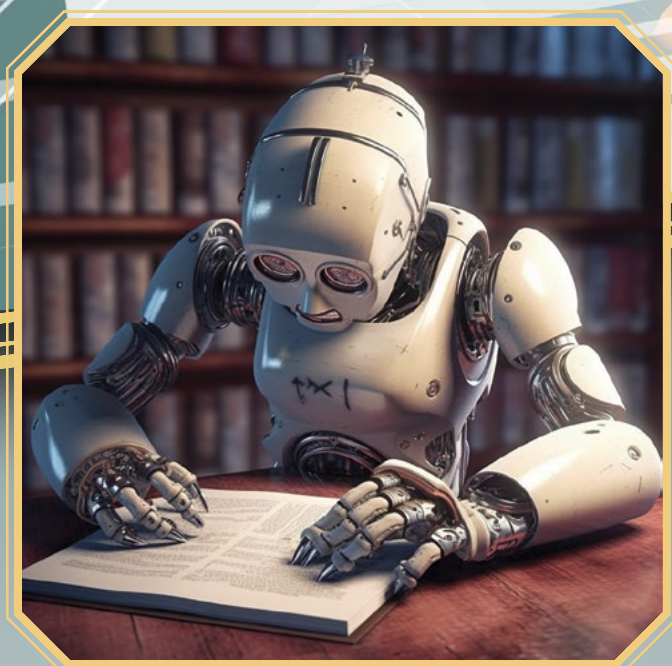
HEY CHATGPT: CAN YOU HELP ME LEARN?

Alison K. Polasik



Like most educators, I felt a spike of alarm when I first saw how easily AI tools like ChatGPT could write a reasonable essay. With less than five minutes of prompting, it was able to write an introduction to how cooling rates affect steel microstructures that I would have difficulty identifying as "fake."

I lean towards optimistic, however, and believe there must be a silver lining. After all, engineering has many examples of catastrophic failures leading to new technologies. Understanding the role of grain boundaries in high temperature creep of metals led to the production of monocrystalline turbine blades. Galvanic corrosion is a catastrophe in the case of partial lead water line replacement, but a benefit in galvanized steel and other cathodic protection mechanisms. I set out to find that silver lining this semester with my students.

Several times during my introductory materials science course, I asked the students to try using ChatGPT to help them in the learning process. I have not figured out how to solve the problems this new technology is creating, but I have identified some promising avenues for how to use AI in undergraduate classes to improve learning.

Hey ChatGPT: Can You Help Me Study?

My students asked ChatGPT to create study resources. It quickly and easily generated a good list of conceptual questions they could ask each other to probe for holes in their understanding. If the first response was too technical, the students could simply ask the program to "explain this topic to me like I am five years old." The groups of students then used this to curate a list of specific questions for me to answer at the end of the class or in an exam review session.

Hey ChatGPT: Do I Make Sense?

Telling students to "proofread their report" is not helpful if they have neither the skills to self-edit nor easy access to someone who can assess whether their main point is coming across. One easy solution is to cut and paste the text into the ChatGPT conversation and ask the AI to explain what the main themes are.

Hey ChatGPT: Can You Write this Program for Me?

Students struggle with programming, and several assignments in my introductory materials science course require students to use MATLAB to plot and analyze data for diffusion, creep, solidification, and tensile tests. Once students completed a flow chart or pseudo-code for their projects, I encouraged them to get help from ChatGPT to create a script in MATLAB. In these tasks, it was clear that ChatGPT could help with *small* tasks only. Asking it to write an entire program will not produce a good result. However, students can carry on a conversation asking for code to do a clearly articulated task such as "How do I add a line with a slope of E that goes through the x axis at x = 0.002?".

I plan to include specific tips on effectively using AI tools to support learning in my fall classes. This will include specific prompts for ChatGPT. My first response to using this tool may have been tinged with existential dread, but I have a lot of hope for using this in the future. What we teach should always be informed at least in part by our students and their future employers. These tools are disruptive now, but they will soon become ubiquitous. If industry is using this as a tool to get things done, then our students should also be taught how to use it correctly and effectively.

Alison K. Polasik

Alison K. Polasik received a B.S.E. degree in Materials Science and Engineering from Arizona State University in 2002, and M.S. and Ph.D. degrees from The Ohio State University in 2005 and 2014, respectively. She is currently an associate professor of engineering at Campbell University in North Carolina. She is very active in TMS, as a member of both the Education and Accreditation committees and as an ABET Program Evaluator.

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A NEW TMS ANNUAL EVENT: Introducing the TMS Specialty Congress

Megan Enright

TMS SPECIALTY CONGRESS 2024


Tim Rupert

"When I think about the benefits of the new TMS Specialty Congress idea, I realize that some of these individual meetings have their own value and bring new ideas to the table, so I see the excitement of the individual participating units," said Tim Rupert, Program Chair on the TMS Board of Directors, introducing a new TMS annual meeting, the TMS Specialty Congress.

The TMS Specialty Congress series will convene the Society's recurring specialty meetings under one roof with a single registration fee that includes all programming and access to multidisciplinary networking opportunities. "What's really exciting is that by co-locating them, you start to see where there's some overlap between these areas and where you can learn things from a related, but slightly different, topical area," said Rupert.

The inaugural TMS Specialty Congress will be held June 16–20, 2024, at the Cleveland Hilton in Cleveland, Ohio, USA. This installment will feature the following three co-located events: The 2nd World Congress on Artificial Intelligence in Materials and Manufacturing (AIM 2024), the Symposium on Digital and Robotic Forming 2024, and Accelerating Discovery for Mechanical Behavior of Materials 2024.

"From an innovative perspective, this type of organization allows some of these medium-sized meetings to be connected and co-located with other groups that are working on innovative new topics that have some relationship, and they can find the synergies and collaborations in this interaction. From a more practical perspective, it allows for economies of scale and for us to really make sure that the event experience is tuned-in and really great," he continued.

The TMS Specialty Congress—like the other two TMS annual events, the TMS Annual Meeting & Exhibition and the TMS Fall Meeting at Materials Science & Technology (MS&T)—will be "built on deep technical content that comes from our members" and "bottom-up science, research, and engineering," Rupert noted.

Read on to hear more about each of these co-located meetings, including comments from the lead organizer of each event.

MEET THE STEERING COMMITTEE

The following individuals are involved in the organizing of the TMS Specialty Congress 2024. These TMS members are experts in their fields and have leveraged their expertise to stringently prepare this event. The Steering Committee includes:

- **Glenn Daehn**, The Ohio State University
- **Frank Delrio**, Sandia National Laboratories
- **Adam Kopper**, Mercury Marine
- **Aeriel D.M. Leonard**, The Ohio State University
- **John Lewandowski**, Case Western Reserve University
- **Robert Maass**, Federal Institute of Materials Research and Testing (BAM)
- **Tim Rupert**, University of California
- **Taylor Sparks**, University of Utah

SUBMIT AN ABSTRACT FOR TMS SPECIALTY CONGRESS 2024

"Who should be attending and participating in the TMS Specialty Congress? I really see it as people who are at the forefront of our field, are pushing in new directions, and are studying very innovative new topics," Rupert said. This new event series will provide opportunities for related communities to find synergies with other areas.

"I hope our members benefit from the best of both worlds—the intimate setting of a specialty conference where they can meet members and really focus on a particular topic with the added benefit of additional content being delivered simultaneously so they can learn more about other fields," said 2023 TMS President Brad Boyce.

The call for abstracts for the TMS Specialty Congress is now open. Share your work to be considered for part of this robust technical program. Abstracts must be submitted by October 30, 2023. Learn more about the specific technical topics and submit your abstract at **www.tms.org/SpecialtyCongress/2024**

THE 2ND WORLD CONGRESS ON ARTIFICIAL INTELLIGENCE IN MATERIALS AND MANUFACTURING (AIM 2024)

Adam Kopper

Following on the success of the first iteration of this meeting held in 2022, "AIM 2024 is focused on integrating artificial intelligence (AI) into materials science research and manufacturing processes," said Rupert. This congress will address key issues and identify future pathways in artificial intelligence implementation in materials science and engineering and related manufacturing processes.

Adam Kopper, technical advisor at Mercury Marine, is the lead organizer for AIM 2024. He became involved in machine learning (ML) after realizing how much data casting processes generate and how the metalcasting industry was not tapping into potential process knowledge. Kopper engages with the greater metalcasting industry through TMS and other industry associations. He said he wanted to be part of the organizing of AIM 2024 because "the top researchers in the world bring their ideas to TMS conferences: applying, improving, and creating leading edge algorithms for materials challenges."

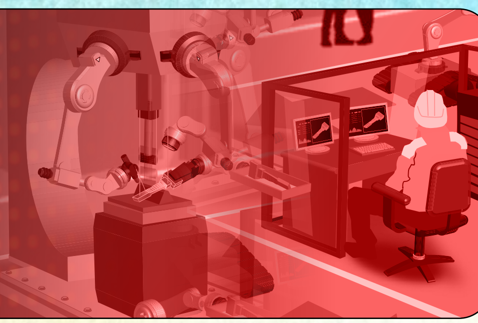
Kopper has several goals and intended takeaways for attendees of AIM 2024. "The field of AI and ML is evolving so quickly . . . I am interested in image processing, so I hope to learn something specifically in that vein. I always have a goal of making new connections with people passionate about what they are doing. . . . I know attendees will see something they were not even looking for and say, 'We can do that! My company, or my research, can benefit from that.'" Specifically, as a TMS member working in industry, Kopper hopes to "offer insights into how manufacturing operations work, what our challenges are, and where researchers could help manufacturers be successful implementing machine learning into their operations."

In addition, Kopper is excited to have AIM 2024 co-located with the other meetings at TMS Specialty Congress 2024. "Attendees interested in more than one of the co-located conferences can save on travel expenses and miss less time in the manufacturing plant, laboratory, or office by taking the one trip. There is [also] great value by co-locating . . . regardless of the focus of the other co-located conferences," he said. "This is because AI and ML can be applied to any data. Many of the tools utilized for materials data analytics were originally developed for a completely different problem. All research generates data; thus, any researcher can benefit from a knowledge of AI."

THE AIM 2024 ORGANIZING COMMITTEE

- **Adam Kopper**, Mercury Marine (Lead Organizer)
- **Remi Dingreville**, Sandia National Laboratories
- **Thilo Muth**, BAM Federal Institute for Materials Research and Testing
- **Elsa Olivetti**, Massachusetts Institute of Technology
- **Adrian Sabau**, Oak Ridge National Laboratory
- **Taylor Sparks**, University of Utah

Symposium on DIGITAL & ROBOTIC FORMING 2024



THE SYMPOSIUM ON DIGITAL AND ROBOTIC FORMING 2024

Glenn Daehn

"The Symposium on Digital and Robotic Forming 2024 is really focused on numerically controlled methods; things like robotics and how they can be applied to forming techniques, processing science, and the way we manufacture and make materials," Rupert said. This brand new TMS meeting will explore this emerging area.

"I hope attendees see how the forging industry, that has not seen too many fundamental changes in the last 50 years, is poised for transformation, with advanced sensors, design methods, and machine learning," said Glenn Daehn, the Mars G. Fontana Professor of Metallurgical Engineering at The Ohio State University and the director of the U.S. National Science Foundation (NSF) HAMMER Engineering Research Center.

Daehn became involved in the areas of digital and robotic forming through the establishment of the HAMMER (Hybrid Autonomous Manufacturing – Moving from Evolution to Revolution) Center. His team came to realize that this emerging area involves a much larger group of stakeholders than just their team. "Deformation processing is the way we make both the largest tonnage of metals and make our highest-performance components. Adding robotics allows us to make this agile," he said. "This Specialty Congress mechanism allows us to bring together the diverse skillsets to make this real—control, robotics, metal forming, standards, applications, and more."

Daehn said he envisions many great crossovers in terms of informal interactions, talks, and keynotes of mutual interest. "This is an area of particular need in the United States," he said. "Our supply chain for large metal parts, such as in aircraft and tooling, is challenged. This [congress] brings together stakeholders with new technology to address these issues."

THE SYMPOSIUM ON DIGITAL AND ROBOTIC FORMING 2024 ORGANIZING COMMITTEE

- **Glenn Daehn**, The Ohio State University (Lead Organizer)
- **Jian Cao**, Northwestern University
- **Kester Clarke**, Colorado School of Mines
- **Babak Raeisnea**, Machina Labs
- **Iain Todd**, University of Sheffield
- **Sarah Wolff**, The Ohio State University

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ACCELERATING DISCOVERY FOR MECHANICAL BEHAVIOR OF MATERIALS 2024

ACCELERATING DISCOVERY FOR MECHANICAL BEHAVIOR OF MATERIALS 2024

Aeriel D.M. Leonard

Accelerating Discovery for Mechanical Behavior of Materials 2024 will tie "together what's happening inside the material and how that affects the mechanical performance of a wide range of material classes," Rupert stated. Another brand new TMS meeting, this conference will encompass cutting-edge research and development efforts surrounding mechanical behavior over a wide range of material types, with an emphasis on the underlying microstructural causes.

Aeriel D.M. Leonard, assistant professor at The Ohio State University, became involved in this area in high school. As a serious science fair competitor, she did a project that included linking grain size to tensile behavior in aluminum alloys. Leonard is passionate about this area because it is necessary for designing and developing materials with superior performance and challenges the community to think beyond conventional methods. "I think an exciting area is understanding mechanical behavior in microstructurally and compositionally complex alloys. Mainly because the mechanisms are multi-scale and require techniques from TEM all the way to high energy diffraction microscopy as well as computational tools," she said.

"I think our meeting will highlight the different techniques and methodologies that research groups are developing to understand these complex mechanisms," she said. "I think it is a unique platform that will promote deep discussions and collaborations across industry, government, and academia." Leonard's main goal with this meeting is to "help attendees build collaborations with others that have similar interests. I hope the meeting will inspire people to think about future material-based challenges such as sustainability."

According to Leonard, the greatest value of co-locating this meeting with the TMS Specialty Congress 2024 is that "it will attract attendees from various organizations, institutions, and national laboratories. I think this is important for early career scientists who are trying to build relationships and connections outside of their local network . . . We have the opportunity to invite speakers that are doing very unique things to advance the field. I think it is important that we facilitate deeper discussions that are harder to do at the annual meeting."

THE ACCELERATING DISCOVERY FOR MECHANICAL BEHAVIOR OF MATERIALS 2024 ORGANIZING COMMITTEE

- **Aeriel D.M. Leonard**, The Ohio State University (Lead Organizer)
- **Brad Boyce**, Sandia National Laboratories
- **Frank Delrio**, Sandia National Laboratories
- **Daniel Gianola**, University of California, Santa Barbara
- **John Lewandowski**, Case Western Reserve University
- **Erica Lilleodden**, Fraunhofer Institute for Microstructure of Materials and Systems
- **Pania Newell**, University of Utah
- **Corinne Packard**, Colorado School of Mines

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TMS Presents the 2024 Board of Directors Nominees

Kelly Zappas

The individuals highlighted in this article have been nominated to fill two open positions on the 2024 TMS Board of Directors. These candidates, if elected by the TMS membership, will be installed at the conclusion of the TMS 2024 Annual Meeting & Exhibition (TMS2024), scheduled for March 3–7, 2024, at the Hyatt Regency Orlando in Orlando, Florida, USA.

Additional nominations for these positions may be submitted for Board consideration by any 25 TMS members by August 15, 2023. Nominations for qualified individuals should be sent to James J. Robinson, TMS Executive Director, at robinson@tms.org, and should include the nominee's name, biography, and written consent to serve if elected.

If additional candidates are proposed, a majority vote of TMS members will determine who fills the position. If no new nominations are received, the individuals named in this article will be automatically elected on August 16, 2023.

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The nominees for the open positions on the 2024–2027 TMS Board of Directors are:

Presidential Cycle
Daniel B. Miracle
Air Force Research Laboratory, USA

Dan Miracle is a senior scientist in the Materials and Manufacturing Directorate of the Air Force Research Laboratory (AFRL). He represents technologies of interest to the U.S. Air Force and U.S. Space Force and leads formation of technical partnerships within the U.S. government and with universities, industry, and the international scientific community. His research has covered nickel-based superalloys and intermetallic compounds; metal matrix composites; advanced aluminum alloys; and boron-modified titanium alloys. His current research explores metallic glasses and high-entropy alloys.

Miracle received a B.S. degree in materials science and engineering from Wright State University, M.S. and Ph.D. degrees in metallurgical engineering from The Ohio State University, and an Honorary Doctor of Science from the Institute of Metal Physics, Ukrainian Academy of Sciences.

He is a TMS Fellow (class of 2018), as well as a fellow of ASM International and AFRL. He is an honorary member of the Indian Institute of Metals and received the Air Force Basic Research Award and the Presidential Rank Award. Miracle is author or co-author of more than 220 peer-reviewed articles and seven book chapters and has co-edited six books. He has given over 200 plenary, keynote, and invited talks.

Over the past 33 years, Miracle has contributed to TMS in many roles. He served on several technical, functional, and ad hoc committees as a member and officer. He has co-organized numerous symposia and conferences, was a *JOM* advisor, chaired a TMS Accelerator Study, and was the lead lecturer for a recent TMS online course. He served as chair of the TMS Structural Materials Division and the Technical Division Council and was a member of the TMS Board of Directors and Executive Committee. He is currently a member of the TMS Foundation Board of Trustees.

Program Director
Robert Maass
Federal Institute of Materials Research and Testing (BAM), Germany

Robert Maass obtained his Ph.D. in materials science from the École Polytechnique Fédérale de Lausanne (EPFL) in Switzerland. He was a postdoctoral researcher at the Swiss Federal Institute of Technology (ETH Zurich), after which he joined the California Institute of Technology as an Alexander von Humboldt Postdoctoral Scholar. After working as a specialist management consultant for metals at McKinsey & Co., he transferred to the University of Göttingen as a junior research group leader. He joined the faculty of the University of Illinois at Urbana-Champaign as an assistant professor of materials science and engineering in 2015, where he still enjoys an adjunct appointment. Since 2020, he is head of the Materials Engineering Department and a member of the directorate at the Federal Institute of Materials Research and Testing (BAM) in Berlin, Germany.

To date, he has published about 100 international peer-reviewed articles in mechanical metallurgy and given more than 60 invited lectures. His honors include the Emmy Noether Award, the U.S. National Science Foundation (NSF) Career Award, the Masing Memorial Medal, and the TMS Young Leaders Professional Development Award, Structural Materials Division.

His research interests revolve around microstructure-property relations, size effects, strain localization and defect structures of amorphous and crystalline metals, defect dynamics, mechanical properties, microplasticity, glass transition phenomena, and test system development.

TMS has been his societal home since 2007. He has been active in various committees, including the Mechanical Behavior of Materials Committee, the Nanomechanical Materials Behavior Committee, and the Emerging Professionals Committee (formerly the Young Professionals Committee). He has organized/co-organized eight symposia at TMS annual meetings, has been a Structural Materials Division representative on the TMS Program Committee since 2019, and is part of the international steering committee for the 2024 TMS Specialty Congress.

2023 TMS Board of Directors

The current members of the TMS Board of Directors, installed at the conclusion of the TMS 2023 Annual Meeting & Exhibition (TMS2023) in March, are:

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In Case You Missed It:

BUSINESS NEWS FROM THE FIELD

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

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

East Hartford, Connecticut, USA: The maintenance, repair, and overhaul (MRO) network for Pratt & Whitney's GTF™ engine announced its second operational facility in Japan and 11th worldwide with the addition of Mitsubishi Heavy Industries Aero Engines Ltd., part of Japanese Aero Engine Corporation. This is part of the overall expansion of their facility and provides more immediate support for customers in the Asia-Pacific region. *(Photo Credit: Pratt & Whitney)*

Alcoa Expands Low-Carbon Alumina Brand

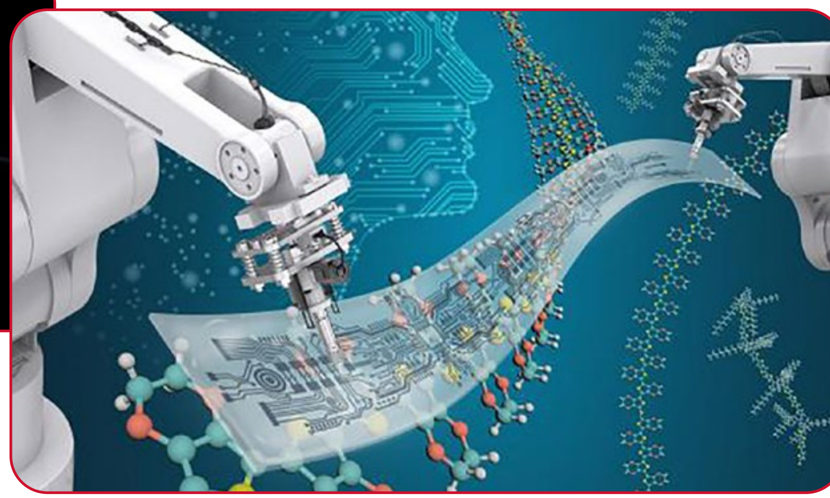
Pittsburgh, Pennsylvania, USA: Alcoa announced the expansion of its EcoSource™ low-carbon alumina brand. Launched in 2020 for smelter-grade applications, EcoSource is now offered in non-metallurgical grades, including hydrates and calcined materials.

Australian and U.S. Researchers Collaborate on Nano-Architectured Materials

Camperdown, Australia: Scientists at the University of Sydney have been awarded a grant from the Australia-U.S. International Multidisciplinary University Research Initiative to join other Australian and U.S. researchers, led by Columbia University, to create responsive materials using nanoparticle self-assembly. These scientists will use nanoparticle self-assembly to establish a new class of materials that can operate as complex devices. One goal is to see how manufactured nanomaterials can mimic the responsiveness of biological systems to external stimuli, including light, heat, and magnetism.

California Nanotechnolgies and Fritsch Form Partnership

Los Angeles, California, USA: California Nanotechnologies Corp. signed a memorandum of understanding with Fritsch Milling & Sizing, Inc. to collaborate on new business development opportunities. The collaborators aim to offer services in material grinding, milling, particle size reduction, mechano-chemistry, and mechanical alloying.



Lemont, Illinois, USA: Researchers at Argonne National Laboratory have established an autonomous discovery laboratory called Polybot. This self-driving laboratory will help speed up discovery time as it automates aspects of electronic polymer research, allowing the scientists to focus on tasks that only humans can accomplish. This tool utilizes the computational power of artificial intelligence and the automation possibilities of robotics. Its main goals are to streamline experimental processes, save resources, and accelerate the rate of discoveries. *(Photo Credit: Argonne National Laboratory)*

Northshore Mining's Iron Range Reopens

Silver Bay, Minnesota, USA: After being shut down for almost a year, Northshore Mining partially reopened their iron ore operation in April 2023. Northshore mines taconite and then ships it to Silver Bay where it is made into marble-sized balls of more than 60% iron. According to Cleveland-Cliffs' (Northshore's parent organization) CEO, Northshore's partial restart is due to higher levels of steel production, and Northshore will be used as needed, serving as a swing operation. Cleveland-Cliffs is the largest iron ore miner in Minnesota and one of the biggest steelmakers in the country.

Seurat Technologies Partners with Siemens Energy on Metal Parts

Wilmington, Massachusetts, USA: Seurat Technologies, a 3D metal printing company, announced an agreement to develop 59 tons of additively manufactured metal components for Siemens Energy turbines. Siemens has also invested in Seurat Technologies through its venture arm, Siemens Energy Ventures, which builds, pilots and invests in startups that are developing innovative energy and decarbonization technologies and business models.

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TMS MEETING HEADLINES

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Meeting dates and locations are current as of April 27, 2023.
For the most recent updates on TMS-sponsored events, visit **www.tms.org/Meetings**.

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

October 1–4, 2023

Columbus, Ohio, USA

Housing Deadline: September 7, 2023

This conference will present robust programming, networking and social activities, and professional development events tailored to TMS members' interests within the broader scope of the MS&T23 technical meeting and exhibition.

www.tms.org/TMSFall2023

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

November 12–15, 2023

Pittsburgh, Pennsylvania, USA

Discount Registration Deadline: September 27, 2023

This cross-disciplinary forum attracts a broad range of international attendees and provides a platform to explore advances in single-phase and multiphase metallic, intermetallic, and ceramic high entropy materials for functional or structural applications.

www.tms.org/HEA2023

TMS 2024 Annual Meeting & Exhibition (TMS2024)

March 3–7, 2024

Orlando, Florida, USA

Book Your Exhibit Space Today

Join your colleagues from nearly 70 nations at the Hyatt Regency Orlando resort for the meeting that the global minerals, metals, and materials community calls home. Visit the website to view more than 90 symposia planned in ten topic tracks, book an exhibit booth, and learn about sponsorship opportunities.

www.tms.org/TMS2024

TMS Specialty Congress 2024

June 16–20, 2024

Cleveland, Ohio, USA

Abstract Submission Deadline: October 30, 2023

This event convenes three specialty meetings under one roof for a single registration fee. This year's events focus on artificial intelligence in materials and manufacturing, digital and robotic forming, and accelerating discovery for mechanical behavior of materials.

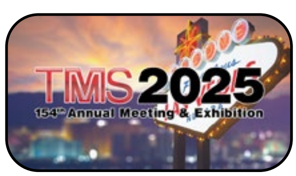
www.tms.org/SpecialtyCongress/2024

Other Meetings of Note

The 15th International Symposium on Superalloys (Superalloys 2024)

September 8–12, 2024
Champion, Pennsylvania, USA

www.tms.org/Superalloys2024



TMS 2025 Annual Meeting & Exhibition (TMS2025)

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

www.tms.org/TMS2025

TMS Specialty Congress 2025

June 15–19, 2025
Anaheim, California, USA

www.tms.org/SpecialtyCongress/2025

Extraction 2025 Meeting & Exhibition (Extraction 2025)

November 16-20, 2025
Phoenix, Arizona, USA

www.extractionmeeting.org/Extraction2025

Energy Materials 2023

October 10-13, 2023
Huzhou, Zhejiang, China

Co-sponsored by TMS

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

October 18-20, 2023
Changsha, China

Co-sponsored by TMS

OTC Brasil 2023

October 24–26, 2023
Rio de Janeiro, Brazil

Co-sponsored by TMS

11th Pacific Rim International Conference on Advanced Materials and Processing

November 19–23, 2023
Jeju, South Korea

Co-sponsored by TMS

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