JOM

AUGUST 2021
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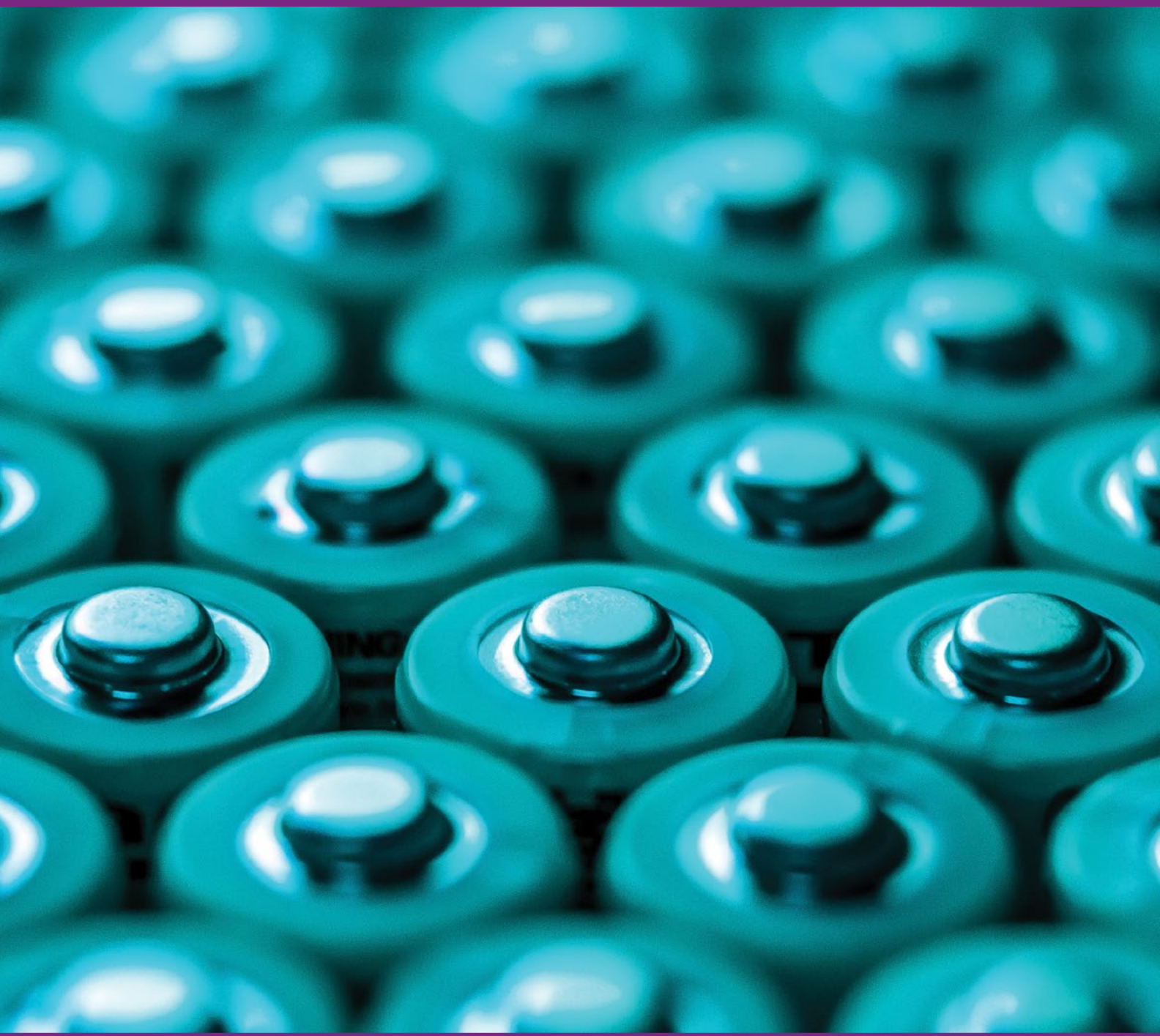
An official publication of The Minerals, Metals & Materials Society

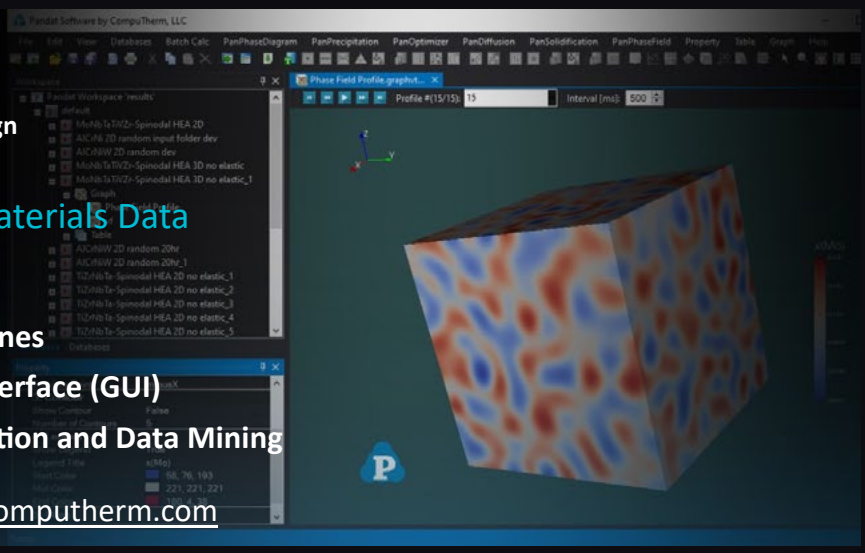


UP NEXT FOR *JOM*: THE JOURNAL: Preview the 2022 Editorial Calendar

TMS Springer

Pandat Software

An Integrated Modeling Platform for Materials Design



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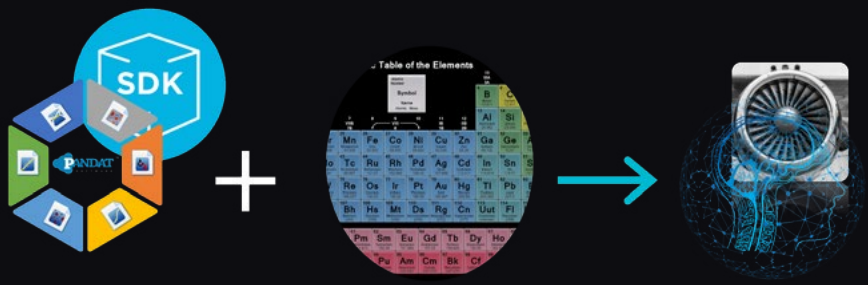

Pandat Software + PanDatabases → ICME & MGI Applications

- 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

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TMS Springer

About the Cover

Lithium-based batteries like the lithium-ion batteries shown on the cover figure prominently in this issue. In particular, see the special topic on Nanomaterials and Composites for Energy Conversion and Storage for articles including "Controlling Morphologies and Tuning the Properties of Co_3O_4 with Enhanced Lithium Storage Properties" by Yanhua Lu et al; "Electrochemical Properties of Mn Doped Nanosphere $LiFePO_4$" by Xiaowu Nie and J. Xiong, and "Facile Synthesis of Boron Doped Reduced Electrochemical Graphene Oxide for Sodium Ion Battery Anode" by Yubai Zhang et al.

August 2021 Guest Editors

Defect and Phase Transformation Pathway Engineering for Desired Microstructures
Phase Transformations Committee
Yufeng Zheng, University of Nevada-Reno
Rongpei Shi, Lawrence Livermore National Laboratory
Rajarshi Banerjee, University of North Texas

Multiscale Experiments and Modeling in Biomaterials and Biological Materials
Biomaterials Committee
Jing Du, Penn State University
Dinesh Katti, North Dakota State University
Hendrik Heinz, University of Colorado Boulder

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

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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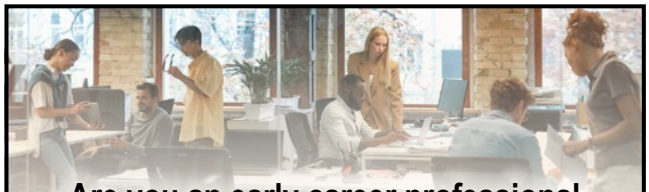

Are you an early career professional age 40 or under looking to become better acquainted with TMS and make important contacts within the Society?

Learn more about the opportunities for professional development with TMS:

- Young Leaders Professional Development Awards, awarded through each of the five TMS technical divisions
  - Extraction & Processing Division
  - Functional Materials Division
  - Light Metals Division
  - Materials Processing & Manufacturing Division
  - Structural Materials Division
- Young Leaders International Scholar – Japan Institute of Metals and Materials (JIM)

Visit the Young Professionals tab at www.tms.org/Awards for more information.

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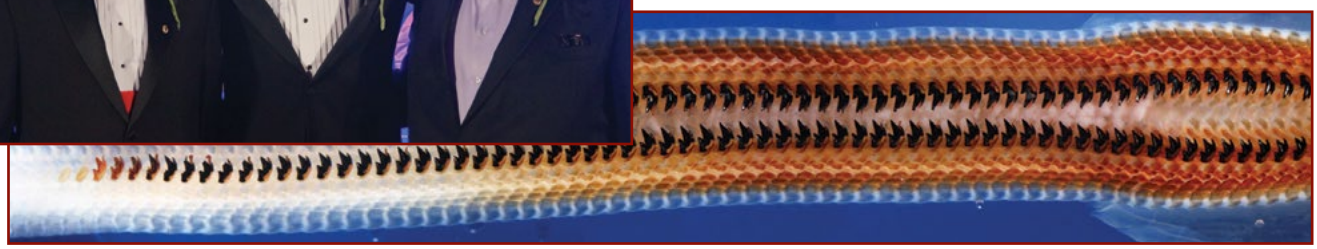
JOM: THE MAGAZINE



JOM: THE JOURNAL

Defect and Phase Transformation Pathway Engineering for Desired Microstructures

Multiscale Experiments and Modeling in Biomaterials and Biological Materials

Nanomaterials and Composites for Energy Conversion and Storage

Technical Articles

Corrections

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WHERE MATERIALS INNOVATIONS HAPPENS

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in the final analysis

"The order I'm about to sign does two things. First, it orders a 100-day review of four vital products: semiconductors—one; key minerals and materials, like rare earths, that are used to make everything from harder steel to airplanes; three, pharmaceuticals and their ingredients; four, advanced batteries, like the ones used in electric vehicles."

—U.S. President Joe Biden on his "Executive Order on America's Supply Chains"

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James J. Robinson
Executive Director
@JJRofTMS

Interesting data point: About 15% of TMS professional members are engaged in the direct support of U.S. government priorities by working for national laboratories, for a branch of the military, for a wide range of agencies, or for another entity. Beyond the work conducted on government premises, there is also the reach and impact of those research dollars issued annually to investigators at universities, industries, and even the occasional professional society. Whether one lives inside or outside of the United States, the scope of the federally funded research enterprise has impact worldwide.

One of the ways that TMS represents its membership is by offering more "material" for informed federal discussion about science and technology. TMS helps inform decision makers by making periodic visits to Washington, D.C., and conversing with legislators, their staff members, and representatives of the President's administration. Historically, we've done this in person. Last year, we didn't do it at all (because of the pandemic and other distractions impacting the capitol city). In Spring 2021, we rebounded and "Zoomed" with two Senators offices, two House of Representatives offices, the House of Representatives Science Committee, and the White House's Office of Science and Technology Policy. Participating from TMS were TMS President Ellen Cerreta, immediate TMS Past President Thomas Battle, Public & Governmental Affairs Director Eric Brown, and the author of this column.

By its nature, TMS is a nonpartisan and apolitical organization. Our visits and positions are never in support of individual politicians or political parties. We stay high level and focus on the importance of science and technology and informed legislation. Bottom line: We think that materials are critical to our economic well-being, quality of life, and standard of living. So, what did we talk about during this year's visits?

- We advocated for an increase of funding for the National Science Foundation (NSF). Both the Senate and the House of Representatives were working on legislation at the time that would do this, and we expressed support for NSF growth to survive within whatever legislation would eventually be adopted.
- We advocated for funding projects to rebuild and modernize our infrastructure. Existing and new materials technologies as well as recycling have roles to play. Again, multiple bills were being discussed. We didn't recommend winners, only that whatever legislation is adopted address hard infrastructure.
- We advocated in support of legislative language that would fill the STEM (science, technology, engineering, and mathematics) pipeline and that these efforts be mindful of supporting the inclusion of underrepresented groups while advancing diversity, equity, and inclusion. We also underscored our support of the need for racial justice.
- We advocated to protect the peer-review process by maintaining a 12-month embargo before the mandatory conversion to open access of federally funded technical papers.

Did our visits have impact? I'm a pragmatist with a lean toward optimist, so I like to think "yes." If nothing else, just making the effort to visit an office creates an opportunity to imprint with officials, especially if you do it *with* forthrightness and grasp of the issues and *without* partisanship and bias. We can't take credit, but it was encouraging to see the Biden administration, a week after our visits, single out three materials sectors for immediate attention in improving the supply chain: Lithium batteries, critical materials and rare earths, and semiconductors. As with the startup of the Materials Genome Initiative a decade ago, it is gratifying to see materials so prominent on the White House agenda. More, please.

"TMS helps inform decision makers by making periodic visits to Washington, D.C., and conversing with legislators, their staff members, and representatives of the President's administration."

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JOM themagazine

In Case You Missed It:

Business News from the Field

Hyperion Expands in Titanium

Charlotte, North Carolina, USA: Hyperion Metals Limited inked an agreement with Blacksand Technology LLC to investigate the commercial development of spherical titanium metal powders using the granulation-sintering-deoxygenation (GSD) technology and an option to enter into an exclusive license agreement for the patents associated with the technology. Hyperion has exclusive rights to the GSD technology that offers major advantages in the production of spherical titanium for use in 3D printing. The Hyperion and Blacksand partnership may develop a sustainable, zero carbon, low-cost, and fully integrated titanium spherical metal powder supply chain in the U.S.

Scientists Plunge New Pacific Depths

Offshore, Japan: Scientists with the International Ocean Discovery Program broke two drilling records in the Pacific Ocean off Japan's northeast coast. Working at an ocean depth of 8,023 meters, the expedition achieved the record for the deepest water site drilled and cored within scientific ocean-drilling history. Additionally, a total of 37.74 meters of sediment core was curated, setting a new scientific drilling depth record for the deepest sub-sea level sample at 8,060.74 meters below sea level. Research of the retrieved core samples may offer new insights into the region's earthquake history and could lead to discoveries of rare earth elements.

Cliffs Opens HBI Plant

Cleveland, Ohio, USA: Steel producer Cleveland-Cliffs Inc. hosted a ribbon-cutting ceremony in June at its state-of-the-art direct reduction plant in Toledo, Ohio, to recognize six months of continued operation and production. The hot-briquetted iron (HBI) plant uses natural gas to create materials for blast furnaces used in the steel production process. The new plant has the capacity to produce 1.9 million metric tons of HBI per year. The plant will not only reduce the company's greenhouse emissions but also boost profitability through enhanced productivity in blast furnaces and the avoidance of prime scrap purchases from third parties. The plant employs nearly 160 employees and cost $1 billion to build.

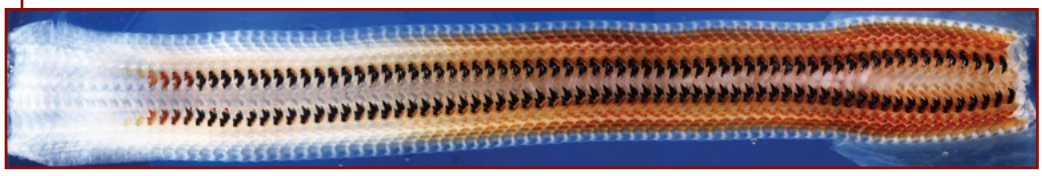
Eck, Imperial Explore Scandium

Manitowoc, Wisconsin, USA: Eck Industries Inc., an aluminum castings producer, and Canada's Imperial Mining Group Ltd. partnered to research scandium as an addition to an aluminum-magnesium alloy that could increase strength and expand applications. Scandium has been used in niche aerospace alloys for the defense sector mainly due to a limited supply. Growing investment in scandium production, such as Rio Tinto's large new scandium oxide plant in Quebec, Canada, has sparked interest in its potential as an alloying agent in advanced lightweight materials for the transportation sector.

Zijin, Citic Metal Buy DRC Copper

Fujian, China: China's Zijin Mining announced one of its subsidiaries and Citic Metal will each buy 50% of the copper output from the first phase of its Kamoa-Kakula mine in Democratic Republic of Congo (DRC). The Zijin unit Gold Mountains (H.K.) International Mining Co. Ltd. and trader Citic Metal, part of state-owned conglomerate Citic Group, will split the initial offtake from what is expected to be the world's highest-grade major copper mine. Canada-based Ivanhoe Mines, Zijin's main partner in the Kamoa Copper joint venture, also announced the deals. First-phase output is projected to be approximately 200,000 tonnes of copper per year.

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.



Evanston, Illinois, USA: The teeth of chiton are helping scientists understand how to develop durable materials. The large rock-chewing mollusk has teeth that contain santabarbaraite, a rare iron mineral previously found only in rocks. Chiton teeth are more than three times harder than human teeth and one of the hardest materials known to nature. Based on the minerals found in chiton teeth, researchers have developed a bio-inspired ink for 3D printing ultrahard materials. (Photo credit: Northwestern University)

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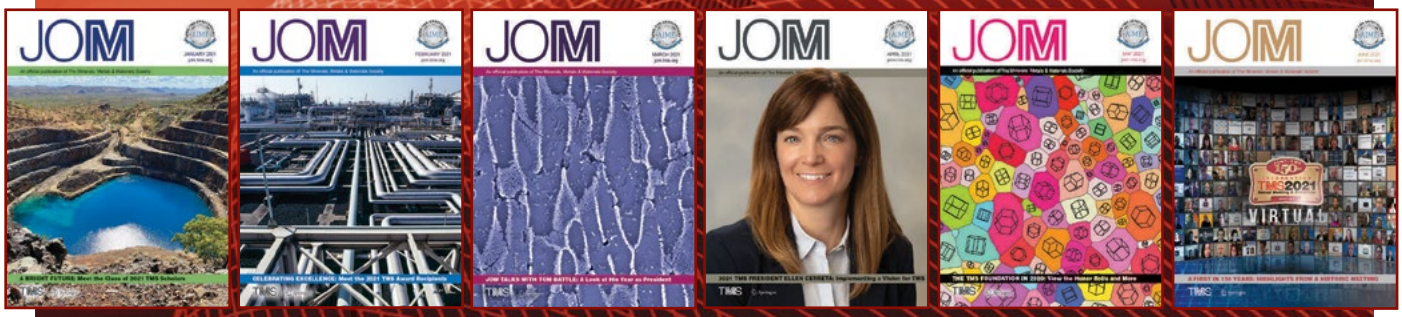
2022 Editorial Calendar: A Vibrant Plan to Satisfy Authors and Readers



Maureen Byko and Justin Scott

Introduction

The 2022 editorial calendar for *JOM*: The Journal is complete, with expansive plans by a diverse group of TMS volunteers.

Forty-five special topics are planned and will be organized by more than 85 volunteers from 15 countries, with each guest editor bringing their unique technical background and perspective to the role. And with the backing of TMS's technical committees, the topics will invite authors from a wide spectrum of minerals, metals, and materials domains to submit their work.

From every angle, it is a promising

Maureen Byko

Justin Scott

JOM Calendar Highlights

Among the special topics on the editorial calendar, each of TMS's five technical divisions are well represented. The following topics are some examples from committees within each division.

Materials Processing & Manufacturing Division

- Exploring the Relationships Between Plastic Deformation and Heat, *Shaping and Forming Committee*
- Phenomena and Scales Influencing Alloy Solidification Microstructures, *Solidification Committee*

Extraction & Processing Division

- Computational Modeling of Metallurgical Furnaces, *Process Technology and Modeling Committee; Pyrometallurgy Committee*
- Progress on Recovery of Critical Raw Materials, *Hydrometallurgy and Electrometallurgy Committee; Recycling and Environmental Technologies Committee*

Light Metals Division

- In-situ Methods for Understanding Deformation & Microstructure Evolution in Mg Alloys, *Magnesium Committee*
- Advances in Continuous Casting of Light Alloys, *Aluminum Committee*

Structural Materials Division

- Materials Interactions with Molten Salt for Nuclear Reactors, *Nuclear Materials Committee; Corrosion and Environmental Effects Committee*
- Cold Dwell Fatigue of Titanium Alloy, *Titanium Committee*

Functional Materials Division

- Artificial Intelligence and Machine Learning in Energy Storage and Conversion Materials, *Energy Conversion and Storage Committee*
- Recent Advances in Multicomponent Alloys and Ceramics, *Alloy Phases Committee*

calendar that builds on the work that continued amid an unprecedented worldwide pandemic. As workplace policies changed to prevent virus spread, *JOM* volunteers persevered to meet deadlines. For 2022, volunteers are re-energized, and the upcoming calendar reflects the resilience of our community. With one of the largest groups of guest editors yet, *JOM* is set to offer authors and readers a vibrant platform for publishing their work.

Enhancing Volunteer Support

In the coming year *JOM* plans to build upon recent improvements to the publishing experience, to offer a welcoming environment for new and returning authors.

First, we look to solidify progress made in time to publication: manuscripts took just 33 days, on average, from submission to first decision in 2020, and 116 days from submission to acceptance. The journal's leadership remains committed to upholding a high standard for manuscript turnaround time.

Also, in pursuit of continued improvement for authors and editors, two associate editors were added to the *JOM* editorial team. Michael Groeber and Victoria Miller were appointed in early 2021, with an overall goal of helping guest editors to develop and publish their topics. Each of these associate editors brings a strong subject matter expertise along with a range of TMS volunteer experiences to the team; see the "Meet the Associate Editors" sidebar for details.

Plan to Publish in *JOM*

A sampling of special topics is shown in the "*JOM* Calendar Highlights" sidebar, but authors interested in publishing in *JOM* should visit the full calendar at www.tms.org/EditorialCalendar to find the best fit for their manuscript. Search by keyword for a topic that fits your expertise and visit the topic's "Details" page for more information including how to submit a manuscript.

Meet the Associate Editors

Michael Groeber

Michael Groeber

"The blend of basic and applied science presented in *JOM* is refreshing and impacts a broad audience, which I find very exciting to be a part of. I look forward to working to continue to grow *JOM*'s impacts in the materials and manufacturing community."

TMS Activity: Member–Additive Manufacturing Committee; Advanced Characterization, Testing, & Simulation Committee; Integrated Computational Materials Engineering Committee; Materials Innovation Committee

Affiliation: The Ohio State University: Associate Professor, Mechanical and Aerospace Engineering

Technical Interests: Additive Manufacturing, 3D Materials Science, Integrated Computational Materials Engineering, Data Analytics

Victoria Miller

Victoria Miller

"I'm really excited to be a part of the *JOM* team because I think the journal plays an important role in the community—spotlighting topics of current interest, working directly with TMS committees, and focusing on emerging areas."

TMS Activity: Light Metals Division (LMD) programming representative; Magnesium Committee member; Member and Student Development Committee, LMD representative

Affiliation: University of Florida: Assistant Professor, Materials Science and Engineering

Technical Interests: Recrystallization, Magnesium Alloys, Recovery

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The COVID-19 Pandemic and Materials Science and Engineering Education

Amber Genau

Amber Genau

"The COVID-19 Pandemic and Materials Science and Engineering Education" serves as an introduction to a thematic group of articles in the August 2021 issue of *JOM* covering how the challenges of the global pandemic have impacted academia. The article package is a feature series developed by the TMS Education Committee. For additional information, contact Kaitlin Calva, *JOM* Magazine Managing Editor, at kcalva@tms.org.

Over the last year and a half, the COVID-19 pandemic has upended our lives in ways most of us never thought possible. As the TMS Education Committee met last fall to discuss topics for our annual *JOM* contribution, a set of articles related to the pandemic seemed the obvious choice. While the pandemic has touched every corner of personal and professional life across all sectors of the economy, education has been one of the areas where those effects were felt most severely, as both students and teachers struggled to adapt to new restrictions and modes of instruction. It's been enough to stretch anyone to the breaking point.

As many universities plan to return to in-person instruction for the 2021–2022 academic year, the following two articles consider the longer-term effects of the pandemic on higher education. The first describes the results of a survey developed and administered by a TMS Education subcommittee, led by Alison Polasik and Kester Clarke, that asked instructors to report on how the pandemic affected their teaching and assessment, what worked well, and what did not. While fully acknowledging the challenges, many survey responses confirmed that learning still happened during the pandemic and even came with some unexpected silver linings. For one thing, many instructors admitted that the trial-by-fire year of COVID-19 forced them to adopt helpful technologies that have been around for a while but that they had never bothered to use before. For me personally, I know I will no longer have to cancel class or find an alternate instructor when I have to travel during the semester. I now have the tools and know-how to hold class via Zoom from wherever I am, or how to easily record and upload a lecture for my students to watch on their own time.

In the second article, Education Committee members Assel Aitkaliyeva, Janelle Wharry, and Simona Murph worked with psychologists to consider the issue of mental health in academia. The article provides some insightful statistics about the concerning levels of stress, anxiety, and depression prevalent in both students and faculty, issues which were only exacerbated by the uncertainty and isolation of a global pandemic. Of course, we have known that students' lives and wellbeing outside the classroom can dramatically affect their academic performance, but the pandemic brought these issues to the forefront in ways that cannot be ignored. It is part of our responsibility as educators and mentors to be informed about how best to support our students' success. The article lists signs to be aware of when instructors return to the classroom that may indicate a student is struggling with mental health issues. It also gives helpful tips for initiating conversations with students about this topic and reminds us not to forget about our own metal wellness in the process!

As you read about how the pandemic has impacted the educational experiences of your colleagues in the minerals, metals, and materials community, I hope that the articles will give you a chance to reflect on how the pandemic has impacted you and your interactions with students, what COVID-inspired changes you will keep moving forward, and ways in which you might be able to create more acceptance of conversations about mental health in the academic community.

Amber Genau is an associate professor of materials science and engineering at the University of Alabama at Birmingham (UAB). She is currently the chair of the TMS Education Committee, vice chair of the Solidification Committee, and Material Advantage faculty advisor at UAB.

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A TMS Education Committee Report: Survey of Changes in Education Due to COVID-19

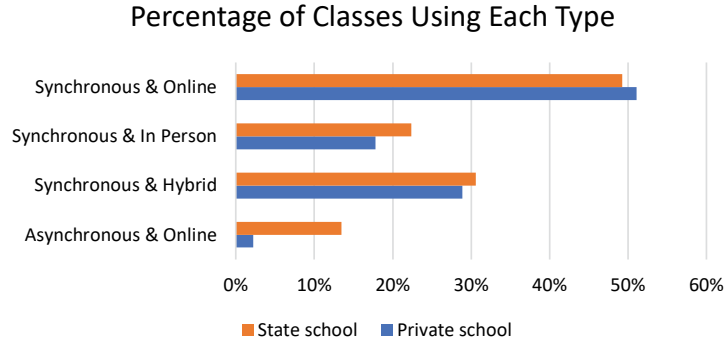
Alison K. Polasik and Kester Clarke

Alison K. Polasik

Kester Clarke

Another academic year finished last spring, and educators nationwide gave a huge sigh of relief. The COVID-19 pandemic has resulted in urgent and profound changes in how courses are taught. Materials science and engineering (MSE) education has some differences from other science and engineering programs that might result in distinct needs. For example, enrollment in MSE is typically lower than in other engineering programs, and many of the textbooks do not have publisher-produced online homework or learning modules (with the notable exception of large introductory MSE courses, which are typically service courses taken by multiple engineering majors). While many of the changes were prompted by requirements at the university and governmental level, the specifics were typically decided by individual instructors. As we move forward into a school year that is likely to be less constrained, individual professors will often determine what tools continue to be used after the pandemic.

In response to the need to understand how the educational landscape has evolved, the TMS Education Committee designated a subcommittee to investigate aspects of teaching in the 2020–2021 academic year from the professors' point of view. The resultant survey contained three sections. Section I asked professors to report on the classes taught and the modality used. Four options were available for each course, and more than one choice could be chosen: synchronous and in person, synchronous and online, synchronous and hybrid, and asynchronous



Course Mode	Private School	State School	Total
Synchronous & In Person	8	30	38
Synchronous & Hybrid	13	41	54
Synchronous & Online	23	66	89
Asynchronous & Online	1	18	19

Figure 1: Course Modality by Institution Type. The number of courses using each delivery mode is shown in the table, broken down by type of institution. The corresponding percentages are shown in the chart. Courses that incorporated more than one delivery mode were fully counted in each noted category.

and online. Section II asked about different tools for online instruction and how the use of them has changed due to the pandemic. Section III asked the professors to comment on their perspective. Sixty-two professors from both state and private schools reported on 189 total courses. The results from Sections I and II are presented in Figures 1 and 2, respectively, and a few interesting outcomes are summarized here:

- *Asynchronous modality was rare but was used much more frequently at state schools*.
- *Of the synchronous modalities, there was little difference between the percentage of courses between private and state schools*. If the data on courses is streamlined into only the four options by double counting any course that had multiple modes, the percentages of the courses were comparable between the two types of institution.
- *Many institutions were still able to conduct courses at least partially in person*. The traditional (synchronous and in person) modality was used fairly evenly by both state and private institutions, and only 28% of courses conducted this way were labs. Thirty-nine percent of the courses that were in-person were in fall semester/quarter, with a slightly larger fraction being held in the winter and spring semesters/quarters.
- *Recorded videos and online exams were the primary "new" tools adopted because of the COVID-19 pandemic*.
- *Major changes were not made to homework assignment distribution or grading*. Few professors began using automatically graded homework through the learning management system (LMS) or homework provided by a publisher.

Section III consisted of open answer opportunities to describe (1) what worked well, (2) what didn't work well, (3) what the student perception was, and (4) how your instruction will change in the future. The results are summarized below.

What Worked Well?

Offering various in-person, hybrid, and/or remote options was a challenge for instructors, but there were many things that worked well and, for the most part, "learning happened." In some cases, student performance improved. Many institutions implemented online tools and in-class equipment for remote access that was not previously available, enabling live video and recordings of class that were often helpful for students. The use of tablets to write electronic notes that can be uploaded after class was perhaps an improvement on the traditional use of a white/blackboard. Institutions supported more undergraduate or graduate assistants for courses that could help with content, interactions, and track online chat during classes. Tools within online platforms allowed for breakout rooms and office hours, and many made more use of the LMS for online content, which also enabled the sharing of foundational content to explain background concepts and support the learning of new concepts. The use of smaller, lower-stakes assignments such as homework, quizzes,

"Offering various in-person, hybrid, and/or remote options was a challenge for instructors, but there were many things that worked well and, for the most part, 'learning happened.'"

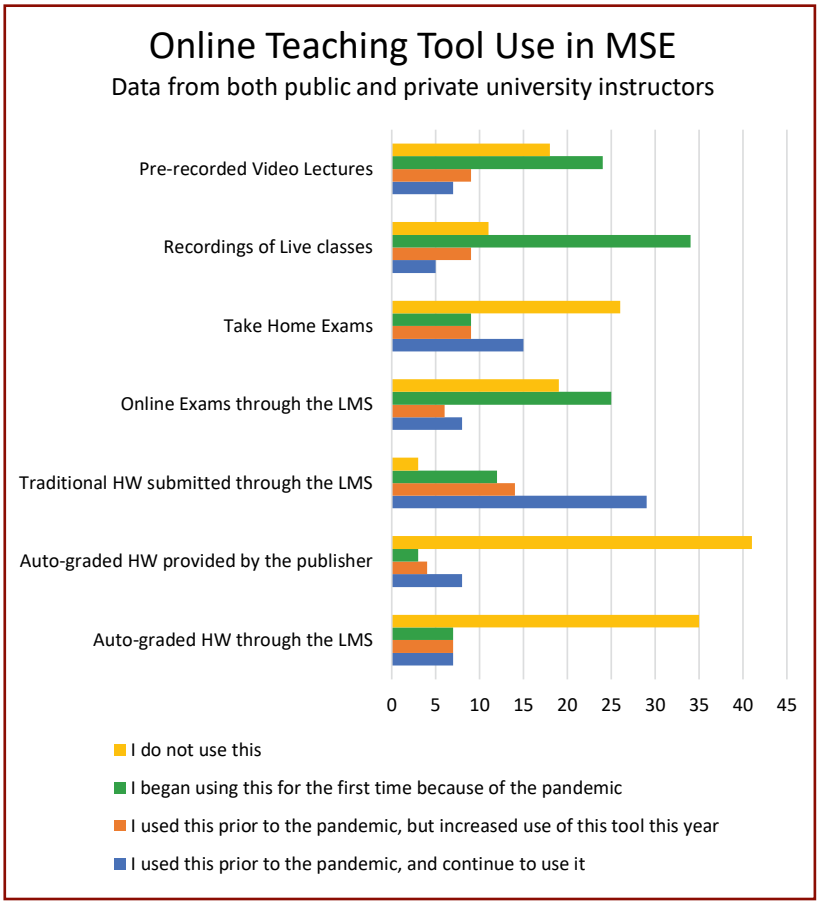


Figure 2: Use of online teaching tools by MSE professors in the 2020–2021 academic years. Data is combined for both state and private institutions.

small group work, projects, readings, and presentations seemed to work better than a more traditional exam-based approach for assessments; when exams were given, take-home and open-book exams increased the available lecture time and lowered students' stress and anxiety. Mastery-based grading was also noted to be successful, and the newly available tools made flipped classrooms easier.

Efforts toward course planning and student feedback were well-rewarded with positive learning outcomes and increased student interactions, and instructors who were understanding and flexible with students and offered pathways for continuous feedback and improvement found students responded positively and were able to identify and support student mental health issues more readily. Shorter, individual lab sessions with preview videos, digital simulations, bring-your-own PPE, and simple at-home experiments somewhat made up for challenges with socially distanced and remote laboratories. Other activities that were positive for student engagement included sprinkling in humor and "quiz the instructor" or "choose your topic" lecture sessions that encourage the students to ask questions and create social connections without grading pressure. There were no concerns about students not following COVID protocols from any of the survey respondents. In some cases, the remote opportunities afforded access to students who would not otherwise be able to take part in the programs or made life easier for commuter students.

What Didn't Work Well?

The most common concerns for teaching in the uncertain COVID climate included lower student engagement, increased stress and anxiety, increased effort from instructors, lower efficiency in teaching content, difficulty in having hands-on labs, challenges in creating effective assessments, and logistical issues with connectivity. For instructors, the perceived lower student engagement provided fewer cues to assess student learning, as remote students typically didn't turn on cameras and were muted. Students seemed to be multitasking during lecture times and were perhaps more easily distracted. Often, students had trouble keeping up with asynchronous content unless there were specific deliverables associated with them, and videoconferencing-fatigue increased as the year went on. This was perhaps most challenging in courses such as senior design.

Student stress and anxiety levels were understandably higher than in previous years, and poor communication made it even more difficult to assess and respond to student mental health. In hybrid courses, the in-person attendance seemed to dwindle despite students indicating a preference for in-person learning. Students also found it difficult to do group/team projects, especially in hybrid courses. Creating course content that worked across modalities required extra effort from instructors, and it was more difficult to teach the content quantity typically taught for in-person courses. Communicating and connecting with students required extra effort from instructors that was not compensated for with reduced workloads elsewhere and could thus be somewhat disheartening and/or overwhelming. Remote laboratories were universally compromised, and in-person or hybrid labs were shortened. Teaching assistants were understandably wary to interact with more than a few students at a time. Assessments of learning were equally challenging, with significant concern regarding the ability to ensure academic honesty for online or take-home assessments. The logistics of keeping online content current, managing in-person and online students in a live classroom, remembering to record lectures, and having backup plans for when internet connectivity or equipment failures inevitably occurred was challenging for all, even those with previous experience in various teaching modalities. Auto captioning of lectures didn't seem to work effectively. Finally, while remote access increased accessibility for some, those with poor internet connections or challenging living situations were likely negatively affected by the inability to attend courses in person.

What Was the Student Perception?

Students seemed to be generally supportive and understanding of the challenges of a relatively sudden switch to remote learning options for courses not specifically designed that way, but of course many students preferred in-person learning. Students appreciated instructors who had clear and transparent deliverables for the course and those that solicited input in course design, both at the beginning and as the course continued. Labs in particular suffered if there was no in-person option. The decreased emphasis on exams for primary assessments and increased focus on shorter, lower-stakes assignments was a positive outcome, as was the ability to review lectures and lecture notes outside class time via recordings and uploads. As with nearly everyone during the COVID year, many students found motivation more difficult, and morale was perceived to be somewhat lower. In some cases, the opportunity to work on group projects afforded students with social opportunities they would not have otherwise had, despite the more challenging logistics of group work. Overall, the remote accessibility for courses and the switch to smaller assignments for assessments was a positive, but the return of in-person learning was preferred over completely online or hybrid course modalities.

How Will Your Instruction Change Going Forward?

Many responses suggested that there was a benefit in the new tools and approaches that were learned during the trial-by-fire year of COVID-19. Some institutions will continue with remote options and others may return to in-person focused curricula, but some of this is still up in the air. However, most instructors suggested that recording of lectures and LMS utilization may have had a steep learning curve but will benefit courses in any modality moving forward. Modifications to assessment types were also useful, with instructors focusing on shorter, more frequent, and lower-stakes assessments. Increased efforts in student engagement, such as having short discussion periods or breakout room group assignments, can be included for in-person courses. Instructors also indicated that frequent feedback solicitation will be incorporated into future courses and might be more open in the future to approaches such as developing a full online course or flipping a classroom. Almost everyone became more familiar with learning management systems, videoconferencing, and in-class recording equipment and will use these to their benefit moving forward.

“Many responses suggested that there was a benefit in the new tools and approaches that were learned during the trial-by-fire year of COVID-19.”

While there were many ups and downs in a very challenging year for all, the end result may produce improved student experiences moving forward, assuming some of the lessons learned are continued in the future. Students and instructors certainly had a testing year, but a combination of extra effort from faculty and understanding and feedback from students resulted in a year where learning outcomes were achieved and impediments to new technologies and approaches were overcome. Here’s to the future!

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Initiating Mental Health Conversations in Academia

Assel Aitkaliyeva, Jaime Jasser-Stone, Amanda Lawson-Ross, Jonathan Ishoy, Janelle Wharry, and Simona E. Hunyadi Murph


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Millions of people are affected by mental health concerns each year. For example, one in five adults experience mental illness each year. Recent studies show that 50% of all lifetime mental illness begins by age 14, and 75% by age 24. Yet, the topic of mental health remains seldom discussed. Although not a taboo, it is usually associated with a negative stigma. Initiating conversations about mental health, burnout, stress, and coping strategies takes courage and strength. Such conversations are perhaps even more difficult for engineers and scientists because they do not conform to the structure and rigidity of our professional lives. Mental health concerns have been documented at all levels of academia—from undergraduate students to graduate students, through senior faculty.

The uncertainty and isolation of the global pandemic has exacerbated feelings of stress, anxiety, and depression. The college years are often transformative, when students transition from adolescence to adulthood, develop autonomy (leave home, organize self-study, etc.), and build competencies. If environments provide appropriate psychological, biological, and social factors, these young adults can transition into adulthood relatively well. Yet, studies suggest that one in three college students suffer from one or more mental health problems.[1] Moreover, similar statistics apply to students leaving universities without a degree.[2] Anxiety and depression amongst graduate students have been on the rise in recent years, and graduate students are three times more likely than the average American to experience mental health disorders and depression.[3] In 2014, nearly half of all University of California, Berkeley graduate students met thresholds for depression.[4] These findings clearly recognize that early onset, duration, and severity of mental health diagnoses negatively impact the trajectory and overall success of college students.

Since the onset of the COVID-19 pandemic, the situation has escalated and students are reporting increasing severity and frequency of mental health concerns, difficulties with concentration, disruption to sleep patterns, increased social isolation, issues with academic performance, disruption to eating patterns, changes in living environment, and financial difficulties. Stressors for remote learners, such as “zoom fatigue” and loneliness, greatly increase the

impact on mental health. Students report feelings of loss and that they are navigating this pandemic alone both emotionally and academically. Jarringly, one in four students reported they seriously considered suicide in the last 30 days.[5]

A recent report from Boston University's School of Public Health indicated that students are increasingly relying on professors for mental health assistance and that faculty are willing to help but they need and want more guidance on how to help.[6,7] To help faculty manage the mental health crisis, in this article we will provide guidance on how faculty can recognize students in distress and a practical guide to initiating a mental health conversation.

Distress in students can be more easily recognized if a professional connection and trusting environment exists between students and their professors. One telling sign of students in distress are changes in their behaviors, such as those described in the REDFLAGS model.[8] Faculty are likely to notice if a student starts missing class or turning in assignments late. Educators should note and inquire about these behavioral changes. Other changes that faculty might observe include changes in dress, hygiene, or class participation. Students may seem less engaged or fatigued. At times, faculty may think that a student doesn't care, isn't invested, or is "lazy." It is important to not make assumptions about students' character based on their academic performance.

When supporting college students, it is important to understand the impact mental health and other environmental factors like COVID-19 have on academic performance. The vast majority of students who are struggling may often feel embarrassed and/or reluctant to ask for help from school counseling services or other academic resources.[9] They may have difficulty verbalizing what is contributing to their struggles, especially during this unprecedented time. Noticing these changes early and empathically bringing it to a student's attention can promote improved academic success and student mental health.[8,10] Additionally, educating TAs about these signs and having them share concerns is another way that faculty can support their students.[10] Faculty are in a unique position to notice behavioral changes and intervene quickly instead of waiting for the student to reach out to them. Students may delay seeking help due to any number of personal reasons or circumstances. Longer intervention times may increase the negative impact on student mental health and make it more difficult for students to recover both mentally and academically.

"Distress in students can be more easily recognized if a professional connection and trusting environment exists between students and their professors."

How can one start the mental health conversation? Faculty may feel concerned that they do not know what to say to a student who is struggling. If they approach the student noting a behavior change and the student acknowledges feeling depressed or that they are struggling, what can we say and do? The most important thing we can do is to first acknowledge that the student is struggling. Avoid giving advice or making judgments. Instead, try reflecting and paraphrasing students' thoughts and feelings, which will help students to feel seen and heard. Try to match the tone, feeling of the words, and students' facial expressions and body language and use introductory phrases such as:

- You feel (insert applicable feeling) depressed, sad, worried, stressed, tired, lonely
- You haven't been getting a lot of sleep lately
- You said you are struggling to keep up in your classes
- You think you might not be able to graduate this semester

Once the student's concerns have been adequately acknowledged, share campus and mental health resources such as counseling centers, academic counseling, and wellness and disability resource centers. Students can also get connected to student organizations, which provide needed social interactions to help combat loneliness and isolation. Additionally, they can receive a higher level of support from

"Providing students with a sense of community and belonging can help them deal with stress and perform better academically."

the National Suicide Prevention Lifeline at 1-800-273-8255. This can help students feel supported and understood. From that place, they are better able to make the best plan to move forward.

In addition to these steps, faculty can take preventative measures at the beginning of the semester to encourage students to practice self-care and maintain a regular schedule. An easy first step is including a list of mental health resources in the syllabus so students have it available should they need help. Another step is reaching out to university support services (e.g., wellness or counseling centers and health promotion organizations within their university system) and having a qualified professional present about mental health in the first weeks of classes. However, talking about it once is not sufficient and faculty should emphasize mental health throughout the semester and model coping skills such as healthy communication skills, stress management, and getting adequate sleep. If faculty members take the time to build student connection within their class, starting with learning names and forming study groups or teams, attending class can become an important support for students who are coping with social isolation. Early intervention is key to addressing these issues. Faculty members can make a world of difference in students' lives by taking these simple steps. Human beings are social individuals. Providing students with a sense of community and belonging can help them deal with stress and perform better academically. The better that we can identify the behavioral changes and symptoms of students in distress, the better we can intervene and get students back on track.

Faculty members, too, can suffer from mental health challenges. With 19.1% of the general population reporting mental health problems, some studies suggest that the percentage is even higher amongst faculty in academia.[11,12] The tenure and promotion system is built on extreme competitiveness and assumes that the faculty members are experienced, resilient, and tough enough to withstand the stresses associated with the job requirement. Yet, faculty mental health is seldom discussed and there is scarcity of data on the prevalence of stress, anxiety, and other mental health-related problems among professors.

As educators care for student mental health, they also should not forget about their own mental wellness. Some suggestions to support faculty mental health include getting enough sleep, eating nutritious meals, practicing good physical hygiene, volunteering (volunteering opportunities can be found at http://www.volunteermatch.org/), connecting with oneself and others, and doing something enjoyable every day. Deep breathing, mindfulness, visualization, repeating a mantra, and meditative exercise (e.g., yoga, tai chi) are all beneficial. The key is finding what works for each individual person. Caring for mental health often takes a backseat to other demands and it takes time and effort to improve; however, the benefits are profound. It is within each person to protect their mental health by staying active, continuing to communicate with friends, family, and community, maintaining a sense of structure in daily life, making time to unwind, engaging in self-care, and taking breaks from the news. Learning to cope with stress in a healthy way is within reach by taking control of our environment: balance work and home life, find a hobby, exercise, bond with a pet, identify goals within your reach, adjust your standards, be kind to yourself and others. Small changes in our daily activities break the mold and pave the way to a happier, healthier, and more productive life.

Our society needs to address mental health on a continuum, similar to how we approach our physical health, by starting with small progressive steps. Acknowledging challenges and adding small changes to one's daily routine can help reduce stress levels. Small steps make a positive difference that can lead to big changes in how we feel and how we live our daily lives.

We hope that this article aids you with starting conversations about mental health and supporting students both in and outside of the classroom. As you return to campus, observe the cognitive and behavioral changes that take place in your buildings and pay attention to signs of distress both in students and faculty. Do not be afraid to initiate conversations about mental health and help us pave the way for creating acceptance of mental health conversations in the minerals, metals, and materials academic community.

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Watch and Learn: Anniversary Keynote Presentations Now Available

Kelly Zappas

In honor of the 150th anniversary of TMS and the American Institute of Mining, Metallurgical, and Petroleum Engineers (AIME), TMS has made a series of recorded talks available from the TMS 2021 Virtual Annual Meeting & Exhibition (TMS2021 Virtual), held March 15–18, 2021. Selected by the TMS technical divisions as Anniversary Keynote Presentations, these noteworthy talks can now be viewed through the TMS website. No log-in is required to view them.

Gain a sneak preview of each talk through this article and view the full presentations at **www.tms.org/AnniversaryKeynotes**.

Extraction & Processing Division

"Materials Innovations Towards Decarbonization of Industrial Processes"

Elsa Olivetti

Presenter: Elsa Olivetti, Massachusetts Institute of Technology

This invited presentation was delivered at Design and Manufacturing Approaches for the Next Generation of Sustainable Materials, the 2021 Student-Led Symposium, which was organized by a team of students from the Colorado School of Mines.

Olivetti discusses work focusing on strategies to mitigate greenhouse gas emissions in materials-related industries and looks at resource use and the complexity of that process.

"Because materials don't exist in isolation—they're part of complex networks—we need to think about the various scales at which we develop these materials in order to understand their environmental impact and to help mitigate that impact," said Olivetti.

This presentation focuses on the significant challenge of reducing the burden of materials production, reviews recent progress in understanding the potential for decarbonization in the materials production sector, and describes where and how the material science community can have significant impact.

"Establishing a Domestic Cobalt Supply Chain: Unlocking Challenging Feedstocks"

Frank Santaguida

Presenter: Frank Santaguida, First Cobalt Corporation

This talk was presented at the plenary session for the 5th International Symposium on Nickel and Cobalt (Nickel-Cobalt 2021), a special event held in conjunction with TMS2021 Virtual.

Cobalt is deemed a critical mineral in the United States and Canada due to its use in power and energy generation and its availability within the global supply chain.

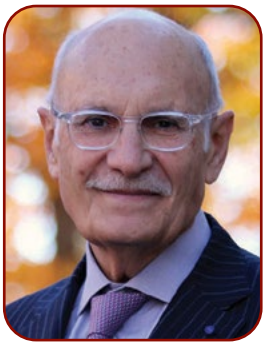
"Cobalt ranks highly along with the rare earth element metals," said Santaguida. "This talk highlights why cobalt ranks so highly and what is being done to address this criticality, specifically the supply risks in North America."

His talk looks at the availability of resources around the world and the challenges this poses to the supply chain. Though he admits that North America is likely about five years away from decreasing its dependance on cobalt imports, his presentation ends on a high note.

"The message I'd like to leave everyone with is positive. Changes are happening to establish a domestic cobalt supply chain that will be needed to sustain the electric vehicle market," he said. While there are some barriers that impede the timeline, he says, "These barriers are not walls."

Functional Materials Division

"Current Perspectives in High-Entropy Alloys"



Diran Apelian

Presenter: Diran Apelian, University of California, Irvine

Co-Authors: Benjamin Macdonald, Cheng Zhang, and Enrique Lavernia, University of Califonia, Irvine

"We shouldn't think of HEAs as a materials class but rather the paradigm by which we can design materials—a new design approach," Apelian says in this keynote presentation from the High Entropy Alloys IX: Alloy Development and Properties symposium at TMS2021 Virtual. In this talk, he discusses how the field of high-entropy alloys (HEAs) has evolved, examines specific systems and mechanistic opportunities, and looks at future directions for HEA research.

Since the first use of the term "high-entropy alloy" in 2004, there has been an explosion in the field, he says. And for good reason. Apelian points out the many structural as well as functional uses. "When you look at a list of the applications, you can see its almost universal application."

Two key research directions include the critical evaluation of the impact of atomic scale compositional fluctuations on alloy properties, and integrated computational materials engineering approach to developing refractory based HEAs with optimal mechanical behavior at elevated temperatures. This presentation seeks to establish the state of the art in both of these areas.

"Designing Electrode Architectures across Length Scales: Some Lessons Learned from Li-ion and 'Beyond Li' Chemistries"

Sarbajit Banerjee

Presenter: Sarbajit Banerjee, Texas A&M University

"We're in the midst of an unprecedented change in paradigm as far as energy is concerned," said Banerjee in this keynote talk from the symposium, Advanced Materials for Energy Conversion and Storage VII. "A big part of this puzzle is going to be energy storage."

Despite a large push for energy storage technologies, he pointed out, we've only had a four-fold improvement in energy density over the last 160 years. So, what are the bottlenecks preventing us from accessing some of the theoretical capacity for materials? Banerjee argues that this is a multiscale challenge, and it requires understanding of the entire range of phenomena.

"The moral of the story is the urgent need to bridge scales starting from understanding atomistic phenomena all the way to mesoscale phenomena and then to electrode-level phenomena," said Banerjee, whose talk discusses efforts to develop an Angstrom-level view of diffusion pathways using a combination of single-crystal X-ray diffraction and density functional theory calculations.

Light Metals Division

"Evolution of Alloy Design, Its Science/Instruments Base, Tech Transfer Routes, and Market Pull, 1921–2021"

Raymond Decker

Presenter: Raymond Decker, University of Michigan

This talk was delivered at TMS2021 Virtual as part of the TMS Light Metals Division symposium, Greater Than the Sum of Its Parts—Concurrent Alloy Design and Processing Science, which was held in honor of Raymond Decker's 90th birthday. In this presentation, Decker, who has been a member of TMS for 70 years, looks back at a century of evolution in alloy design and application, from 1921 to 2021.

Six successful case histories of alloy design and applications are presented, from the Inconel Alloy 600 in 1921 to maraging stainless steel for additive manufacturing at QuesTek in 2021 using integrated computational materials engineering (ICME). Drawing on his extensive experience, Decker offers a closer look at each example and looks at trends that have developed in the field during that time.

After looking at a century of examples, Decker states, "The best in alloy design is yet to come." He closes the talk by offering his own recipe for alloy design and applications.

Light Metals Division

"Near Net Manufacturing of Light Metal Alloys"

Mark Easton

Presenter: Mark Easton, RMIT University

In this talk, which was delivered at the TMS Light Metals Division Awards Ceremony & Special Lecture at TMS2021 Virtual, Easton discussed research that has been a theme throughout his career.

He began by defining near net shape manufacturing as a term given to processes that aim for the initial fabrication of a component to be close in size and shape to the finished product. This approach, he explained, reduces production costs and times associated with finishing steps and is particularly appealing for component manufacturing for high-value materials.

He spoke about challenges to the process and also how some of the themes of this research can travel from one manufacturing technology to the next.

"Near net shape manufacturing is continuing to evolve from more traditional methods such as casting to more modern methods such as additive manufacturing," he said. Many of the challenges, such as microstructure control and defect formation, remain the same, but approaches used in more traditional technologies to dealing with these issues can also be used in additive manufacturing.

Materials Processing & Manufacturing Division

"The High Entropy Alloy Space Is Not as Big as We Think It Is"

Raymundo Arroyave

Presenter: Raymundo Arroyave, Texas A&M University

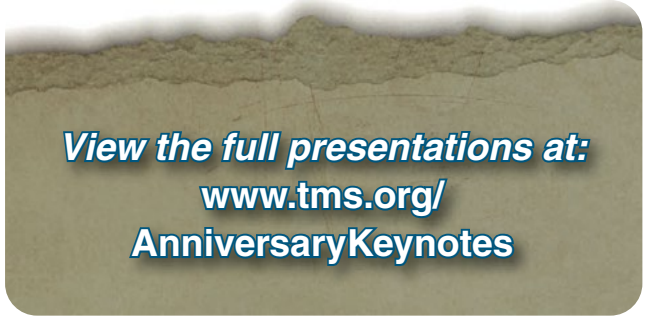
Co-Author: Tanner Kirk, Texas A&M University

How big is the available, feasible alloy space in high-entropy alloys (HEAs)? That is the question this invited talk from the Computational Thermodynamics and Kinetics symposium at TMS2021 Virtual sets out to answer.

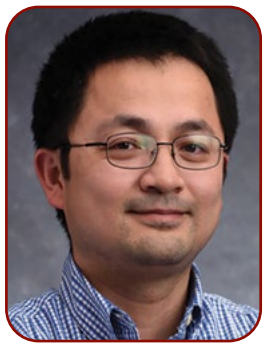
Arroyave presents recent investigations suggesting that, while big, the feasible HEA space in any given sub-sector (e.g., face-centered cubic HEAs, refractory HEAs, etc.) is severely constrained by typical alloy design considerations.

Combining CALPHAD, physics-based models, machine learning, and search/optimization algorithms, Arroyave presents a more nuanced view of the HEA space.

Ultimately, Arroyave concludes, the answer to his initial question is, "Not as large as we thought it would be."



"Applying Additive Manufacturing Itself as a High-throughput Tool to Accelerate Heat Treatment Design of Additively Manufactured Alloys"



Wei Xiong

Presenter: Wei Xiong, University of Pittsburgh

Co-Authors: Yunhao Zhao, Noah Sargent, and Kun Li, University of Pittsburgh

"Additive Manufacturing (AM) has become a very popular processing technique," Xiong says in this invited talk from the symposium, Additive Manufacturing: Solid-State Phase Transformations and Microstructural Evolution. "However, right now, we still have a limited understanding of processing-structure-property relationship in many of the AM processes."

As a result, he says, we have limited choices of new alloys or customized alloys for AM itself. "Therefore, this is a giant push for us to study this."

In thinking about how to accelerate the design of AM, Xiong's group looked at high-throughput computation with machine learning. This presentation looks at their research, which developed a gradient temperature heat treatment on a bar shape Inconel 718 alloy sample prepared by the laser powder bed fusion.

"I hope that with the community developing such strong interest, eventually we can develop more and more robust, high-throughput experiments to serve the purpose of alloy manufacturing design," he concludes.

Structural Materials Division

"Beyond Superalloys: An Efficient Strategy for Assessing Environmental Resistance"

Bruce Pint

Presenter: Bruce Pint, Oak Ridge National Laboratory

As part of the symposium, Materials for High Temperature Applications: Next Generation Superalloys and Beyond, Pint's talk looks at the interest in developing new materials with higher temperature capabilities to improve cycle efficiency and thereby, reduce fuel consumption and greenhouse gas emissions. He begins by discussing oxidation resistance and how not much has changed since 2004.

"Oxidation issues have become more important and harder to ignore," he said. "It's a foolish strategy to think that a practical high-temperature material will be developed without inherent oxidation resistance."

For refractory metals, high entropy alloys, and other candidates, embrittlement also is a concern for long-term performance. Examples are provided of assessments that include a variety of conventional and experimental alloys in environments simulating turbine exhaust and supercritical CO_2.

"The Role of Fracture in the Reduction of Iron Ore with Hydrogen"

Dierk Raabe

Presenter: Dierk Raabe, Max-Planck Institute

This invited presentation was delivered as part of 100 Years and Still Cracking: A Griffith Fracture Symposium at TMS2021 Virtual. Raabe opens his talk with some numbers: globally, we produce two billion tonnes of metallic products a year, consuming about 8% of global energy and accounting for about 30% of all industrial greenhouse gas emissions. On the other hand, the global market for materials products is about 3,000 billion euros per year.

The question Raabe's presentation poses is this: Can this market be turned into a circular/sustainable one?

This talk looks particularly at steel. While its products are a sustainability enabler (lightweight cars, wind farms, magnets), its production is not. Iron is typically reduced from ore using carbon, but this presentation looks at emission reductions that can be achieved by using hydrogen as a reductant instead. This lecture reports on recent progress in this research field, presenting results of a multi-scale structure and composition analysis of iron reduced from hematite with pure H_2.

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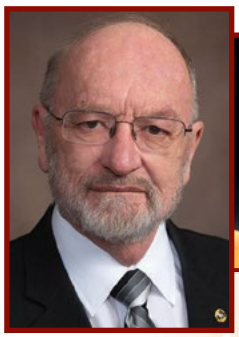

Stanley M. Howard's presidential portrait from 2016.

Honoring Stanley Howard, A True Friend to TMS

Kaitlin Calva

Stan Howard (left), Patrice Turchi (center), 2015 TMS President, and Hani Henein (right), 2014 TMS President, pause for a photo before the awards ceremony at the TMS 2016 Annual Meeting & Exhibition.

The TMS family has lost a great supporter, excellent teacher, and true friend in Stanley M. Howard, who passed away on May 15, 2021, at the age of 75.

As an undergraduate student at Colorado School of Mines, Howard joined TMS—then still The Metallurgical Society of the American Institute of Mining, Metallurgical, and Petroleum Engineers (AIME)—in 1966. After receiving his Ph.D. in metallurgical engineering, he joined South Dakota School of Mines and Technology as an assistant professor, holding a number of leadership positions over the years, including chair of the Department of Materials and Metallurgical Engineering from 1994 to 2000, Faculty Senate Chair, Chair of the Faculty, and Material Advantage Advisor. Most recently, he was professor emeritus, since 2014, for a 50-year career with the university. Howard was also a registered Professional Engineer since 1973.

As an active member of TMS, Howard participated in many committees, both functional and technical, within his "home division" of the Extraction & Processing Division. He was a key reader for *Metallurgical and Materials Transactions B* and has also instructed several short courses and presented numerous papers at TMS annual meetings over the years. His first term on the TMS Board of Directors came in 2009 as the Financial Planning Officer. Just a few years later he was elected to the presidential rotation, serving as the 2016 TMS President. His presidential year was a busy one, as Howard set out to improve upon the member experience through his work with the Board of Directors. In his March 2016 *JOM* article, "Building the Global Professional Community: A Priority for the Year Ahead," he said: "Mostly, my focus will be trying to give back what I have gained from TMS by ensuring that it is a welcoming professional home to all—a place where anyone, from anywhere, at any point in their career can find inspiration, collegiality, shared passion, and answers to their questions or colleagues who will join them in the search for answers."

As president, Howard helped the Society realize a number of new projects and collaborations. Patrice Turchi, 2015 TMS President, outlined just a few of his contributions: "During his presidential cycle, it is worth noting several of Stan's major accomplishments: more international collaborations and a completed agreement for Extraction 2018; accomplishment towards facilitating the transition of

In April 2016, Stan Howard visited TMS headquarters in Warrendale, Pennsylvania, and was presented with his presidential *JOM* cover, pictured here. The June 2016 *JOM* cover featured the style of Nashville's Hatch printing, as Nashville, Tennessee, was the location of that year's annual meeting, and the blue and gold color scheme reflects Howard's school colors at South Dakota School of Mines and Technology.

Stan Howard (left) and TMS Executive Director Jim Robinson visit Cambridge University in 2016 to participate in TMS Fellow Michael Ashby's 8th International Materials Education Symposium, where Howard gave an invited presentation on the TMS student program.

students and young professionals to meaningful participation in the life of the Society with digital access to information; the creation of the Bladesmithing Committee; and the promotion of a more diverse cadre of young professionals; as well as his role in the move of the TMS headquarters to Pittsburgh, and in the TMS Foundation activities."

Howard was also a longtime supporter of the TMS Foundation and a strong believer in its mission to give back to the next generation of scientists and engineers. "I participate in supporting the TMS Foundation because I was blessed with the opportunity to receive an engineering education and continue to be the beneficiary of many generous thoughts and actions," he said in a February 2015 *JOM* article, "TMS2015 Shines A Spotlight on the TMS Foundation." He became a TMS Foundation Trustee and member of the Silver Society for lifetime giving in 2015 and rose to the Titanium Society in 2017.

In one of his last activities as a TMS member, Howard received the 2021 Alexander Scott Distinguished Service Award. He recorded a brief acceptance speech for the virtual TMS-AIME Awards Ceremony, which debuted at the TMS 2021 Virtual Annual Meeting & Exhibition in March 2021.

Stan Howard addresses viewers of the TMS-AIME Awards Ceremony during the TMS 2021 Virtual Annual Meeting & Exhibition as he receives the 2021 Alexander Scott Distinguished Service Award.

In the video, which can be viewed through Channel TMS on YouTube at www.youtube.com/user/ChannelTMS (see Howard's award at time stamp 44:00), he made the following comments about his experiences as a TMS member: "John Hager informed me in 1968 as his graduate student at Colorado School of Mines that I would be saying 'yes' to TMS service for many years to come. He mentored me

Sharing Memories of Our Friend Stan

"As I reflect on my contact with Stan, I remember that he always spoke well of everyone. He was very confident of his talents, abilities, and capabilities, but very humble about them at the same time. When he was Financial Planning Officer of TMS, he was very astute about TMS finances. As a member of the TMS Executive Committee, I never worried about TMS finances, because Stan was at the wheel."
—Hani Henein, Professor, University of Alberta, and 2014 TMS President

"Stan was a great mentor and friend. He modeled the virtues we should aspire to, including respect, dignity, empathy, and especially and most prominently, integrity. We can do no less than our best to pay it forward."
—Robert W. Hyers, Professor, University of Massachusetts

"Dr. Howard was a professor for several of my metallurgical engineering courses as an undergraduate while at the South Dakota School of Mines and Technology. As students, we were always in awe of his knowledge of and talent with thermodynamics and transport phenomena—two of the harder subject areas for undergrads. While the classes were difficult, Dr. Howard always strove to find real-world examples to make the topics relevant. Later, while serving with the TMS Board of Directors and in other committee roles, I worked with Stan under different circumstances. I discovered a whole different side of his personality. He had a dry wit and a deep caring for TMS and its members. He was always a pleasure to work with because of his infectious enthusiasm and positive attitude."
—Ray Peterson, Technology Director, Real Alloy, and 2009 TMS President

"Stan was always a calm voice of reason. Not only was he one of the smartest people I've ever met, but he was really, really good at spotting unforeseen problems or consequences to some course of action. Jokingly I told him once recently that he was an LMD (Land Mine Detector)! He laughed and said that was a lot different than his younger years when he liked to blow things up! It seemed to me Stan was good at everything he attempted, whether it was genealogy, investing, economics, teaching, fundraising, ABET requirements, etc. His teaching skills were phenomenal. Beyond his polymath skills, Stan was a 'one in a million' friend, mentor, educator, and many other titles. For me there will be a huge void in any future TMS meeting, since that was always a chance for me to get to sit and talk to Stan."
—Garry Warren, Professor Emeritus, University of Alabama, 2011 TMS President, and Chair, TMS Foundation Board of Trustees

"Professor Stan Howard, an accomplished leader in his capacity as a TMS volunteer for decades in addition to being a remarkable dedicated materials scientist since the 1960s, will be greatly missed. I interacted more closely with Stan during his presidential cycle that started when I was TMS President in 2015. I came to realize that Stan was an effective TMS leader because of his knowledge, vision, and experience. Every successful organization needs a continued and sustainable roadmap, and Stan always had boundless enthusiasm to grow TMS via new programs while nurturing the initiatives already in progress.

As to the person, Stan Howard is the paragon of professionalism with a special passion for thermodynamics, a topic that occupied a lot of our free time together. He did what he promised, with a kind soul. Besides giving much to TMS, Stan has been involved in many civic activities in addition to all of his professional responsibilities and the mentorship of many students. Stan was articulate, efficient, and a person of very high standards and ethics. On a parallel track, Stan was unbeatable on literature, poetry, and family history. Needless to say, it was with great sadness that I was made aware that my dear friend Stan had passed away. The materials science community and TMS has lost a great mind, and I will miss a great friend."
—Patrice Turchi, Retired Senior Scientist, Lawrence Livermore National Laboratory, and 2015 TMS President

during my early career and urged me to participate in a number of the many activities at TMS, and I urge you to do the same for your young charges and not-so-young associates; otherwise TMS is just a meeting, or an e-mail, or a website. TMS can only function effectively with a cadre of dedicated and talented volunteers, who we fortunately have in great abundance…Through service, volunteers become better professionals through the opportunities afforded them. I have gained much more than I have given. Thank you for this very much appreciated recognition. However, the greatest honor has been simply to serve our fantastic minerals, metals, and materials society. I love TMS."

Remembering Stanley Howard

Marc Meyers

The loss of my dear friend Stan Howard saddens me greatly. He is one of the persons for which I have nourished an admiration ever since we were colleagues at the South Dakota School of Mines and Technology, in 1976. I was a young assistant professor, and he was a more experienced associate professor and provided guidance and advice. We were a small department, only six members, and shared coffee every morning at 10:30 in the faculty lounge. This was a welcome break from our matinal teaching and was an opportunity to exchange ideas and comment on the progress and challenges of our students. I was deeply impressed by the personal attention that each student received. The professors were also counselors and their guidance often pointed them in the right directions when they strayed.

I arrived in the middle of the winter and, as soon as spring brought a welcome warmth, started to jog with Stan. This time together gave us the opportunity to exchange ideas and aspirations. From him I learned the complexities of churches in a small community. Stan played an important role in the Church of Christ, and continually helped members of his church in all kinds of situations. Gradually, I learned more about his personal background. He was born in Torrington and spent his childhood between Lusk and Lingle, Wyoming, where his family had a ranch. He used to joke that all people in Lusk were super-intelligent, setting up the question: "Why?"

He would smile and answer: "Because they are bi-Lingle!"

These three neighboring towns were only a couple of hours from Rapid City, South Dakota, and I drove through them many times. He had a great love for the immense skies of Wyoming, which he called, "God's Country."

TMS Foundation Trustees (left to right) Marc Meyers, Viola Acoff, Carl Cady, and Stan Howard catch up at a donor dinner event held at the TMS 2018 Annual Meeting & Exhibition in Phoenix, Arizona.

At some time, I had the opportunity to meet his mother, a very intelligent lady who had a B.S. in literature. His father was an excellent mathematician. He and his three brothers and sister must have inherited the clear logical mind which made him a superior teacher of difficult subjects, such as thermodynamics, pyrometallurgy, and computer engineering. My brother Carlos was one of his students and can attest to his rigor and excellence. Stan was a man with high moral principles and led his life in a true Christian way. His actions were guided by commitment, honesty, and dedication.

The Wyoming lands had been granted to his family and he worked on the ranch throughout his childhood and college days. It was interesting that he did not adhere to the cowboy mystique of boots, silver buckle, and ten-gallon hat. He was usually dressed in a suit and preferred his Oldsmobile Toronados to pickup trucks. A devoted father and husband, he was abstemious and hardworking. As a proof of love, one of his daughters donated a kidney to him when his own failed. I was amazed when he described the project he undertook in his Rapid City house. He was expanding his basement and ran into a large rock. He thought about using explosives to blast it, but this was not feasible. In the end, he found a solution: he lifted the entire house using hydraulic jacks and redid the foundation!

After getting his Ph.D. form the Colorado School of Mines, under the hardest-working professor in the department, John Hager, Stan joined South Dakota School of Mines where he spent his entire career. The many classes of students can attest to his high standards and excellence in teaching. He was also a bright researcher and developed extraction methods for the Black Hills ores. He introduced me to TMS and nominated me to the Board of Editors of *Metallurgical and Materials Transactions* in the late 1970s. He served TMS in many capacities and his careful attention to all aspects of the Society generated admiration from his colleagues and led to his election to President. More recently, he was very active in the TMS Foundation and performed spectacularly. He regularly called me to discuss Foundation matters or just to chat. Our TMS has lost a dedicated member, the university a most talented professor, and I, personally, an esteemed colleague and a friend.

Marc Meyers is a Distinguished Professor of Materials Science at the University of California, San Diego. He has been a TMS member since 1974 and is a 2011 TMS Fellow.

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JOM themagazine

TMS meeting headlines

TMS is committed to your safety during the pandemic. Meeting dates and locations are current as of June 7, 2021. For the most recent updates on TMS-sponsored events, visit www.tms.org/Meetings.

Other Meetings of Note

Materials in Nuclear Energy Systems (MiNES 2021)
September 19–23, 2021
Pittsburgh, Pennsylvania, USA

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

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

2nd World Congress on High Entropy Alloys (HEA 2021)
December 5–8, 2021
Charlotte, North Carolina, USA

TMS 2022 Annual Meeting & Exhibition (TMS2022)
February 27–March 3, 2022
Anaheim, California, USA

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

Additive Manufacturing Benchmarks
August 15–18, 2022
Bethesda, Maryland, USA

September 12–16, 2021
Virtual Event
Register Now
www.tms.org/Superalloys2021

- The 14th International Symposium on Superalloys (Superalloys 2021) aims to highlight technologies for lifecycle improvement of superalloys. In addition to traditional focus areas, the symposium invites papers from academia, supply chain, and product-user members of the superalloy community that highlight technologies that contribute to improving manufacturability, affordability, life prediction, and performance of superalloys.
- As the latest installment of one the most established and impactful conferences series on superalloys, Superalloys 2021 will showcase some of the leading names in the field as presenters, with papers carefully and stringently curated to ensure the highest quality programming.

MS&T21

October 17–21, 2021
Columbus, Ohio, USA
Registration Now Open!
www.matscitech.org/MST21

- Materials Science and Technology (MS&T) is three meetings in one: the TMS Fall Meeting, the American Ceramic Society's 123rd Annual Meeting, and the Association for Iron & Steel Technology's Steel Properties & Applications event.
- More than 25 symposia are planned as part of the TMS Fall Meeting to be held at MS&T21. Visit the website for updates on registration.

TMS ICME MANUFACTURING DESIGN MATERIALS

November 14–18, 2021
Lake Tahoe, Nevada, USA
Discount Registration Deadline: October 1, 2021
www.tms.org/ICME2021

- The 6th World Congress on Integrated Computational Materials Engineering (ICME 2021) convenes leading researchers and practitioners to share the latest knowledge and advances in the discipline. This congress is the recognized hub of interaction among software developers and process engineers along the entire production chain, as well as for materials scientists and engineers developing new materials.
- The plenary speakers include **Bita Ghaffari**, Ford Motor Company; **Louis Hector**, GM Global Technical Center; **Andrea Rovinelli**, Argonne National Laboratory; and **Kandler Smith**, National Renewable Energy Laboratory.

TMS AIM First World Congress on ARTIFICIAL INTELLIGENCE IN MATERIALS & MANUFACTURING 2022

April 3–6, 2022
Pittsburgh, Pennsylvania, USA
Submit an Abstract by September 3, 2021
www.tms.org/AIM2022

- The TMS World Congress on Artificial Intelligence in Materials and Manufacturing (AIM 2022) is the first event of its kind to focus on the role of artificial intelligence in materials science and engineering and related manufacturing processes.
- The goal of AIM 2022 is to convene stakeholders from academia, industry, and government to address key issues and identify future pathways.
- Share your work today! Visit the website to submit your abstract.

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JOM thejournal

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.**

February 2022

Manuscript Deadline: September 1, 2021

Topic: Artificial Intelligence and Machine Learning in Energy Storage and Conversion Materials

Scope: Artificial intelligence (AI) and machine learning (ML) have emerged as important tools for material scientists aimed at finding optimum solutions to complex scientific dilemmas. This special topic invites papers from industry, academia, and national labs that focus on AI and ML advances in field of materials design, characterization, and applications for energy storage and conversion.
Editors: Simona Hunyadi Murph and Surojit Gupta
Sponsor: Energy Conversion and Storage Committee

Topic: Bauxite to Aluminum: Automation, Data Analytics and New Processes

Scope: This topic covers automation and data analytics, fostered by developments and implementations of Industry 4.0, and also new processes or engineering technologies used throughout the primary aluminum production chain, from bauxite to aluminum. Papers are invited focusing on novel developments aiming to improve those processes, or on scientific/innovative approaches within these areas.
Editors: Jayson Tessier and Hong Peng
Sponsor: Aluminum Committee

Topic: Characterization of Waste-Derived Materials

Scope: Papers are invited on the latest achievements in exploration of novel value-added materials derived from various wastes. In particular, papers on characterization and modification for those originated from mineral/metallurgical/material processing are welcome. Of interest are multifunctional slag/tailing-based materials with unique combinations of desirable thermo-mechanical-chemical performance for sustainable industrial and municipal applications.
Editors: Zhiwei Peng, Yunus Eren Kalay, Rajiv Soman, and Jian Li
Sponsor: Materials Characterization Committee

Topic: Exploring the Relationships Between Plastic Deformation and Heat

Scope: This topic will exlore experimental, computational, and theoretical methods to understand heat generation and heat transfer in materials, through the interactions between phonons, electrons, and dislocations. Manuscripts are invited that examine factors (composition, microstructure, etc.) that determine the fraction of work converted into heat, mechanisms of converting deformation to heat, role of "phonon radiation" of dislocations as they move at high velocities, etc.
Editors: Aashish Rohatgi, Sean Agnew, and Thomas Bieler
Sponsor: Shaping and Forming Committee

Topic: Plasmonics in Nanocomposite Materials

Scope: Plasmonic nanocomposites are an emerging class of materials that integrate a plasmonic metallic nanoparticle with an assortment of other similar/dissimilar nanostructures leading to new multifunctional systems with improved functionalities and properties. This special topic will cover recent achievements in the design, fabrication, and application of plasmonic nanocomposites in fields including material science, medicine, and industry.
Editors: Nasrin Hooshmand and Simona Hunyadi Murph
Sponsor: Composite Materials Committee

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: Nov. 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; 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

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AIME–TMS 150th CELEBRATION

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Annual Meeting & Exhibition

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Visit the TMS2022 website for updates on meeting plans:

www.tms.org/TMS2022

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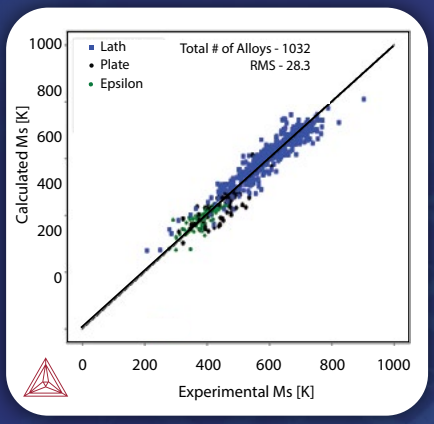
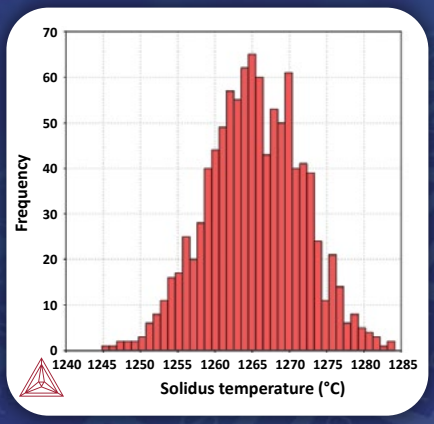


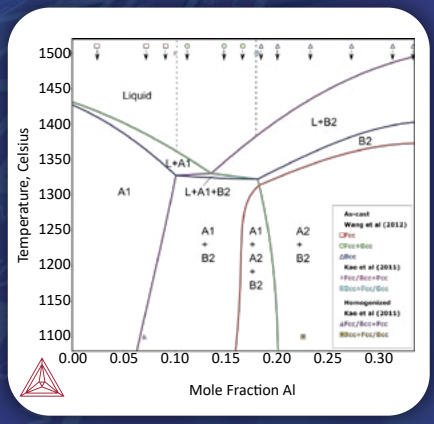
Comparison of calculated and experimental Ms temperatures for a wide range of steels

Nickel



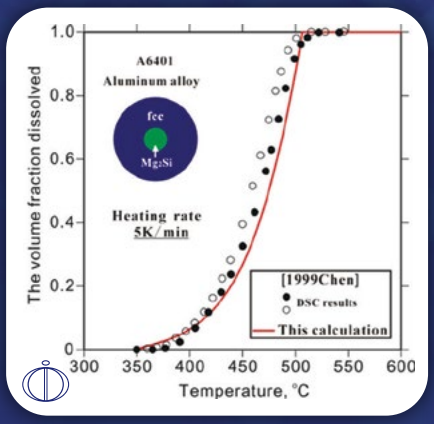
Variation in solidus temperature over 1000 compositions within alloy 718 specification

High Entropy Alloys



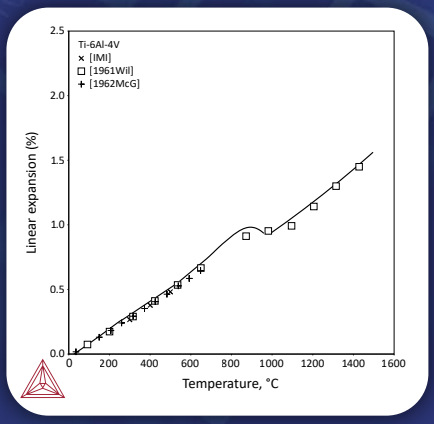
Calculated phase diagram along the composition line of CoCrFeNi-Al

Al Alloys



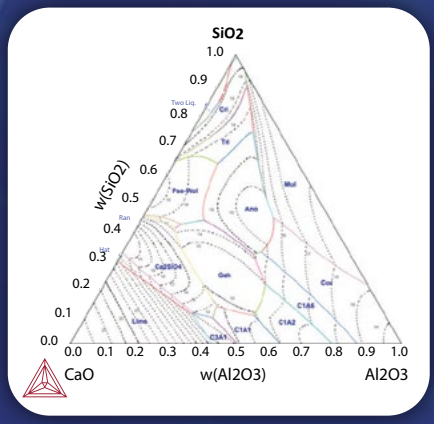
Dissolution of Mg2Si precipitate in Alloy A6401

Ti and TiAl Alloys



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

Oxides



Ternary liquidus projection in oxide systems

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