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An official publication of The Minerals, Metals & Materials Society

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JOM | table of contents

Volume 72
Number 7
July 2020

JOM: THE MAGAZINE

JOM: THE JOURNAL

Dry Metal Shaping and Forming

Emerging Mechanisms for Enhanced Plasticity in Magnesium

Recycling Silicon and Silicon Compounds

Thermodynamic Modeling of Sustainable Non-Ferrous Metals Production: Part I

Technical Article

JOM

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TMS
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About the Cover

Fort Wayne Metals, a manufacturer of medical grade alloys, is exploring the production of coil (as pictured), long bar, and wire from ultrafine grain (UFG) alloy variants. The intended application of these products includes medical devices and other demanding environments. More information on this topic can be found in "Isothermal Continuous Equal Channel Angular Pressing Processing of Magnesium Alloy AZ31" by Casey F. Davis et al.

July 2020 Guest Editors

Dry Metal Shaping and Forming
Invited
Heinz Palkowski, Clausthal University of Technology
Frank Vollertsen, University of Bremen

Emerging Mechanisms for Enhanced Plasticity in Magnesium
Magnesium Committee
Petra Maier, Stralsund University of Applied Sciences
Jishnu J. Bhattacharyya, University of Virginia

Recycling Silicon and Silicon Compounds
Recycling and Environmental Technologies Committee
Shadia Ikhmayies, Jabal El-Hussain

Thermodynamic Modeling of Sustainable Non-Ferrous Metals Production: Part I
Process Technology and Modeling Committee; Recycling and Environmental Technologies Committee
Fiseha Tesfaye, Abo Akademi University
Alexandra Anderson, Gopher Resource
Mingming Zhang, ArcelorMittal Global R&D

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.

Publishing Information:

JOM is an official publication of The Minerals, Metals & Materials Society and is owned by the Society.

TMS has granted Springer the exclusive right and license to produce, publish, archive, translate, and sell *JOM* throughout the world. Publication Frequency: 12 issues per year.

Springer, 233 Spring Street, New York, NY, 10013-1578, USA

JOM articles from 1949 to the present are archived at http://link.springer.com/journal/volumesAndIssues/11837.

Postmaster:

Send address changes to: *JOM*, Springer, 233 Spring Street, New York, NY 10013, USA. Periodicals postage paid at New York, NY and additional mailing offices.

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JOM, Vol. 72, No. 7, 2020
https://doi.org/10.1007/s11837-020-04226-0

in the final analysis

JOM
Volume 72
Number 7
July 2020

"Son of Jor-el, kneel before Zod!"
—Zod

If you know your comic book lore or comic book movies, Zod is a renegade general from Superman's home planet of Krypton, having the same superpowers as Superman himself. Because of a bitter grudge against Superman's father, Zod lives to humiliate and subjugate our unfailingly noble and heroic "Man of Steel" (c.f., *Superman II,* which is the best Superman movie according to my cinematic palate). Many years ago, a real-life man of steel for his seeming invincibility was boxer Mike Tyson, otherwise known as Iron Mike. While more Zod than Superman in character and disposition, Tyson was unrelenting and merciless in the ring during the late 1980s . . . until the pummeler became the pummeled courtesy of journeyman "Buster" Douglas. One year before that greatest upset in boxing history, Mike Tyson forever intertwined himself in my mind with the TMS Annual Meeting & Exhibition.

True, true, true. Here's why: 31 years ago in Las Vegas, we convened TMS1989 in a hotel full of excitement, celebrities, glitterati, and conspicuous wealth because superman and super-luminary Mike Tyson was on property to destroy another opponent. The atmosphere crackled with electricity, even more so than normal for a TMS event, if such a thing is even possible! As I later wrote in *JOM*:

> "TMS Scores a Knockout in Las Vegas: The brief match between world heavyweight boxing champion Mike Tyson and challenger Frank Bruno may have been the featured attraction at the Las Vegas Hilton on Saturday, February 25, 1989, but another knockout event—the 1989 TMS Annual Meeting and Exhibition—commanded those same facilities for the next five days. In fact, this year's meeting showed TMS to be at the peak of its formidable programming powers, as the society broke long-standing attendance records."

A lot has changed since 1989 (beside Mike Tyson tumbling far from his status as pugilist extraordinaire and spending time in jail). During that exciting meeting in Las Vegas, we had about 160 sessions and 3,000 attendees, we used overhead and slide projectors, the abstracts in the technical program were typewritten, we attracted 200+ mostly aluminum exhibitors, we sold hundreds of hardcover books (also typewritten), we sold photocopies of individual papers, and everyone registered using forms torn from *JOM*. Today, we expect nearly 500 technical sessions and 4,500+ attendees, we use PowerPoint for everything, there are no abstracts in the on-site program as they are all online and in the app (no apps or Internet back in Mike Tyson's heyday), our aluminum-centric exhibition has contracted along with the U.S. aluminum industry, we give all attendees papers virtually and for free via SpringerLink, and everyone registers via secure e-commerce. Oh yes, one joyful difference of great significance: If you look at the event photos from 1989 in *JOM,* you'll see that the diversity profile of our event has changed considerably over the decades—a most welcome change for TMS and our community overall!

While we can't replicate the zeitgeist of having in-his-prime Mike Tyson on-site, TMS2021 will nonetheless have an extra charge of excitement as this event will celebrate the 150th anniversary of TMS via its origination within the American Institute of Mining, Metallurgical, and Petroleum Engineers, which itself was founded in 1871. From March 14–21, our members will reflect on that 150-year heritage, consider the present, and look to an exciting future as only remarkable individuals such as those found within the TMS membership can envision. Did I mention that Diversity in the Minerals, Metals, and Materials Professions 4 will be co-located with TMS2021?

What are the topics to be discussed next March? You tell us as July is when abstracts are due. Act quickly so that your contribution is among those that help make TMS2021 an installment that we will remember and discuss for decades to come.

James J. Robinson
Executive Director
@JJRofTMS

"31 years ago in Las Vegas, we convened TMS1989 in a hotel full of excitement, celebrities, glitterati, and conspicuous wealth."

JOM, Vol. 72, No. 7, 2020
https://doi.org/10.1007/s11837-020-04227-z

JOM themagazine

Impact Factor for *IMMI*; TMS Debuts Materials Needs Exchange

member news

Share the good news about your professional accomplishments! Contact Kaitlin Calva, JOM Magazine Managing Editor, at kcalva@tms.org. Please note that only news submitted by current TMS members will be considered.

TMS Journal to Receive Impact Factor in 2021

The TMS journal *Integrating Materials and Manufacturing Innovation* (*IMMI*) has been accepted into the Science Citation Index and will receive its first Impact Factor in 2021.

Beginning with Volume 6, Issue 1 (2017), the journal will be indexed in the Science Citation Index Expanded (also known as SciSearch®), Journal Citation Reports/Science Edition, and Current Contents®/Engineering Computing and Technology.

"Being accepted into the Science Citation Index Expanded is truly a milestone in the journal's growth as it formally recognizes *IMMI*'s meaningful value to the materials science and engineering community," said Charles Ward, editor-in-chief of *IMMI*. "To be accepted, a journal must show a consistent level of quality that demonstrates it will provide lasting value to readers."

Launched in 2012, *IMMI* is a peer-reviewed journal that is committed to building a seamless and dynamic materials and manufacturing design framework supporting the accelerated discovery, development, and application of materials and processes. The journal explores innovations from the discovery of materials through their manufacture that support the practice of integrated computational materials engineering (ICME).

"For authors, having *IMMI* included in the index will mean much greater visibility for their research," said Ward. "Additionally, *IMMI*'s scope provides an outlet for discussion of non-traditional, yet very valuable, research products that have been overlooked by other publication venues."

TMS members can read current and archived issues of *IMMI* for free by logging in to the TMS Journals web page at www.tms.org/Journals, which also includes a link to the journal's submission site.

TMS Member Nominated for NSB

Sudarsanam Suresh Babu

Sudarsanam Suresh Babu, professor and University of Tennessee (UT)–Oak Ridge National Laboratory (ORNL) Governor's Chair for Advanced Manufacturing at UT Knoxville, was nominated to a seat on the U.S. National Science Board (NSB) in April 2020. If confirmed, Babu will serve a six-year appointment. The purpose of the NSB is to help shape policy and research for the National Science Foundation, as well as advise members of Congress and the President on scientific matters.

An expert in developing advanced materials, Babu lends his knowledge to many collaborative projects through appointments with IACMI–the Composites Institute; UT's Department of Mechanical, Aerospace, and Biomedical Engineering and Department of Materials Science and Engineering; ORNL's Energy and Environmental Sciences Directorate; the U.S. Department of Energy's Manufacturing Demonstration Facility at ORNL; the Bredesen Center for Interdisciplinary Research and Graduate Education; and the Joint Institute for Advanced Materials.

A TMS member since 1993, Babu has participated in several technical committees within the Materials Processing & Manufacturing Division. He has also been an instructor for TMS's prominent Additive Manufacturing Materials and Processes Workshop, held for several years in conjunction with the TMS Annual Meeting & Exhibition and Materials Science & Technology conferences.

TMS Connects Members and Resources through Materials Needs Exchange

In April 2020, TMS launched the COVID-19 Materials Needs Exchange as a means of connecting TMS members and/or their employers with organizations on the front lines of the COVID-19 pandemic for the purpose of rendering materials and manufacturing assistance, resources, or expertise. The Exchange is available at www.tms.org/COVID-19Materials.

Organizations that can provide materials assistance or expertise addressing the challenges presented by COVID-19 were invited to post a description of what they can offer and contact information on the Exchange. (Please note that only TMS members are permitted to post their expertise as individuals.) Organizations or programs in need of materials and/or manufacturing support were invited to post their requests as well.

"In this time of crisis, many of us are looking for ways we can help our communities, countries, and the world—or we need help ourselves. TMS members are no exception," explained 2020 TMS President Tom Battle regarding the creation of the Exchange. "We, and the companies we work for, constitute a unique resource in this time. The materials we produce, the technologies we use to produce them, and the broad expertise of our membership can be of great value in the world at this time. So TMS is proud to have created a Materials Needs Exchange to connect our wide-ranging capabilities to those in need of it."

The Exchange listings are currently still open to all to review. You can directly contact any of the organizations listed that you believe are a good match for what you or your organization can provide.

Concurrently with the Exchange, TMS also launched the TMS COVID-19 Resource Portal to provide a one-stop gateway to the Society's online content, virtual networking opportunities, COVID-19 related updates, and other resources and support available to our members during these difficult times. See all available resources at www.tms.org/COVID-19.

Both the TMS COVID-19 Materials Needs Exchange and the TMS COVID-19 Resource Portal are direct results of ideas and input that have been shared and advanced by members through our TMS volunteer structure.

In Memoriam: George T. Murray

TMS extends its condolences to the friends, family, and colleagues of George T. Murray, who passed away on March 22, 2020, at the age of 93. Murray studied math and physics at the Eastern State Teacher's College in Kentucky and, after a break from his education to enlist in the U.S. Navy, transferred to the University of Kentucky where he earned his B.S. in metallurgical engineering. He went on to earn his M.S. from the University of Tennessee and his Ph.D. from Columbia University. Shortly after, he co-founded the Materials Research Corporation, where he worked as the director of research and, later, as corporate vice president. In 1978, Murray made the switch to academia, serving as a professor of materials engineering at California Polytechnic State University, San Luis Obispo until his retirement in 1993. He co-wrote the textbook, *Introduction to Engineering Materials*, and has authored more than 30 articles for technical journals and trade magazines. Murray joined TMS as a member in 1960.

George T. Murray

JOM, Vol. 72, No. 7, 2020
https://doi.org/10.1007/s11837-020-04228-y

In Case You Missed It:

Business News from the Field

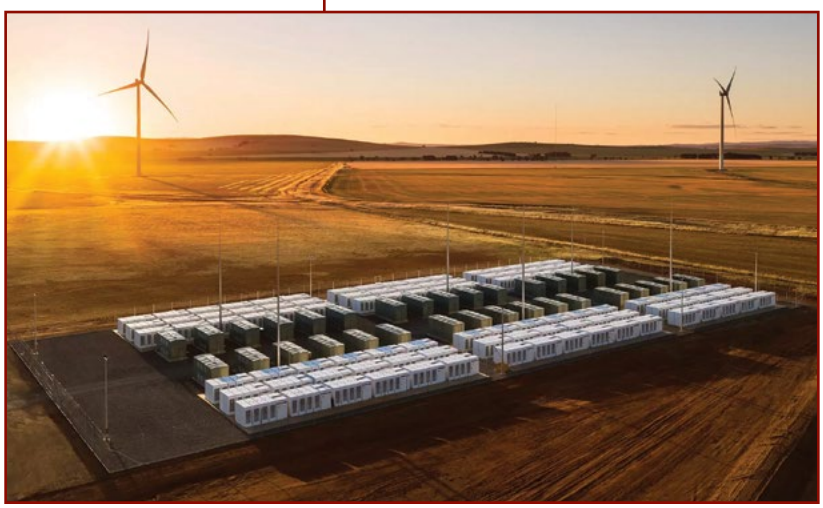
Do you have business or industry news of interest to the minerals, metals, and materials community? Submit your announcement or press release to Kaitlin Calva, JOM Magazine Managing Editor, at kcalva@tms.org for consideration.

Cobalt Safety Program Expands

Alexandria, Virginia, USA: A program to monitor and improve artisanal cobalt mines in the Democratic Republic of Congo (DRC) will double the number of mining sites it covers this year through a partnership between RCS Global Group and the Responsible Minerals Initiative. The program will grow from three sites to six in 2020, and to 12 or more sites by 2023. The DRC, which is the source of two-thirds of the world's cobalt, has come under fire for needing improved health and safety practices for miners. Artisanal miners account for around 20% of the country's cobalt production, so the industry has an interest in helping improve these mine sites to open up new sources of cobalt they can buy without fearing a tainted supply chain.

Copper Discovery Sparks British Hopes

Cornwall, United Kingdom: Engineers discovered high-grade copper in Cornwall while exploring for lithium in hot underground springs. The discovery spurs hope of reviving the British copper industry in an area once called "the richest square mile on Earth" due to rich metal deposits. Strongbow Exploration owns the mineral rights at the United Downs site and plans to determine the size of the copper zone. The grade of copper discovered is 16 times the average grade at 8% copper.



Hornsdale, Australia: Tesla Inc., in partnership with French renewable energy company Neoen SA, completed a major expansion of the Hornsdale Power Reserve in South Australia to increase storage capacity by 50%. The battery extension project increased reliability of the grid and secured 100 MW to 150 MW total capacity to make Hornsdale the largest lithium-ion storage site in the world, followed by Stocking Pelham facility's 49.99 MW of battery storage in the United Kingdom. (Image courtesy of Neoen.)

South Korea OKs Vanadium Flow Batteries

Daejeon, South Korea: The South Korean government agreed to the use of vanadium redox flow battery (VRFB) to store renewable energy within the Energy Storage System (ESS) market. The move will expand options in the industry. South Korean ESS maker H2 is the first company prepared to enter the market with its product EnerFlow 430, which pairs with photovoltaic generation. H2 plans to install the country's first flow-battery-based ESS at a power plant by the end of 2020.

Tethyan to Acquire Serbian Mines

Vancouver, Canada: Tethyan Resource Corp. is working to acquire the idle Kizevak and Sastavci silver-zinc-lead mines in Serbia. An agreement in process would secure a 100% ownership in the company holding the exploration licenses of the mines, EFPP. Initially, Tethyan plans to acquire 10% of EFPP shares and management control. Then, within 12 months, Tethyan has the right to acquire the remaining 90% of the shares, granting the sellers a 2% net smelter return over the licenses; issuing four million ordinary shares of Tethyan in installments; and making a deferred payment of €500,000 on the two-year anniversary of the first closing.

Enovix to Produce 3D Silicon Lithium-Ion Battery

Fremont, California, USA: Enovix Corporation, a California-based lithium-ion battery developer, has secured over $200 million in venture, strategic, and private funding to produce and commercialize its 3D silicon lithium-ion battery. The battery cell's architecture incorporates a 100% active silicon anode, compared to the very little silicon of conventional anodes. Enovix's strategic investors include Intel, Qualcomm, and Cypress. Production will start by the end of 2020.

JOM, Vol. 72, No. 7, 2020
https://doi.org/10.1007/s11837-020-04229-x

Zachary Harris Highlights Strengths in Characterization Techniques

Kaitlin Calva

Zachary Harris

young professional technical notes

This occasional feature highlights the scientific interests and professional accomplishments of a young TMS member who has contributed to the technical content of the current issue of *JOM* as an author, advisor, or guest editor. The development of this feature is a special project of the TMS Young Professionals Committee. For additional information contact Kaitlin Calva, *JOM* Magazine Managing Editor, at kcalva@tms.org.

In his May 2020 *JOM* paper, "Multiscale Assessment of Deformation Induced by Hydrogen Environment-Assisted Cracking in A Peak-Aged Ni-Cu Superalloy," Zachary Harris and his co-authors use a multiscale characterization approach to probe the microscale mechanisms responsible for hydrogen environment-assisted cracking. Harris, a research associate in the Department of Materials Science and Engineering at the University of Virginia (UVA), says that "while there are so many amazing techniques out there, each has its own set of positive and negative attributes. We believe that by coupling several of them together, it is possible to minimize the weaknesses of the individual techniques, while highlighting strengths."

This connects to Harris' own research on understanding the "microscale mechanisms that are responsible for the reduced performance of structural metals exposed to aggressive environments." New tools and techniques, Harris explained, can lead to new insights and, ultimately, the ability to design materials for a certain environment or make more accurate predictions about component lifetimes. "The continued development of high-resolution characterization techniques, coupled with the significant progress in modeling deformation behavior at multiple scales, offers an exciting opportunity to improve our understanding of how exposure to aggressive environments affect materials properties," he said. "At the same time, environmental effects on structural metals can manifest in so many different ways depending on the alloy, environment, and loading conditions. Folks have become quite good at modeling behavior for a single system but developing generalized predictive frameworks that are broadly useful remains a significant challenge."

Harris first started his work in this field as an intern running fatigue experiments in high-pressure hydrogen gas at Sandia National Laboratories' Hydrogen Effects on Materials Lab with Brian Somerday. "The very first sample we tested was a titanium alloy that was so embrittled by hydrogen that it ended up turning into powder—it was so amazing to see how severely the environment could degrade a metal."

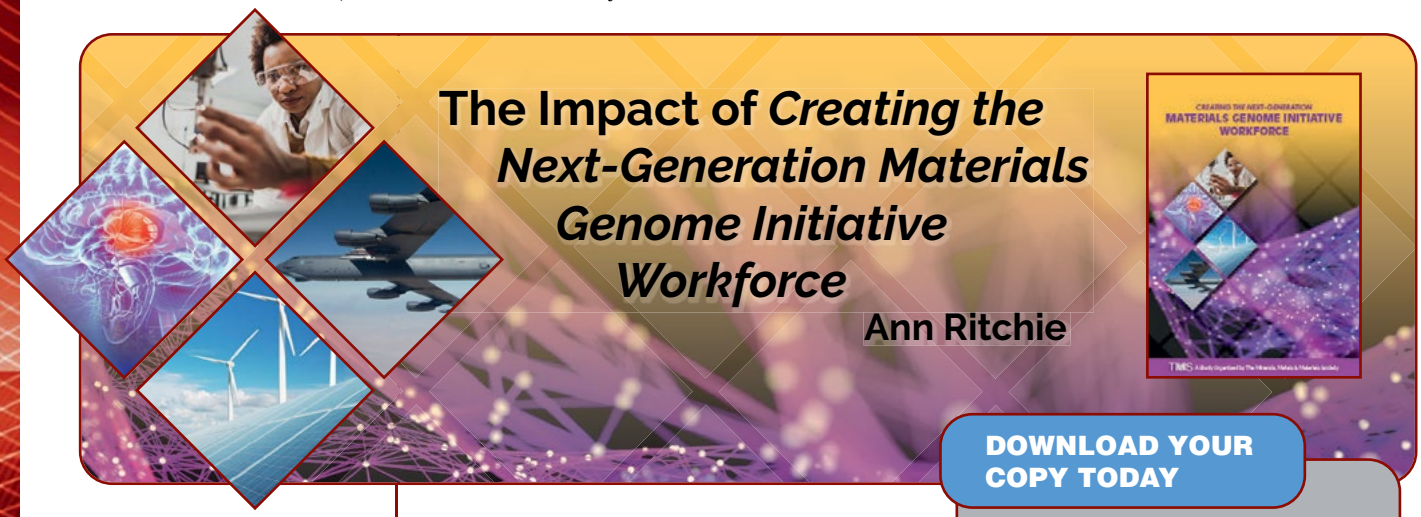
Of all the experiences in his career so far, one particular moment stands out from the others; in 2019, Harris traveled to Cambridge University to present his work, which cited a 1970 paper from Professor Alan Windle of Cambridge. Not only did an audience member take note of the Cambridge connection, but Harris was introduced to Windle himself. "It was an awesome experience—we had afternoon tea in the Trinity College Fellows' Room and talked about my work and the state of the field," he said. "Definitely something I will never forget."

In addition to his current responsibilities, Harris counts mentoring junior researchers in his lab among his priorities. "The excitement associated with conducting experiments is definitely still there, but as my role has evolved to include more mentoring, I have also found working with students to be extremely rewarding."

Harris recognizes the importance of finding mentors during your education and early career, expressing his gratitude for the chance to work with mentors such as Somerday at Sandia and Jimmy Burns at UVA. "Both of them have encouraged my curiosity, challenged me to think critically, and been excellent sounding boards as I moved through graduate school and beyond," he said.

In this regard, Harris encourages the students that he works with to "identify mentors who genuinely care about your success and push you to be your absolute best." Additionally, he advises to "identify great collaborators. No one can be an expert in everything, so identify folks who can augment the skills you have and reach out to them."

JOM, Vol. 72, No. 7, 2020
https://doi.org/10.1007/s11837-020-04230-4



The Impact of *Creating the Next-Generation Materials Genome Initiative Workforce*

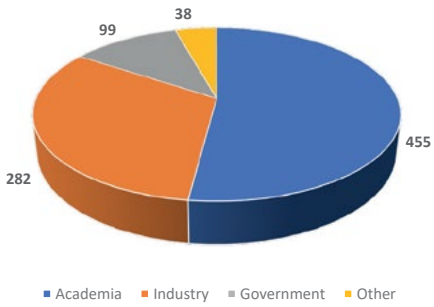
Ann Ritchie

DOWNLOAD YOUR COPY TODAY

Access your free copy of *Creating the Next-Generation Materials Genome Initiative Workforce* today at **www.tms.org/MGIWorkforce**.

Additionally, the entire suite of TMS studies is available at **www.tms.org/Studies**.

Downloads by Economic Sector



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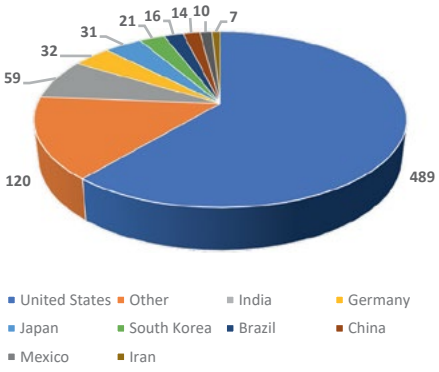


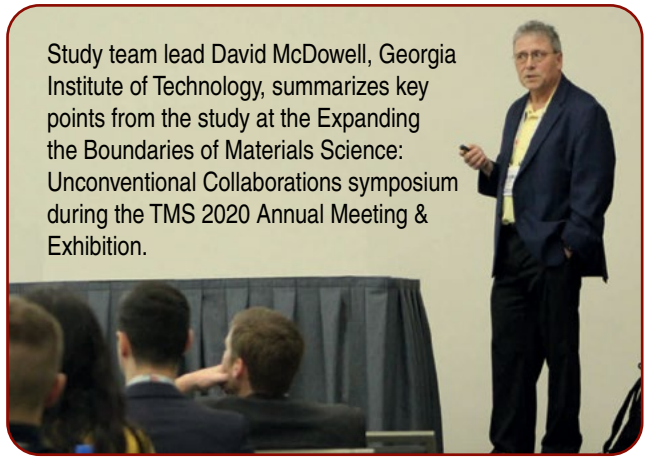
Figure 1. The charts above show report downloads of *Creating the Next-Generation Materials Genome Initiative Workforce* by economic sector and country. This data indicates diverse readership with roots around the globe. The charts are based on download data from TMS, retrieved May 4, 2020.

Creating the Next-Generation Materials Genome Initiative Workforce outlines actions for workforce development that lie at the intersection of experiment, computation, and data in materials. Building on the U.S. Materials Genome Initiative (MGI) started in 2011, the publication is one of the latest TMS science and technology accelerator study reports on work sponsored by the U.S. National Science Foundation (DMR #1840716).

Published in December 2019 and available for free download, the community acted quickly to access the report when it became available, with hundreds of unique downloads within the first month. As of the writing of this article in May 2020, 874 individuals from 60 countries have downloaded an open-access copy of the report, with 52% from academia, 32% from industry, and 11% from government.

Materials Genome Initiative workforce topics were among the discussions at the TMS 2020 Annual Meeting & Exhibition in February. David McDowell, Regents' Professor and Carter N. Paden Jr. Distinguished Chair in Metals Processing at the Georgia Institute of Technology and study team lead, presented key points of the study as part of the symposium, Expanding the Boundaries of Materials Science: Unconventional Collaborations.

"I believe this TMS study will have significant impact on federal funding agency calls and priorities to support workforce development that is savvy in application of data science methods in the materials development and deployment space, along with transformation of U.S. materials university curricula at the intersection of data science and materials," McDowell said.



Study team lead David McDowell, Georgia Institute of Technology, summarizes key points from the study at the Expanding the Boundaries of Materials Science: Unconventional Collaborations symposium during the TMS 2020 Annual Meeting & Exhibition.

With a focus on future materials workforce development, the report recommends key tasks, timeframes, metrics, and resources for accelerating the discovery, development, deployment of advanced materials. Highlights of the publication include the following outputs from the study team's efforts:

- A summary of the current state of academic curriculum and training of the U.S. workforce to support the MGI.
- A definition of 10 key competency areas along with core and advanced/specialty areas of knowledge and skills, which are organized according to the initiative's foundational pillars.
- Capture and synthesis recommendations of past MGI workshops, reports, and activities.
- Seven detailed action plans that describe how individuals, groups, and organizations can drive near-term actions that will have long-term impact.

Utilizing color coding and reader-friendly tables for easy reference, the report summarizes the knowledge and skills that will be needed as part of the next-generation materials workforce.

Foundational Pillars	Key Competency Areas
Data	• Data handling • Modeling and simulation visualization • Software and codes to manage MG workflows
Computation	• Quantum and atomistic modeling methods • Microstructure evolution and material response • Multiscale and continuum modeling methods • Integrated workflows for computational tools
Experiments	• Multi-objective design and decision-making under uncertainty • Measurement methods and tools • Sensor fusion, high-throughput methods, and automation

The three foundational pillars that map onto the MGI are data, computation, and experiment. For each of the pillars, a set of subtopics is listed that explains associated key competencies.

A set of core and advanced/specialty knowledge and skills are provided for each key competency area, along with examples. As described by the report, "it is not necessary for someone to become an expert in all of the knowledge and skills

Figure 2. This table presents a summary of foundational pillars and corresponding 10 key competency areas for the MGI workforce. The report provides detailed core and advanced knowledge and skills along with examples for each of the noted key competency areas. (*Creating the Next-Generation Materials Genome Initiative Workforce*, 2019, p. 30.)

MEET THE STUDY TEAM

Members of the *Creating the Next-Generation Materials Genome Initiative Workforce* study team visited TMS headquarters in February 2019 to begin work on the project, conducted by TMS on behalf of the U.S. National Science Foundation. To learn more about the 16 internationally recognized experts who led the study, and to download a free copy visit **www.tms.org/MGIWorkforce**.

Pictured row 1, left to right: Mark D. Asta, Lawrence Berkley National Laboratory; George Rodriguez, ExxonMobil Chemical; Will Joost, Pratt & Whitney; and Aaron Gilad Kusane, National Institute of Standards and Technology. **Row 2, left to right:** Matt Earnest, Virginia Polytechnic Institute and State University; Xin Sun, Oak Ridge National Laboratory; Kevin Anderson, Brunswick Corporation; and Stefano Curtarolo, Duke University. **Row 3, left to right:** Raymundo Arroyave, Texas A&M University; Cathy Tway, Johnson Matthey; and David McDowell, study team chair and Georgia Institute of Technology. **Study team members not pictured:** Allison Beese, Penn State University; Michele Manuel, University of Florida; Rampi Ramprasad, Georgia Institute of Technology; Katsuyo Thornton, University of Michigan, Ann Arbor; and Peter Voorhees, Northwestern University.

"This study has spurred more serious consideration and discussion regarding what kinds of instructional and retraining venues need to be developed to usher in the digital information age of materials discovery, development, and deployment…"

—David McDowell

areas...it is important for students—both undergraduate and graduate—to develop awareness of these concepts and to be conversant in multiple topical areas such as data handling and measurement tools."

"We require a sustained community effort to reform the curricula. It's time to build on the momentum in federal agencies, professional societies, and academia," McDowell said.

As part of the study team's efforts, they surveyed members of the University of Materials Council (UMC), which includes department heads, chairpersons, directors, and group leaders from academic programs in the materials field in U.S., Canadian, and Australian universities. While the majority of participants considered MGI concepts "somewhat important" or "very important" to both undergraduate and graduate curricula, further investigation revealed more opportunities in the current curriculum to introduce MGI components at both levels.

Study team members lay the groundwork for *Creating the Next-Generation Materials Genome Initiative Workforce* at an in-person meeting at TMS headquarters in February 2019.

An investigation on existing coursework related to the MGI in a sampling of 50 U.S. universities also took place as part of the study's work. While 80% of universities sampled offered computational materials science and engineering coursework, only 9 of the 50 universities offered instruction on data science. This indicates there are opportunities to incorporate this third pillar of the MGI into materials science and engineering curricula.

"This study has spurred more serious consideration and discussion regarding what kinds of instructional and retraining venues need to be developed to usher in the digital information age of materials discovery, development, and deployment in academia, industry, and government," McDowell said. "I expect we will see a significant increase of joint workshops and online collaborative education and training platforms aimed at addressing the study recommendations in the coming years. Universities will need to rethink the notion of essential information and skills to be taught at both undergraduate and graduate levels."

Seven action plans give direction to the supply side and demand side of the community and outline sets of tasks to implement for taking part in the progress to build the next-generation MGI workforce.

On the supply side of the MGI workforce, the action plans address the following four recommendations: modernize academic curricula with MGI content; identify, develop, and package instructional modules; develop targeted short courses, boot camps, and summer schools; and articulate foundational MGI moonshot objectives.

"Although the goals will take time and planning, it is clear across sectors that the needs of the MGI workforce require action now."

The demand-side action plans address the following three recommendations: solicit input from industry and government laboratories regarding necessary MGI workforce knowledge and skills; develop a summit event for executives and communicate to the broader community; and create a web-based registry to document MGI successes.

The study's findings, recommendations, and action plans will help to accelerate workforce development in the next decade. Although the goals will take time and planning, it is clear across sectors that the needs of the MGI workforce require action now. As the study concludes, "major emergent R&D themes such as additive manufacturing and artificial intelligence in materials discovery and development resonate strongly with the MGI, and in fact it is difficult to see how to move forward in these directions without the MGI." The path to innovation necessitates strong talent; the path's navigation takes the shape of this report.

JOM, Vol. 72, No. 7, 2020
https://doi.org/10.1007/s11837-020-04231-3

TMS Presents the 2021 Board of Directors Nominees

Kelly Zappas

The individuals highlighted in the following pages have been nominated to fill two open positions on the TMS Board of Directors: Vice President/President/Past President (the three-year Presidential Rotation) and Programming Director.

These candidates, if elected by the TMS membership, will be installed at the conclusion of the TMS 2021 Annual Meeting & Exhibition, scheduled for March 14–18, 2021, in Orlando, Florida.

Additional nominations for these positions may be submitted for board consideration by any 25 TMS members by August 15, 2020. Nominations for qualified individuals should be sent to James J. Robinson, TMS Executive Director, at robinson@tms.org, and should include the nominee's name, biography, and written consent to serve if elected.

If additional candidates are proposed, a majority vote of TMS members will determine who fills the position. If no new nominations are received, the individuals named in this article will be automatically elected on **August 16, 2020**.

Many board leaders began as members of a TMS technical committee. If you aspire to Society leadership, find out more about how you can get involved today. Visit the TMS Divisions & Committees web pages at www.tms.org/Committees to choose the technical committee that best matches your interests and contact the chair about becoming a member. Committee membership is open exclusively to TMS members.

The nominees for the open positions on the 2021–2024 TMS Board of Directors are:

Vice President

W. Jud Ready
Georgia Institute of Technology

W. Jud Ready is the deputy director, Innovation Initiatives, for the Georgia Institute of Technology (Georgia Tech) Institute for Materials. He has also been an adjunct professor in the School of Materials Science & Engineering at Georgia Tech and a principal research engineer on the research faculty of Georgia Tech Research Institute (GTRI) for 17 years.

Prior to joining the Georgia Tech faculty, he worked for a major military contractor, General Dynamics, as well as in small business at MicroCoating Technologies. He has served as principal investigator (PI) or co-PI for grants totaling approximately $18 million awarded by the U.S. Army, Navy, Air Force, Defense Advanced Research Projects Agency, NASA, National Science Foundation (NSF), National Institute of Standards and Technology, industry, charitable foundations, private citizens, and the states of Georgia and Florida.

His current research focuses primarily on energy, aerospace, nanomaterial applications, and electronics reliability. Ready has more than 1,700 citations from his numerous refereed publications on electronic and nanoscale materials, and his research developments have been presented at well over two dozen international conferences, including invited talks in Prague, Hong Kong, Berlin, Tokyo, Uzbekistan, Austria, and Chile.

In 2002, Ready received the TMS Young Leaders Professional Development Award from the TMS Electronic, Magnetic & Photonic Materials Division (now the Functional Materials Division). In 2006, he was selected as the TMS/Japan Institute of Metals and Materials Young Leaders International Scholar. He has served as chair of the TMS Nanotechnology, Education, and Membership & Student Development Committees. He was first elected to the TMS Board of Directors in 2005 as director of Membership & Student Development and again in 2010 as director of Content Development & Dissemination. In 2015, he was named a TMS Brimacombe Medalist, which recognizes mid-career individuals for sustained excellence and achievement in business, technology, education, public policy, or science related to materials science and engineering.

Programming Director

Timothy Rupert
University of California, Irvine

Tim Rupert is an associate professor of materials science and engineering at the University of California, Irvine, with a joint appointment in mechanical and aerospace engineering. He received a B.S./M.S. in mechanical engineering from Johns Hopkins University in 2007 and a Ph.D. in materials science and engineering from the Massachusetts Institute of Technology (MIT) in 2011.

Rupert's research focuses on uncovering new structure-property relationships in nanomaterials for structural and energy applications, as well as increasing the reliability and lifetime of these materials. To achieve their research goals, his lab uses a combination of computational and experimental techniques.

In recent years, Rupert has received an NSF CAREER Award, a U.S. Department of Energy Early Career Research Program Award, an Army Research Office Young Investigator Program Award, a Hellman Fellowship, the ASM International Bradley Stoughton Award for Young Teachers, and the AIME-TMS Rossiter W. Raymond Memorial Award. He serves on the editorial boards of *Materials Science and Engineering A, Metallurgical and Materials Transactions A,* and *Scientific Reports.*

Rupert has served TMS in a number of capacities. He is the current chair of the Thin Films and Interfaces Committee, following terms as vice-chair and secretary. He has also been a Programming Committee representative, served on the Awards Subcommittee, and was a Young Leaders representative for the Structural Materials Division Council. Rupert recently helped lead the planning and implementation of the inaugural Frontiers of Materials Award.

2020 TMS Board of Directors

The current members of the TMS Board of Directors, installed at the conclusion of the TMS 2020 Annual Meeting & Exhibition in February, are as follows:

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Thomas Battle
Extractive Metallurgy Consultant

Vice President
Ellen K. Cerreta
Deputy Division Leader, Explosive Science and Shock Physics Division, Los Alamos National Laboratory

Past President
James C. Foley
Sigma-1 Group Leader, Los Alamos National Laboratory

Financial Planning Officer
Charles H. Ward
Chief of the Manufacturing and Industrial Technologies Division, U.S. Air Force Research Laboratory's Materials and Manufacturing Directorate

TMS Secretary (non-voting)
James J. Robinson
Executive Director, TMS

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Judith Schneider
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Professional Development Director/Chair
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Temple Foundation Professor of Mechanical Engineering, The University of Texas at Austin

Programming Director/Chair
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Distinguished Member of the Technical Staff, Sandia National Laboratories

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Associate Professor, University of Pittsburgh

Light Metals Division Director/Chair
Eric Nyberg
Technology Development Manager, Tungsten Heavy Powder & Parts

Materials Processing & Manufacturing Division Director/Chair
Mark R. Stoudt
Materials Research Engineer, National Institute of Standards and Technology

Structural Materials Division Director/Chair
Daniel Miracle
Senior Scientist, Air Force Research Laboratory

JOM, Vol. 72, No. 7, 2020
https://doi.org/10.1007/s11837-020-04232-2

TMS Welcomes New Members

The TMS Board of Directors approved professional membership for the following individuals at its April 2020 meeting. Please join us in congratulating and welcoming them to all the privileges and benefits of TMS membership.

Abdullaev, Azat; Nazarbayev University, Kazakhstan

Abraham, Tim; Fraunhofer Institute IST, Germany

Acevedo, Claire; University of Utah, United States

Ackerman, Abigail; Imperial College London, United Kingdom

Adcock, Peter A.; South Dakota School of Mines & Technology, United States

Adeleke, Sakiru A.; Abubakar Tafawa Balewa University, Nigeria

Adewale, Adeleke Abraham; Obafemi Awolowo University, Nigeria

Adilson De Castro, Jose; Universidade Federal Fluminense, Brazil

Agiannitis, Panagiotis; Bridgnorth Aluminum Ltd., United Kingdom

Aherwar, Amit; Madhav Institute of Technology and Science, Gwalior, India

Ahmad, Shahin; Aditya Birla Science & Tech. Co. Pvt Ltd., India

Ahmed, Abdulla; Aluminium Bahrain (Alba), Bahrain

Aichi, Taro; Dowa Metals and Mining, Japan

Alabort, Enrique; Oxmet Technologies Ltd., United Kingdom

Alapiha, Risto; Boliden Kokkola Oy, Finland

Albenze, Erik; Department of Energy/National Energy Technology Laboratory, United States

Alder, William A.; United States

Ali, Syed Arif; Rio Tinto, Canada

Alkan, Kivanc; Roketsan Inc., Turkey

Allu, Srikanth; Oak Ridge National Laboratory, United States

Altuner, Hatice Mollaoglu; Assan Aluminum, Turkey

Alvarez, Ana Cecilia; Selee Corporation, United States

Alvarez Montano, Victor Emmanuel; Universidad De Sonora, Mexico

Amorim Melo, Caio César C.A.; Norsk Hydro Brasil, Brazil

An, Qi; University of Nevada, Reno, United States

Anderson, John; Wood Mackenzie, United Kingdom

Andruschak, Nicholas; Chrysalix Venture Capital, Canada

Angelov, Gavrail; KCM Technology Eood, Bulgaria

Annamareddy, Ajay; University of Wisconsin-Madison, United States

Antillon, Edwin; Naval Research Laboratory, United States

Antoni-Zdziobek, Annie; Grenoble INP/SIMaP, France

Aotani, Koichiro; Nissan Motor Co. Ltd., Japan

Aparicio, Conrado; University of Minnesota, United States

Aranas, Clodualdo; University of New Brunswick, Canada

Aranda, Michell; Jet Propulsion Laboratory, United States

Araya Bravo, Claudia; Chemetics Inc., Chile

Armendariz, Guillermo; Met Mex Penoles, Mexico

Aronhime, Natan; Carpenter Technology, United States

Arzt, Eduard; Institute for New Materials, Germany

Atzmon, Michael; University of Michigan, United States

Aubert, Guillaume; ICMCB-CNRS, France

Auchter, Eric; State Department, United States

Aucott, Lee; United Kingdom Atomic Energy Authority, United States

Ausec, Don; Navy Nuclear Laboratory, United States

Azar, Amin; SINTEF, Norway

Blyskun, Piotr; Warsaw University of Technology, Poland

Bache, Solène; Rio Tinto, France

Bachhav, Mukesh; Idaho National Laboratory, United States

Baehr, Heinz; Aircraft Philipp Group, Germany

Bak, Seongmin; Brookhaven National Laboratory, United States

Bakas, Michael P.; Army Research Office, United States

Baker, Camille; Honeywell FM&T, United States

Balachandran, Prasanna Venkataraman; University of Virginia, United States

Balakrishna, Ananya; University of Minnesota/University of Southern California, United States

Balde, Mamadou; ArcelorMittal, France

Bang, Jaeoh; SEMES, South Korea

Banish, R. Michael; University of Alabama in Huntsville, United States

Bansil, Arun; Northeastern University, United States

Barba, Daniel; University of Oxford, United Kingdom

Baron, David; Canada

Bartkowski, Piotr; Warsaw University of Technology, Poland

Bartlett, Collin; Outotec, Canada

Baumbach, Ryan E.; Florida State University, United States

Bazarnik, Piotr; Warsaw University of Technology, Poland

Beamer, Chad M.; Quintus Technologies, United States

Becerra, Ana Maria; Outotec GmbH & Co. KG, Germany

Beeler, Benjamin W.; North Carolina State University, United States

Behler, Kristopher; ARL (SURVICE Engineering), United States

Behrmann, Dirk; Kuettner GmbH Co. KG, Germany

Beinerts, Toms; University of Latvia, Latvia

Bellamy, Michael; United Kingdom

Belland, Gregory; Nyrstar, Netherlands

Ben Khalifa, Noomane; Helmholtz-Zentrum Geesthacht, Germany

Berchtold, Dominik; NKM Noell Special Cranes GmbH, Germany

Bernardi, Marco; Caltech, United States

Berthebaud, David; CNRS, Japan

Bezushenko, Andrei; Volzhsky Abrasive Works, Russia

Bhate, Dhruv; Arizona State University, United States

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Bian, Linkan; Mississippi State University, United States

Bieda-Niemiec, Magdalena; IMMS PAS, Poland

Birry, Laurent; Rio Tinto Aluminium, Canada

Biswas, Sudipta; Idaho National Laboratory, United States

Blanpain, Bart J.; KU Leuven, Belgium

Bober, David; Lawrence Livermore National Laboratory, United States

Bohlen, Annika; Bias GmbH, Germany

Bohlen, Jan; Helmholtz-Zentrum Geesthacht, Germany

Boleininger, Max; U.K. Atomic Energy Authority, United Kingdom

Bollero, Alberto; IMDEA Nanociencia, Spain

Bolzoni, Leandro; The University of Waikato, New Zealand

Bonafos, Caroline; CEMES CNRS, France

Bonduelle, Anne Sophie; Jean Goldschmidt International SA, Belgium

Bonnamy, Sylvie; CNRS, France

Boscato, Manuel; Ikoi S.R.L., Italy

Bourahima, Fazati; Chpolansky, France

Bourgès, Cédric; NIMS, Japan

Bradshaw, Rich C.; Boston Metal, United States

Bradwell, David; Ambri Inc., United States

Brassart, Eric; Nyrstar, France

Brazil, Owen; Texas A&M University, United States

Bridges, Kara; Pratt and Whitney, United States

Britz, David A.; Applied Materials, United States

Broadbent, Curtis; University of Rochester, United States

Bryan, Matthew S.; Oak Ridge National Laboratory, United States

Burheim, Odne Stokke; Norwegian University of Science and Technology, Norway

Burns, Malcolm John; Los Alamos National Laboratory, United States

Burr, Patrick A.; UNSW Sydney, Australia

Bush, Andy; International Lead Association, United Kingdom

Buzunov, Viktor Yurievitch; RUSAL ETC, Russia

Byun, Myunghwan; Keimyung University, South Korea

Callahan, Patrick; U.S. Naval Research Laboratory, United States

Cannell, Gary R.; Fluor Enterprises, United States

Cantor, Brian; Oxford University, United Kingdom

Capek, Jan; Paul Scherrer Institute, Switzerland

Cappia, Fabiola; Idaho National Laboratory, United States

Caron, Francis; Alcoa, Canada

Caron, Luana; Bielefeld University, Germany

Castro, Daniel; Williams Companies Inc., United States

Cervellon, Alice; University of California Santa Barbara, United States

Chae, Eul Yong; Hyundai Motor Company, South Korea

Chagnes, Alexandre; Université de Lorraine-Georess, France

Chakraborti, Nirupam; Indian Institute of Technology, India

Chambers, Timothy; University of Michigan, United States

Chan, Choen-May; Wood, United Kingdom

Chandrasekar, Srinivasan; Purdue University, United States

Chang, Ting-Ting; Industrial Technology Research Institute, Taiwan

Changlani, Hitesh J.; Florida State University, United States

Chaphalkar, Shirin; United States

Chapman, David J.; University of Oxford, United Kingdom

Chaput, Laurent; Lorraine University, France

Chaterjee, Abhrajit; Uniseven Engineering, India

Chatterjee, Arya; University of Michigan, United States

Chattopadhyay, Aditi; Arizona State University, United States

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Chen, Aiping; Los Alamos National Laboratory, United States

Chen, Chuantong; Osaka University, Japan

Chen, Jhewn-Kuang; National Taipei University of Technology, Taiwan

Chen, Lihua; Georgia Institute of Technology, United States

Chen, Nanjun; Pacific Northwest National Laboratory, United States

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Chen, Wei; Illinois Institute of Technology, United States

Chen, Xin; University of California Los Angeles, United States

Chen, Zheng; University of California San Diego, United States

Chendurpandian, Chandru; Hindustan Zinc Ltd., India

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Cheng, Jonathan; University of Rochester, United States

Chernenko, Volodymyr; Fundación BCMaterials, Spain

Chi, Ike; Jet Propulsion Laboratory, United States

Chiaramonti, Ann; National Institute of Standards and Technology, United States

Ching, Wai-Yim; University of Missouri-Kansas City, United States

Cho, Lawrence; National Institute of Standards and Technology-Boulder, United States

Cho, Yong Chan; Korea Research Institute of Standards and Science, South Korea

Choi, Seokheun; State University of New York at Binghamton, United States

Chong, Yan; University of California Berkeley, United States

Chrominski, Witold; Warsaw University of Technology, Poland

Chun, Dongwon; Korea Institute of Science and Technology, South Korea

Cilianu, Marin; ALRO S.A., Romania

Cocco, Alex; U.S. Army Research Laboratory, United States

Colwill, Troy; Rio Tinto, United States

Cook, John; Xerion Advanced Battery Corp., United States

Cooper, Khershed P.; National Science Foundation, United States

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Crane, Jeffrey; K-Tube Technologies, United States

Culp, Jeffrey; Battelle Memorial Institute, United States

Cumaranatunge, Lasitha; Novelis Inc., United States

Cusentino, Mary Alice; Sandia National Laboratories, United States

Cybulski, Andrzej Stanislaw; Lukasiewicz-Institute of Non-Ferrous Metals, Poland

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Da Silva, Alisson K.; Max-Planck Institut für Eisenforschung, Germany

Dabo, Ismaila; Pennsylvania State University, United States

Dai, Qiang; Argonne National Laboratory, United States

Daphalapurkar, Nitin; Los Alamos National Laboratory, United States

Dasgupta, Neil; University of Michigan, United States

Dattelbaum, Dana; Los Alamos National Laboratory, United States

Davey, Theresa; Tohoku University, Japan

Davidson, Karl Peter; HP-NTU Digital Manufacturing Corporate Lab, Singapore

Davis, Alec E.; University of Manchester, United Kingdom

Daviy, Julia; New Age Clothing Lab, United States

De Wild, Gerard; NKM Noell Special Cranes GmbH, Germany

De Wilde, Evelien; Umicore, Belgium

Dean, Andrew; Nyrstar, United States

Decaluwe, Steven C.; Colorado School of Mines, United States

Decamps, Brigitte C.; IJCLAB/CNRS, France

Deckers, Kristiaan; Rezinal, Belgium

Demange, Gilles; CNRS-University of Rouen Normandy, France

Demaree, John Derek; CCDC Army Research Laboratory, United States

Demetriou, Marios D.; Glassimetal Technology, United States

Demir, Ali Gökhan; Politecnico di Milano, Italy

Depelteau, Marc; CDB, Canada

Dessolier, Thibaut; Imperial College London, United Kingdom

Dewald, Jay; Nyrstar Tennessee Mines, United States

Dezerald, Lucile; Institute Jean Lamour, France

Dias, Maria Jose; Nexa Resources, Brazil

Dicus, Austin; Carpenter Technology, United States

Diefenbach, Angelika; DLR Microgravity User Support Center, Germany

Difonzo, John; Apple, United States

Ding, Xiaxin; Idaho National Laboratory, United States

Dobbelaere, Wim; Opeccellente SRL, Italy

Doganov, Georgi; KCM AD, United States

Dolinsek, Janez; Jozef Stefan Institute, Slovenia

Donik, Crtomir; Institute of Metals and Technology, Slovenia

Dos Santos, Antonio; Oak Ridge National Laboratory, United States

Doux, Jean-Marie; University of California, San Diego, United States

Drakopoulos, Michael; Brookhaven National Laboratory, United States

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Drazkowski, Daniel B.; Naval Nuclear Laboratory, United States

Drezdzon, Mark; RSR Technologies, United States

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Drozdenko, Daria; Nuclear Physics Institute, Czech Republic

Duncan, Anne; Hatch, United States

Dundar, Murat; Assan Aluminum, Turkey

Dupin, Nathalie J.; Calcul Thermodynamique, France

Dupuis, Claude; Rio Tinto, Canada

Dursun, Aziz; Assan Aluminum, Turkey

Duscher, Gerd; University of Tennessee Knoxville, United States

Ebihara, Ken-Ichi; Japan Atomic Energy Agency, Japan

Ebin, Burçak; Chalmers University of Technology, Sweden

Ebner, Tamara; Montanuniversitaet Leoben, Austria

Ecker, Lynne; Brookhaven National Laboratory, United States

Eckert, Chad E.; Johnson & Johnson, United States

Eddir, Tareq; Fluxtrol Inc., United States

Edick, Jacob D.; Nanomag LLC, United States

Efe, Mert; Pacific Northwest National Laboratory, United States

Egli, Mette; General Electric, Aluminium, Norway

Ek, Magnus; Boliden, Sweden

Elder, Gregory; Scepter Inc., United States

El-Hadad, Shimaa; Central Metallurgical Research and Development, United States

Ellis, Brett Daniel; University of Maine, United States

Emota, Daiki; Kosaka Smelting & Refining Co. Ltd., Japan

Eriksen, Dag Øistein; Primus.Inter.Pares AS, Norway

Erisir, Ersoy; Kocaeli University, Turkey

Ertorer, Osman; Oryx Advanced Materials, United States

Etienne, Auriane; CNRS GPM/Université de Rouen Normandie, France

Euh, Kwangjun; Korea Institute of Materials Science, South Korea

Eykens, Koen; Campine Recycling, Belgium

Fahami, Abbas; Eurofins EAG Laboratories, United States

Fahler, Sebastian; Leibniz IFW Dresden, Germany

Fan, Yong; TU Freiberg, Germany

Fancher, Chris; Oak Ridge National Laboratory, United States

Fatemi, Ali; University of Memphis, United States

Fauber, Erin N.; Amcor, United States

Feng, Zhiyuan; University of Kentucky, United States

Fernandes, Vanderlei; Albras - Aluminio Brasileiro SA, Brazil

Ferry, Sara Elizabeth; Massachusetts Institute of Technology, United States

Flampouri, Athanasia; Elkeme SA, Greece

Fluss, Michael J.; Nuclear Materials Consultancy, United States

Fok, Alex; University of Minnesota, United States

Fonseca, Daniela; RHI Magnesita, Austria

Fort, Lorene; Carbone Savoie, France

Franco, Alejandro A.; Université de Picardie Jules Verne, France

Frederick, Curtis Lee; Carl Zeiss, United States

Freitas, Stephen; IMI CCI, United States

Frenzel, Jan; Ruhr University Bochum, Germany

Frias Gomez, Carlos; Cobre Las Cruces SA, Spain

Friese, Karen; Forschungszentrum Juelich GmbH, Germany

Friis Poulsen, Henning; DTU, Denmark

Frint, Philipp; Chemnitz University of Technology, Germany

Fu, Daxue; Northeastern University, China

Fu, Jia; Delft University of Technology, Netherlands

Fu, Wenkai; Pacific Northwest National Laboratory, United States

Fuentes, Adolfo; Met Mex Penoles, Mexico

Fujita, Asaya; AIST, Japan

Furukawa, Atsushi; Honda R&D Co. Ltd., Japan

Gakhar, Ruchi; Idaho National Laboratory, United States

Galenko, Peter; Friedrich Schiller University Jena, Germany

Galli, Giulia; University of Chicago, United States

Ganesh, Panchapakesan; Oak Ridge National Laboratory, United States

Gao, Meng; University of Wisconsin-Madison, United States

Gao, Si; Kyoto University, Japan

Gao, Yan; GE Research, United States

Garay, Javier E.; University of California, San Diego, United States

Garcia, Juan; Metalurgica Met-Mex Penoles SA de C.V., Mexico

Garrett, Glenn R.; United States

Gaskey, Bernard; Nanyang Technological University, Singapore

Geandier, Guillaume; IJL CNRS (UMR 7198), France

Gelbstein, Yaniv; Ben-Gurion University, Israel

Gelinas, Patrick; CDB, Canada

Genée, Julien; Lorraine University/LEM3, France

Georgakopoulos, Evangelos; TU Delft, Netherlands

Gerbig, Yvonne B.; National Institute of Standards and Technology, United States

Gershen, Adam; Naval Surface Warfare Center, Carderock Division, United States

Gibbins, Ian; United Kingdom

Gibmeier, Jens; Karlsruhe Institute of Technology, Germany

Gigax, Jonathan; Los Alamos National Laboratory, United States

Gill, Simerjeet; Brookhaven National Laboratory, United States

Godlewska, Elzbieta M.; AGH University of Science and Technology, Poland

Gofryk, Krzysztof; Idaho National Laboratory, United States

Golden, Patrick; Air Force Research Laboratory, United States

Goldman, Nir; Lawrence Livermore National Laboratory, United States

Golem, Lindsay L.; Gestamp, United States

Gonzales, Manny; Air Force Research Laboratory, United States

Gould, Benjamin; Argonne National Laboratory, United States

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Grazyna, Makowska; Paul Scherrer Institute, Switzerland

Greenlee, Joseph; CNS, United States

Grundy, Anthony; Thermo-Calc Software AB, Sweden

Gruner, Markus Ernst; University of Duisburg-Essen, Germany

Gu, Tianhong; Imperial College London, United Kingdom

Gubel, Nathan; CNS, United States

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Guo, Jicheng; Argonne National Laboratory, United States

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Gupta, Arunava; University of Alabama, United States

Gustmann, Tobias; Fraunhofer IWU, Germany

Guzman-Leong, Consuelo E.; LPI Inc., United States

Haarberg, Geir-Martin M.; Norwegian University of Science & Technology, Norway

Haden, Garrett; Shell Oil Company, United States

Haggerty, Ryan; Sandia National Laboratories, United States

Haghshenas, Meysam; University of Toledo, United States

Hahn, Yoon-Bong; Jeonbuk National University, South Korea

Haines, Chris D.; CCDC Army Research Laboratory, United States

Haley, James C.; Oak Ridge National Laboratory, United States

Hamilton, Ernie R.; Limpact International, Canada

Hammerschmidt, Jörg; Outotec GmbH & Co. KG, Germany

Hammerschmidt, Thomas; Ruhr University Bochum, Germany

Han, Jun Hyun; Chungnam National University, South Korea

Han, Junsoo; University of Virginia, United States

Hance, Brandon Michael; U.S. Steel, United States

Handayani, Dika; Cal Poly Pomona, United States

Haouaoui, Mohammed; Mantle Inc., United States

Harada, Hiroshi; NIMS, Japan

Harahap, Rainaldy; PT Indonesia Asahan Aluminium, Indonesia

Harie, Takahiro; Mitsui Mining & Smelting, Japan

Harris, Cameron Leslie; Canadian Engineering Associates, Canada

Harris, Erika; U.S. Army Ground Vehicle Systems Center, United States

Hart, Gus LW; Brigham Young University, United States

Hasegawa, Tetsuya; University of Tokyo, Japan

Hassall, Claire; CHR Metals, United Kingdom

Hawthorne, Krista; Argonne National Laboratory, United States

Haynes, James A.; Oak Ridge National Laboratory, United States

Hazan, Joseph; Technion Israel Institute of Technology Haifa, Israel

Hazeli, Kavan; University of Alabanma in Huntsville, United States

Hecht, Ulrike; Access E.V., Germany

Heczko, Milan; The Ohio State University, United States

Heineman, William; University of Cincinnati, United States

Heintzmann, Pascal; DLR Space Administration, Germany

Hekmat, Alireza; Pyrotek, Canada

Helgadóttir, Sigrún; Nordural Grundartangi, Iceland

Hellsten, Niko; Aalto University, Finland

Hemadi, Miryana; Université de Paris, France

Henn, Manuel; Institut für Strahlwerkzeuge, Germany

Henry, Chris; HRL Laboratories LLC, United States

Henry, Philippe; Jean Goldschmidt International SA, Belgium

Heo, Tae Wook; Lawrence Livermore National Laboratory, United States

Herbig, Michael; Max-Planck-Institute for Iron Research, Germany

Herrera, Raul; Mexico

Herring, Carl; Vesuvius, United States

Hesterberg, Travis; RSR Technologies, United States

Hilding, Patrik; Scanarc Plasma Technologies AB, Sweden

Hirsi, Tuomas; Outotec, Finland

Hockaday, Susanna Aletta Carolina; Mintek, South Africa

Hoffman, Christopher; Markforged, United States

Hoffman, James; Nyrstar, United States

Hoffman, Nolan; U.S. Army ERDC, United States

Hogan, James; University of Alberta, Canada

Hohenwarter, Anton; University of Leoben, Austria

Holtzhouser, Emily; Depuy Synthes, United States

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***Membership grade recommendations are based on a review of credentials provided by the individuals. These credentials are taken on the honor system and not independently verified except by exception.**

JOM, Vol. 72, No. 7, 2020
https://doi.org/10.1007/s11837-020-04233-1

JOM themagazine

TMS meeting headlines

Meeting dates and locations are current as of May 11.
For the most up-to-date list of TMS-sponsored events, visit www.tms.org/Meetings.

Other Meetings of Note

The 11th International Conference on Molten Slags, Fluxes and Salts (Molten 2021)
February 21–25, 2021
Seoul, South Korea

The 6th World Congress on Integrated Computational Materials Engineering (ICME 2021)
April 18–22, 2021
Lake Tahoe, Nevada, USA

Solidification Course 2021
May 30–June 4, 2021
Villars-sur-Ollon, Switzerland

5th International Congress on 3D Materials Science (3DMS 2021)
June 29–July 2, 2021
Washington, D.C., USA

Additive Manufacturing Benchmarks (AM-Bench 2021)
July 12–15, 2021
Bethesda, Maryland, USA

The 13th International Conference on the Technology of Plasticity (ICTP 2021)
July 25–30, 2021
Columbus, Ohio, USA

Liquid Metal Processing & Casting 2021 (LMPC 2021)
September 19–22, 2021
Philadelphia, Pennsylvania, USA

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

TMS METALLURGICAL AND MATERIALS PROFESSIONAL ENGINEER (PE) LICENSING EXAM REVIEW COURSE

August 12–15, 2020
TMS Headquarters Office
Pittsburgh, Pennsylvania, USA
Discount Registration Deadline: July 12, 2020
www.tms.org/PEReview2020

- This course is designed for professionals planning to take the Metallurgical and Materials Professional Engineering (PE) Licensing Exam by the National Council of Examiners for Engineering and Surveying (NCEES).
- The three-and-a-half-day course includes presentations in a small group setting with opportunities to address topical questions, share exam experiences, and discuss solutions to practice problems for a more customized learning experience.

MS&T20
MATERIALS SCIENCE & TECHNOLOGY

October 4–8, 2020
David L. Lawrence Convention Center
Pittsburgh, Pennsylvania, USA
www.matscitech.org/MST20

- Materials Science & Technology 2020 (MS&T20) is the most comprehensive forum for materials science and engineering technologies, supported by the strengths of three major materials organizations: The American Ceramic Society (ACerS), Association for Iron & Steel Technology (AIST), and The Minerals, Metals & Materials Society (TMS).
- Approximately 100 symposia are planned for MS&T20—a 10% increase from previous years!
- Excellent exhibit opportunities are available that offer exposure to three technical conferences for one exhibition price. Connect to thousands of diverse attendees in minerals, metals, ceramics, and glass.

TMS2021
150th Annual Meeting & Exhibition

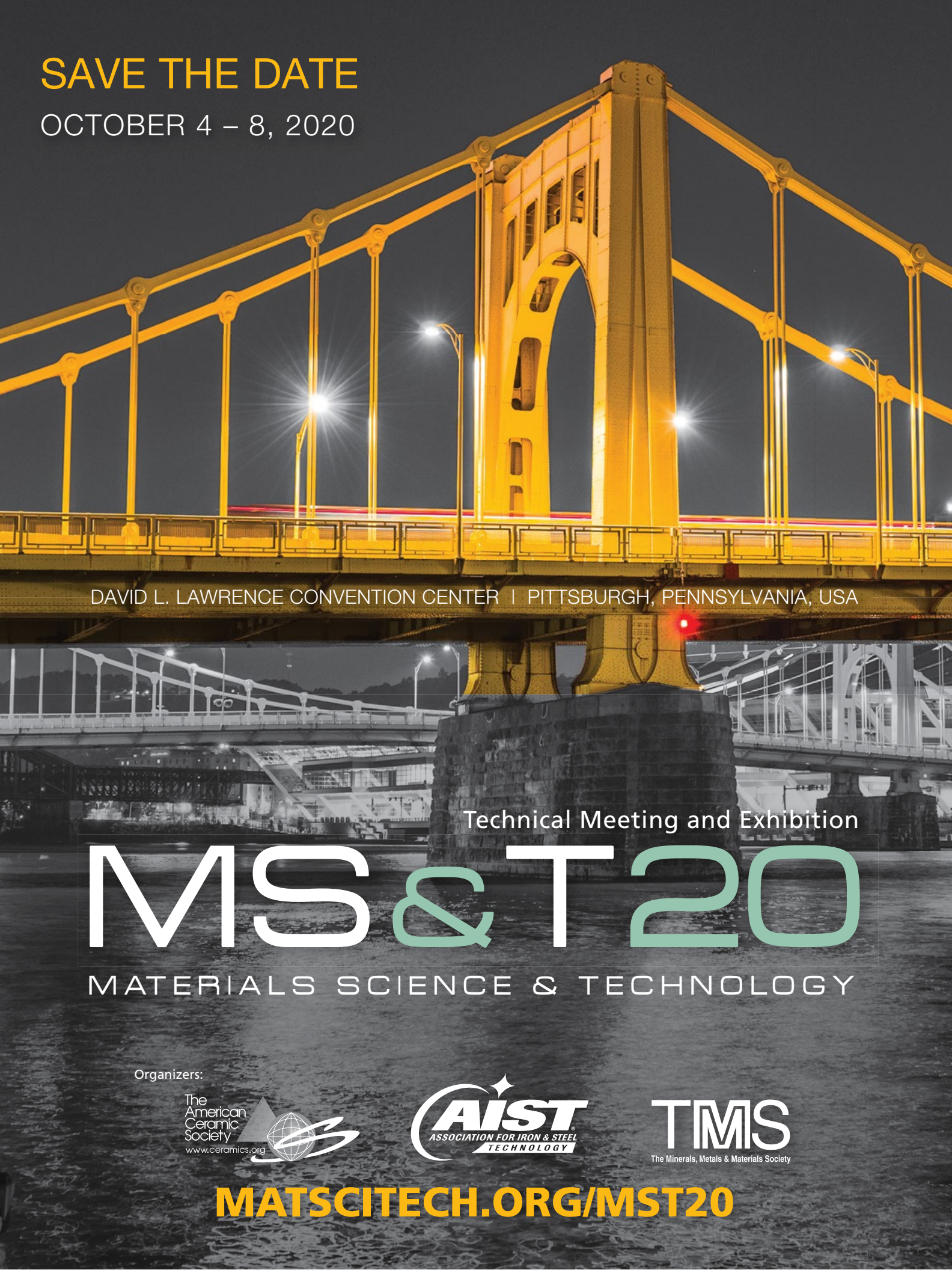
March 14–18, 2021
Orlando World Center Marriott
Orlando, Florida, USA
www.tms.org/TMS2021

- The 150th anniversary of the TMS Annual Meeting & Exhibition (TMS2021) will gather more than 4,000 engineers, scientists, business leaders, and other professionals for an unprecedented celebration of advances in materials science and the exciting road ahead.
- Be sure to attend the All-Conference Plenary Session on Monday, March 15, featuring Anne Lauvergeon, founder and CEO of ALP; chair, École des Mines de Nancy; and former CEO of Areva S.A.
- Co-located at TMS2021, Diversity in Minerals, Metals, and Materials Professions 4 will discuss actionable strategies for advancing diversity, inclusion, and equity in the workplace.

2021 Mg 12th International Conference on Magnesium Alloys and their Applications

June 15–18, 2021
Hotel Omni Mont-Royal
Montreal, Canada
Abstract Submission Deadline: September 15, 2020
www.tms.org/Mg2021

- Start making plans now to be a part of the longest-running conference dedicated to the development of magnesium alloys. Submit an abstract to the 12th International Conference on Magnesium Alloys and their Applications (Mg 2021).
- Sponsorship and tabletop exhibit opportunities are available for reaching the light metals community. Visit the Exhibits & Sponsorship page of the Mg 2021 website for details.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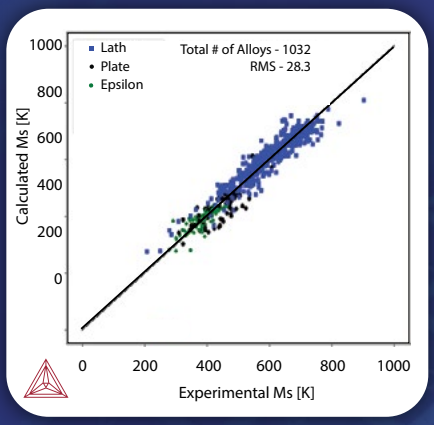
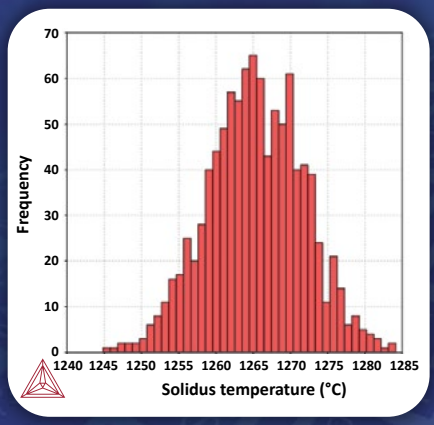


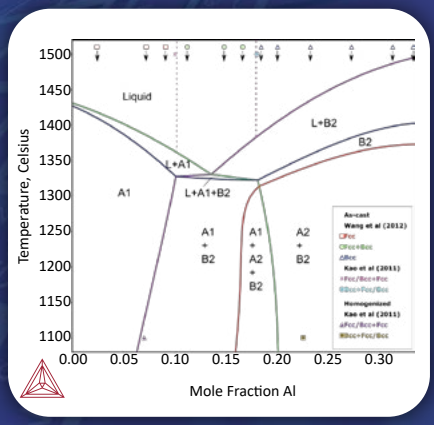
Comparison of calculated and experimental Ms temperatures for a wide range of steels

Nickel



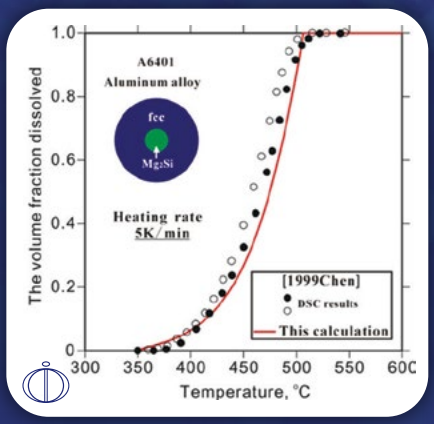
Variation in solidus temperature over 1000 compositions within alloy 718 specification

High Entropy Alloys



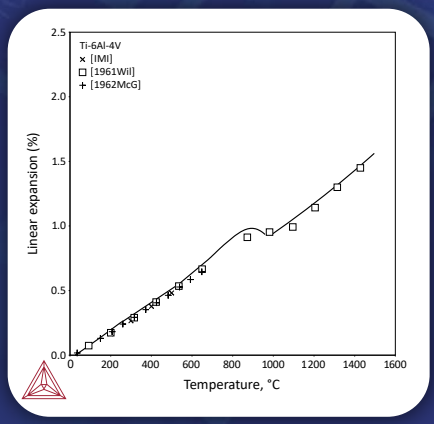
Calculated phase diagram along the composition line of CoCrFeNi-Al

Al Alloys



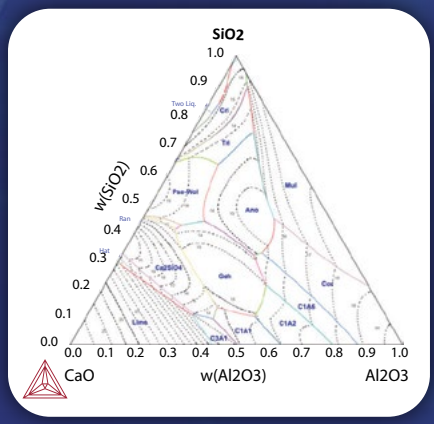
Dissolution of Mg2Si precipitate in Alloy A6401

Ti and TiAl Alloys



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

Oxides



Ternary liquidus projection in oxide systems

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