

JOMI THE MAGAZINE

SEPTEMBER 2024

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News and insights about TMS, its members


and the professions it serves

CRAFTING LEGENDS: 2024 TMS BLADESMITHING COMPETITION



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/// ABOUT THE COVER



This month's cover features three of the winning entries from the 2024 TMS Bladesmithing Competition, held at the TMS 2024 Annual Meeting & Exhibition. Beginning on page 6 is a feature article that showcases all of this year's entries, names the 2024 winners, and pays tribute to a member who was influential in building the TMS Bladesmithing Program. Cover designed by David Rasel, TMS Senior Manager, Brand and Digital Assets.



Access Technical Journal Articles

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

About *JOM: The Magazine*:

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

About TMS:

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

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IN THE FINAL ANALYSIS

"Each conference feels like a world unto itself—a cosmos of lanyards, printed schedules and elevator banter with other wearers of lanyards. . . . Conferences offer just the right blend of social interaction and reflection for an introvert like me. You can listen to keynote speakers and attend a breakout workshop, then retreat to your room or disappear into a cozy, slightly hidden chair in the lobby. . . . People are warm and friendly, even the somewhat frazzled organizers."

— Julia Cho, "My Secret to Creative Rejuvenation? Conferences," *The New York Times*

As quoted above, Julia Cho taps into the universal and exhilarating *je ne sais quoi* that one invariably experiences when attending a good conference. For decades, I've heard the same sentiment articulated by our members about their TMS-conference-going adventures. I've experienced it myself when attending TMS events, the events of other professional materials societies, and meetings convened for association professionals such as those of us on the TMS headquarters staff. Spending a few days at an event like the TMS Annual Meeting & Exhibition or next month's Materials Science & Technology (MS&T) conference is about much more than giving a talk, taking in a presentation, visiting an exhibitor, or having an engaging chat over coffee. It's all of that and more, with the totality of the interactions comprising a joyful experience by mingling with new acquaintances, long-time friends and colleagues, mentors, and the occasional superheroes of the profession.

Delivering "creative rejuvenation" to a discerning and expectant audience is a heavy responsibility and a not-inconsequential challenge for the organizing team that issues the lanyards. Conference organization is certainly an essential function of TMS, and it is one that an army of volunteers and an array of professional staff and contractors work very hard to deliver in an expert fashion.

We can always, always do better, but I'll admit to some joy in our conference organization skills based on input from this year's biennial TMS membership survey. Some of the questions probed to determine member thoughts on 19 activities in which TMS is engaged. Without letting this column get obsessed with data and general wonkiness, I'll largely confine my observations to the fact that the TMS activity that members value most highly is our conduct of conferences.

No less an authority than ChatGPT says, after ingesting the survey results, "members overwhelmingly rate 'conduct conferences' as highly valuable and the performance in this area as excellent. This indicates that conferences are a key offering that meets member needs and expectations. . . . 'Conducting conferences' is the single most highly valued activity by TMS members. This reflects the importance of in-person networking, learning, and professional development opportunities that conferences provide." The A.I. then pulled a trio of observations from the open comments section:

- "The format and the level of useful content in technical symposia is among the best that I've experienced."
- "Interactions generated by TMS along with the quality and variety of talks at the annual meeting drive motivation to be active in this great society."
- "Quality conferences that bring passionate individuals invigorates us all and drives myself to present my best self at these meetings."

Shifting from A.I. to plain old "Jim intelligence," I see that 74% of survey respondents say that the TMS conduct of conferences is of "high value" to them as members, and 74% of respondents say that the performance of the Society in this area is "excellent." These are the leading responses in their categories.

Were there any negative comments on how TMS convenes conferences? You bet! Some have concerns about conference fees being too high, the app is unloved by many, and there are always situational instances that could be better. So, what do we do with this feedback?

Easy: We listen, we learn, we try harder, and sometimes we improve.



James J. Robinson
Executive Director



James Robinson

"Conference organization is certainly an essential function of TMS, and it is one that an army of volunteers and an array of professional staff and contractors work very hard to deliver in an expert fashion."

JOM TECHNICAL TOPICS

Find peer-reviewed technical articles covering the full range of minerals, metals, and materials science and engineering in the September issue of *JOM: The Journal*. Each issue features several technical topics presenting a series of related articles compiled by guest editors. A preview of September technical topics and articles are listed below. TMS members can log in to www.tms.org/Journals for full access to technical articles from *JOM: The Journal* and additional TMS journals.

Below is a sample of articles that will appear in the September issue, based on information available at press time. For the most up-to-date article listing, visit www.tms.org/JOM.

SEPTEMBER 2024

Advanced Characterization of Additively Manufactured Materials

Editors: Allison Beese, Pennsylvania State University; Michael Kirka, Oak Ridge National Laboratory
Sponsor: Additive Manufacturing Committee

"A Comparative Study of Laser Additive Manufacturing of Ni-Base Superalloy and Low-Alloy High-Strength Steel," **Hailong Cheng**, et al.

"Process Optimization of CoCrFeMnNi High Entropy Alloy Fabricated by Selective Laser Melting Based on Thermal Mechanism and Molten Pool Behavior Analysis," **Rong Guo**, et al.

"Microstructural Evaluation of a Dissimilar Metal Interface of Ni-Co-based Superalloys Fabricated using Wire Arc-Directed Energy Deposition Additive Manufacturing," **Benjamin Adam**, et al.

"Image-Based Fracture Surface Defect Characterization Methods for Additively Manufactured Ti-6Al-4V Tested in Fatigue," **Austin Ngo**, et al.

Characterization Techniques and Methods for Low-Carbon Metallurgical Processes

Editor: Zhiwei Peng, Central South University
Sponsor: Materials Characterization Committee

"Magnetization Roasting of Siderite Ore in a Low-Oxygen Atmosphere," **Pengchao Li**, et al.

"Density Tuning in Conjunction with Pelletizing of Reductants for Enhanced Copper Recovery from Copper Smelting Slag," **Jun Xia**, et al.

"New Insights into Digestion Kinetics of Gibbsite in the Bayer Process: High-Pressure DSC," **Xiaofeng Zhu**, et al.

"Numerical Simulation of Multiphase Flow in Top-Blown Converter Smelting Lead Anode Slime Process," **Ailiang Chen**, et al.

"Methane-Hydrogen Base Pre-reduction Chromite: Reduction Behavior and Pellet Compressive Strength," **Shaowen Wu**, et al.

New Insights into Processing and Manufacturing of Magnetic Materials

Editors: Min Zou, Lab Magnetism; Alex Baker, Lawrence Livermore National Laboratory
Sponsor: Magnetic Materials Committee

"Shape Anisotropy and Magnetic Texture Determination in Anisotropic and Isotropic Alnico Magnets," **Marcos Flavio de Campos**, et al.

"Fracture Behavior of Sandwich-Structured Fe-Based Amorphous Alloy Strip and ABS Polymer Composite Laminates," **Shujie Yan**, et al.

"Texture, Microstructure, and Properties of Fe-Cr-Co Permanent Magnetic Alloy Fabricated by Laser Powder Bed Fusion In-Situ Alloying," **Yazhou He**, et al.

"Investigation of Demagnetization Effect on C-Shape Anisotropic Ferrite Permanent Magnet," **Chih-Liang Chien**, et al.

"Preparation for High-Frequency Soft Magnetic Composites with Carbonyl FeNi50," **Jian Luo**, et al.

"Material Formulation of Strontium Ferrite Permanent Magnets from Phase Diagrams and Microstructures," **Ching-Chien Huang**, et al.

"Effects of Non-field Annealing and Magnetic Field Annealing on the Soft Magnetic Properties of Ni-Doped FINEMET Cores," **Xue Yang**, et al.

"Investigation into the Influencing Factors of the Center Magnetic Force of Anisotropic Permanent Ferrite Magnets in Motor Stator Application," **Chih-Liang Chien**, et al.

"Influence Mechanism of Sn on 2.7%Si-0.5%Al Non-oriented Silicon Steel," **Hai-jun Wang**, et al.

"Effects of Post-sintering Annealing on (NdLa)-(FeCo)-B Magnets," **Wei Tang**, et al.

"Hot-Roll Fabrication of Anisotropic Nanograin Nd-Fe-B Magnet," **Chaochao Pan**, et al.

"Ultrasound-Assisted Electrodeposition of Fe-Ni-Co Ternary Alloy Film: Microstructure, Corrosion Resistance, and Soft Magnetic Property," **Yu Yu**, et al.

"Crystallization, Corrosion, and Magnetic Properties of Soft Magnetic Nanocomposite $\text{Co}_{75.4}\text{Fe}_{2.3}\text{Mn}_{2.3}\text{Si}_2\text{Nb}_4\text{B}_{14}$ Alloy for Elevated Temperature Operation," **Yuankang Wang**, et al.

Phase Transformation and Microstructure Evolution during Thermomechanical Processing

Editors: Bin Ouyang, Florida State University; Clodualdo Aranas, University of New Brunswick; Tong Wang, Northeastern University

Sponsor: Alloy Phases Committee

"Rapid Thermal Treatment of Oriented Microstructures to Generate Fine Globular Grains," **Sathyanarayan Sairam Jaishankar**, et al.

"Effect of Annealing Temperature on the Microstructure and Corrosion Resistance of Atmospheric Plasma-Sprayed FeCoCrNiMo_{0.2} Coatings," **Shitao Zhang**, et al.

"An Investigation of Energy Dissipation in Beta III Titanium Alloy," **Jacopo Romanò**, et al.

"Enchantment in the Wear Resistance of the Ti-Al-Si Coatings Fabricated by Hot Dipping," **Tao Zhao**, et al.

"Decoupling the Effects of Strain Rate and Temperature Rise on Martensitic Transformation in a 316 Austenitic Stainless Steel," **Dianqiang Shu**, et al.

"Hot Forward-Extruded Nanocrystalline Anisotropic Nd-Fe-B Magnetic Sheets with High Magnetic Properties," **Liyun Zheng**, et al.

"Effect of Ti Content on Microstructure Evolution and Mechanical Properties of High-Strength Anti-seismic Rebar," **Chao Lu**, et al.

"Research on Microstructural Evolution and Deformation Mechanisms in SCM435 Steel Based on a Dynamic Material Model," **Tongyao Yang**, et al.

"Nanocrystalline $\text{Ni}_{25}\text{Co}_{20}\text{Cu}_{10}\text{Fe}_{25}\text{Mn}_{20}$ High-Entropy Alloys Prepared by Mechanical Alloying," **Samaneh Mamnooni**, et al.

"Enhancing Strength-Ductility Synergy and Corrosion Residual Strength of Hot-Rolled Mg-2Zn-0.85Y Alloy," **Pengyu Li**, et al.

"Hot Deformation Characteristics of GH4975 Nickel-Based Superalloy in the Coexistence Region of γ and γ' Phases," **Yushuo Li**, et al.

"Microstructure and Properties of Dissimilar Butt Joints of Aluminum to Copper by Cold Metal Transfer with Preheating," **Huan He**, et al.

"Heat Treatment Optimization of Laser Powder Bed Fusion Formed WC/18Ni300 Maraging Steel Composites," **Xiaobiao Shang**, et al.

"Effect of Aging Treatment on the Mechanical Properties of 45 vol.% SiCp/6061Al Composite," **Leigang Cao**, et al.

"Microstructural Analysis of Diffusion-Bonded AZ31 Mg Alloy Fabricated by Wire-Arc-Directed Energy Deposition for Lightweight Complex Structures," **R. Dipin Kumar**, et al.

"Microstructure Prediction of 80MnSi8-6 Steel After Hot Deformation Based on Dynamic Recrystallization Kinetics and FEM Simulation," **Krystian Zyguła**, et al.

"Effect of Precipitates on Dynamic Recrystallization and Texture of Mg-Sn Alloy Under Different Strain Rates," **Yuzhou Du**, et al.

"Elucidating the Influence Mechanism of Vanadium Addition on Dendritic Structure and Precipitated Phase of 30Cr15Mo1N Ingot During Pressurized Solidification," **Hong-Chun Zhu**, et al.

"Thermal Deformation Behavior and Microstructural Evolution Mechanism of TC4 Titanium Alloy Based on Hot Processing Map," **Zhiyi Li**, et al.

"Study on the Preparation of Reinforced Copper-Clad Steel Wires by Continuous Cladding and Rapid Solidification," **Chenglin Li**, et al.

"Effect of Multi-component Alloy Interlayer on Interfacial Microstructure and Shear Strength of Titanium/Bronze Bimetal," **Lixing Sun**, et al.

"Preparation and Characterization of Cu-Ag Alloys Doped with Refractory High Entropy Alloy (HEA) Particles," **Daoqi Zhang**, et al.

"New Wrought Heat Treatable Aluminum Alloy Based on the Al-Cu-Ca-Si System," **T.K. Akopyan**, et al.

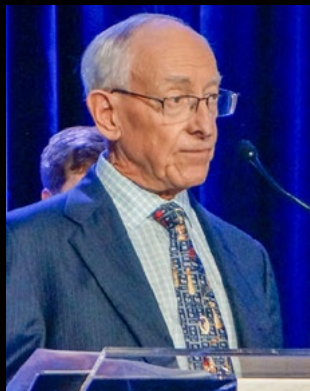
"Microstructure Evolution and Mechanical Properties of FSW SA516 Gr.70 Steel Joints at Different Rotation Rates," **Xiuying Wang**, et al.

"The Influence of Aging Treatment on a Ti-Nb-Ta-Zr-O Alloy Processed by High-Pressure Torsion," **Luisa Coelho de Carvalho**, et al.



CRAFTING LEGENDS: JOURNEY THROUGH THE 2024 TMS BLADESMITHING COMPETITION

Megan Enright



"The TMS Bladesmithing Competition is a unique event that was designed to bring metallurgical concepts to life for the next generation of scientists and engineers. It has also provided an opportunity for students to demonstrate their creativity, resourcefulness, and determination, as well as their materials knowledge," said Garry W. Warren, past chair of the TMS Foundation Board of Trustees, as he welcomed attendees to the 2024 TMS Bladesmithing Competition Awards Ceremony. Twenty-four teams of university students rose to the challenge of forming a blade through hand hammering or trip hammer forging in the fifth iteration of the TMS Bladesmithing Competition held during the TMS 2024 Annual Meeting & Exhibition (TMS2024) in Orlando, Florida.

TMS2024 attendees were able to explore this year's entries at an extensive display in the Exhibit Hall during the meeting.

"Regardless of the final results, every student that made it to this point deserves our praise and commendation," Warren commented. "Completing an entry is no small feat . . . This competition marries physical skill and academic rigor as each entry is judged on a cumulative score for the blade, report, poster, and video submissions," he continued.

Read on in this article for an overview of this year's award and special citation recipients, as well as all 2024 submissions. Learn more about how each team forged their blade and what it takes to complete an entry by viewing the team videos at www.YouTube.com/ChannelTMS/Playlists under the Bladesmithing Competition 2024 playlist. New details for the next TMS Bladesmithing Competition, to be held at the TMS 2026 Annual Meeting & Exhibition in San Diego, California, will be posted soon. Check the Bladesmithing website at www.tms.org/Bladesmithing for news and updates.

TMS WADSWORTH-SHERBY GRAND PRIZE

The TMS Wadsworth-Sherby Grand Prize is made possible due to the generous support of Jeffery Wadsworth, retired CEO and president of Battelle, in honor of his late mentor, Oleg B. Sherby, Stanford University. Both Wadsworth and Sherby are internationally recognized for unlocking the secrets of Damascus steel and other ancient sword-making processes. The recipient of this award receives a \$2,000 cash prize, the TMS Wadsworth-Sherby Bladesmithing Grand Prize Medal, and a commemorative volume of the *Wadsworth-Sherby Collected Works on Damascus Steels & Related Topics*.

South Dakota School of Mines and Technology

"Migration Period Pattern Welded Sword"

Team Members: Stephen Gebes, Cora Gehrke, Brianna Hoff, Isaac Johnston, Cole Ledman, Thaddeus Malsam, Christopher Mercado, Tyler Reinarts, Antonio Romero, Jed Sieverding, and Nathan Staley

"Migration Period Pattern Welded Sword" is a recreation of a migration era sword utilizing materials from the Black Hills of South Dakota. The blade has a pattern welded blade, with adornments of gold plating and garnets. Modern heat treating and characterization methods were used to achieve a balance of high hardness for edge retention and toughness for flexibility.



SECOND PLACE

The recipient of this award receives a \$500 cash prize and a certificate.

University of Minnesota Twin Cities

"Éire Sword"

Team Members: Wyatt Fish, Thomas Golin, Regina Gonzalez Lona, Ashlie Hamilton, Edward Hydukovich, Sabrina Mueller, Hagmar Tinoco Madeira, Nathan Tomas, Cuong Quoc Ho, and Dat Tran

This blade was a recreation of a historical blade associated with Gaelic culture, particularly found near Lough Neagh and the Galway-Roscommon region of Ireland. AISI 5160 steel was heated in a propane forge and hand-hammered to form the blade's tip and bevels. After normalization and quenching, shaping and polishing were done using various tools. The guard



and pommel were designed with computer-aided design (CAD), 3D printed, then cut from AISI 1018 steel using a waterjet cutter and manually milled.



THIRD PLACE

The recipient of this award receives a \$250 cash prize and a certificate.

University of Arizona

"CopperHead"

Team Members: Katheryn Garrett, Dallas Green, Ranger Stevenson, Chuy Talavera, Blaise Wilson, and Alton Zhang

This blade is a copper-Damascus tanto blade, created by traditional Japanese construction methods. The team included copper in their blade to reflect Arizona's copper mining history. Elements representing Arizona, such as serpentine patterns and engraved symbols of the "5 C's" (Copper, Cattle, Cactus, Cotton, Climate), were integrated into the design. The resulting "CopperHead" tanto showcased a modern interpretation of a historical Japanese blade, both resilient in function and visually striking.



HONORABLE MENTION

The recipient of this award receives a \$100 cash prize and a certificate.

University of Illinois Urbana-Champaign
"Holdfast"

Team Members: Kira Martin and Abby Sreden



This blade aimed to blend medieval inspiration with modern techniques, exploring the mechanical properties affected by forging and heat treatment. The forging process involved folding 13 layers of alternating steels to form a 117-layer billet, shaping it using traditional methods and modern equipment. The blade features a fluted Macassar ebony handle with sterling wire inlay and hot blued hardware for both aesthetics and durability. The patterning involved creating a laddered random Damascus pattern through grooves and chemical etching.



SPECIAL CITATIONS

Special citations are awarded to acknowledge blades that showed outstanding performance in individual categories such as beauty, creative use of materials, and resourcefulness.

BEAUTY

Missouri University of Science and Technology
"Kris-topher"

Team Members: Jerimiah Cohn, Tatianna Reinbolt, Benjamin Rodrigue, Abigail Rosendahl, Allison Rush, and Harrison Smith



HISTORICAL ACCURACY

University of British Columbia
"Southern Tutchone Dagger"

Team Members: Connor Gingera, Maxim Levi, Simon McMillan, Douglas McKinnon, Rachel Miner, Daniel Song, Kerrie Ye, and Haoyi Yue



CREATIVE USE OF MATERIALS

University of Alberta
 "Recycled Higonokami Knife"

Team Members: Luke Androski, Raeed Asif, Kara Beinert, Tom Betts, Nura Bitew, Kallen Boulet, Caleb Foster, Meghan Huppertz, Mackenzi Johnston, Cate MacKenzie, Benita Malaba, David McCracken, Catherine Milliken, Levi Power-Fardy, Trinity Shilka, Max Stuart, and Patryk Szmuc



MATERIAL PROCESSING EXCELLENCE

Royal Melbourne Institute of Technology
 "Antipodean Iron"

Team Members: Matthew Humbert and Ari Milke



ENGINEERING EXCELLENCE

Texas A&M University
 "M1 Bayonet"

Team Members: Joshua Cline, Jose Cortez, Parker King, Sebastian Vazquez Lizarraga, Ashley Nicole Person, and Kendrick Tran



APPLICATION OF MATERIALS SCIENCE

PRINCIPLES
 Queen's University
 "QBlade 1.0"

Team Members: Fadi Al Anid, Mitchell Beallor, Madelyn Bratuz, Eric Brazeau, Brad Diak, Liam Dreany, Forged in Canada, Joel Gallagher, Ben Hackett, James Zeyuan Ji, Nathan Jones, Steven Ma, Will Macdonald, Corbet Mackinnon, Kodinna Mkpasi, Brock Nowak, Sebastian Parsons-Hall, Dante Pereira, Jesse Pound, Casey Quiring, Matthew Sharpe, SparQ Makerspace, Rishabh Tamhane, Claire Uy, and Tom Wakefield



TEAM SPIRIT & VIDEO

Rice University
 "Talon of Athenia"

Team Members: Jackson Hughes, George Lyu, Matt Moore, Balla Sanogo, and Nathan Yun



CONGRATULATIONS TO ALL OF THE 2024 TMS BLADESMITHING TEAMS

Arizona State University
 "Sunblade"



Colorado School of Mines
"Relic Fusion"



Illinois Institute of Technology
"Haladie Dagger"



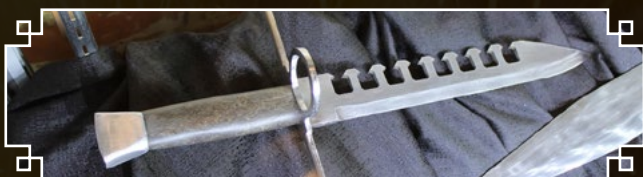
Imperial College London
"Sustaining the Falchion"



Instituto Tecnológico de Morelia
"Mystic Blade Steel"



McMaster University
"The SwordBreaker"



Purdue University
"Gladius Maximus"



HONORING DAVID SAPIRO



David Sapiro (right) gifts the Flame-Bladed Longsword he designed and forged for the 2017 TMS Bladesmithing Competition to TMS Executive Director James J. Robinson (left). The sword is on display in the TMS headquarters lobby.

In August 2023, TMS member David Sapiro passed away. Sapiro was heavily involved with the TMS Bladesmithing program having entered the inaugural student competition in 2015 and the second iteration in 2017. After graduating, he continued his involvement by joining the TMS Bladesmithing Committee where he served as Vice-Chair and drew from his own experiences as a participant to make valuable improvements to the program.

"I competed against David in the first Bladesmithing Competition and had the pleasure to serve with him on the Bladesmithing Committee later," said Sam Wagstaff, TMS Bladesmithing Committee chair. "His infectious passion drove all around him to be better. He was not afraid to brag about his mistakes, hoping it would make others better. His is a spirit of collaboration, enthusiasm, and kindness we should all try to emulate. I will miss catching up with him each year at the annual meeting."

Sapiro also served as the keynote speaker for the 2023 Bladesmithing Symposium, delivering the presentation "Reverse Engineering of Historical Swords," and published the technical paper, "Fabrication of a Bronze Age Sword Using Ancient Techniques" in *JOM*.

"I met David when he was a graduate student at Carnegie Mellon University," said Garry W. Warren. "I was extremely impressed with his active, and somewhat homemade, approach. When he moved from California to Pittsburgh, he brought some equipment with him and set up a simple foundry in his garage! I really wondered how he did it. He contacted me wanting to know more about our Bladesmithing Competition and volunteered to get involved in any way he possibly could. At the time, Bladesmithing was a relatively new activity for TMS, and David made significant contributions to developing and refining the competition as well as the symposium held in alternating years. David was a bright light, and his contributions will be felt for years to come."

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Sweet Briar College
"Vetus Vulpes Belli"



University of North Texas
"The Zhànshi Jian"



Texas A&M University
"Modernized Khanda"



University of Texas at El Paso
"Khopesh Blade"



United States Air Force Academy
"Mosaic Damascus Bowie Knife"



West Virginia University
"Ol' Smokie"



Visitors to the TMS2024 Exhibit Hall view a display of blades, along with posters and videos that showed their development.

BLADESMITHING SYMPOSIUM AT TMS2025

Held in alternating years with the TMS Bladesmithing Competition, the TMS Bladesmithing Symposium provides students with the opportunity to present their current work on bladesmithing topics. Be on the lookout for more information about the TMS Bladesmithing Symposium at the TMS 2025 Annual Meeting & Exhibition (TMS2025) in Las Vegas, Nevada, on March 23–27, 2025.

Learn more at www.tms.org/TMS2025.

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STEP CHANGES REQUIRED FOR CARBON ANODES:

Highlights from the Aluminum Committee Workshop Session at TMS2024

Alan Tomsett, Barry Sadler, and Julien Lauzon-Gauthier



One of the outcomes from the honorary symposium for Professor Barry Welch held during the TMS 2023 Annual Meeting & Exhibition was recognition of the need for step change improvements in carbon anodes. This is necessary despite the potential for inert anodes on the horizon as there is currently a gap between current typical anode characteristics and customer requirements. To explore closing this gap, a special session was held within the Electrode Technology for Aluminum Production Symposium at the TMS 2024 Annual Meeting & Exhibition (TMS2024). The session had a facilitated workshop format where interaction between attendees was encouraged rather than the usual format of a presentation followed by a question-and-answer (Q&A) period.

The session was split into three sub-topics:

- What is the ideal carbon anode and assembly design—from the customer's perspective?
- Are we measuring the right things on anodes the right way?
- What incremental and large step changes can be made to improve the anode production process?

A panel of experienced industry experts was assembled to provide context, present ideas, but above all pose challenging questions to generate discussion from the attendees. Panel members included **Pascal Lavoie** (Alcoa), **Laurent Fiot** (Rio Tinto), **Daniel Whitfield** (Boyer Smelters Limited), **Amer Al Marzooqi** (EGA), **Markus Meier** (R+D Carbon), **Christophe Bouche** (Fives), **Stephan Broek** (Kensington Technologies), and **Kim Hammill** (Hatch). The organizers are indebted to these panel members for their contribution to the success of the session.

SUMMARY OF THE DISCUSSIONS

From the customer's perspective, the current anode quality is no longer sufficient. Achieving a quality carbon anode block that operates efficiently and effectively in modern cells is the minimum requirement. In addition, the performance of the whole anode assembly needs to be improved. The focus of this improvement must be on quality but more importantly, on reducing variability. This should include a redesign of the existing connection between the rod and the carbon anode (stub-carbon connection) to improve the steel/cast iron/carbon contact across the connection. Discussion during the session also included the size and shape of the anodes, with topics

DIGITAL TRANSFORMATION

Fives E2E Carbon Optimisation Based on Tracking, Vision, Soft and Scoring Sensors

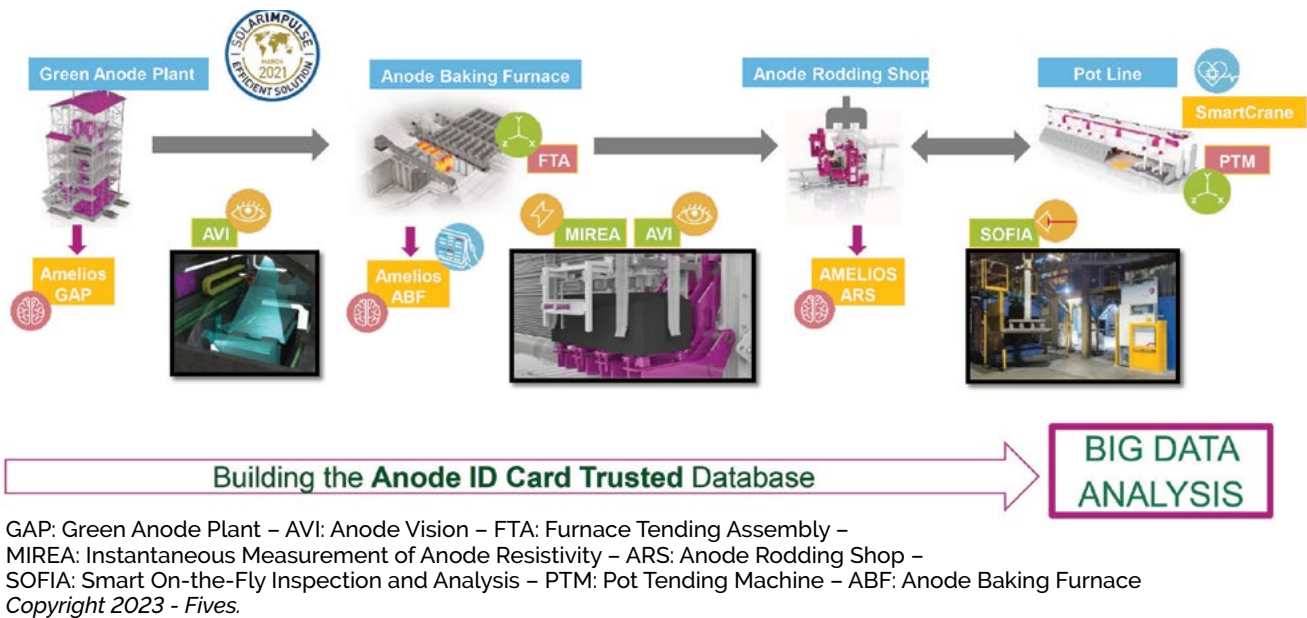


Figure 1. Christophe Bouche, Product Director–Aluminum at Fives, presented the following information on how his organization is developing solutions in digital transformation. (Reprinted with Bouche’s permission.)

including using different anode dimensions and slot designs for different stall positions to optimize liquid/gas flow patterns in the cell.

The importance of anode cover material was discussed and improving the performance and cost of anode oxidation protective coatings was seen as an opportunity to optimize the anode cover heat transfer properties independently from providing air oxidation protection.

On the measurement side, there is still improvement potential to better exploit the currently available information, and digitalization as incorporated in “Industry 4.0” is helping support this. Bouche (Product Director–Aluminum) presented how Fives is developing solutions as shown in **Figure 1**.

This diagram shows how anode tracking technologies enable anode quality to be linked to potroom performance. Although these tracking systems are available now, their use is not widespread. Tracking and other online measurement methods are generally “enablers.” In order to deliver tangible benefits,

INDUSTRY 4.0 AT EGA: Where Innovation Isn’t a Cost, It’s a Strategic Investment in Tomorrow

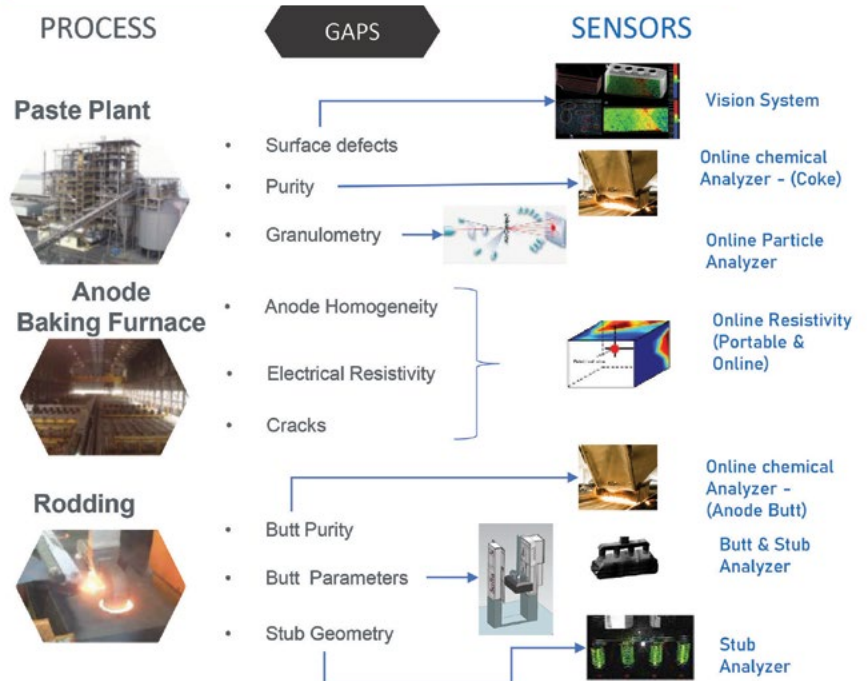


Figure 2. Amer Al Marzooqi, Vice President, Carbon and Ports at EGA, presented EGA’s progress and plans related to the online measurement systems they have installed and planned. (Slide reprinted with Al Marzooqi’s permission.)

including substantial potential cost savings, the data generated must be used to productively change processes and products. While these technologies are considered critical to deliver the anodes needed by potlines, being enablers can make justifying them using current capital approval processes more difficult. How to get approval for these systems was a large part of the discussion for this topic.

Al Marzooqi (Vice President, Carbon and Ports) presented how the carbon plants at EGA have used a process of “Identifying Gaps, Piloting Solutions” and “Staged Roll Out” to justify and implement the online measurement systems they have installed and have planned. EGA progress and plans in this area are shown in **Figure 2**.

Several ideas were shared and discussed for incremental changes to the way we manufacture and use carbon anodes. This includes different baking methods such as continuous baking for prebaked anodes, using raw materials with a different carbon structure, optimizing baking temperature based on cell performance, incorporation of some biomaterial, and revisiting the continuous prebaked anode concept.

The need for a lot more work on decarbonization in anode production was discussed as a driver of change in the manufacturing process. Step changes are needed to deliver major reductions in carbon emissions from anode production. The point was well made by several of the panel members, however, that the greatest potential at present is to improve the efficiency and effectiveness of the current process.

Overall, there was a consensus that R&D is still needed on carbon anodes. How to do it, how to pay for it, and what are the priorities are important aspects for the future. Having a multi-company consortium structure could be one way to proceed. Changing environmental regulations and economic incentives will probably dictate the next step in the development of carbon anode manufacturing.

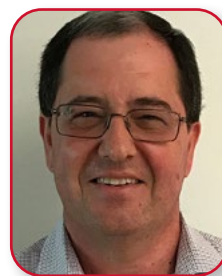
LESSONS LEARNED

The workshop format was well received, with the high level of audience interaction and participation appreciated by attendees. The room set up in a U shape rather than the traditional rows facilitated the discussion as people were facing each other.

Presentations are valuable in supporting the discussion. The session had a mix of presentation styles—some that provided open-ended questions to generate discussion and others with a more traditional short presentation with Q&A. The presentations with open-ended, thought-provoking questions worked better in the workshop format.

In the future, with confidence in the approach, the number of topics covered could be reduced to enable sufficient time for more in-depth discussion.

ABOUT THE AUTHORS



Alan Tomsett is the technical manager at Rio Tinto Pacific Operations. He, along with Barry Sadler, organized the Electrode Technology workshop session at TMS2024. Tomsett is a past Aluminum Committee chair and was editor of *Light Metals 2020* and *Essential Readings in Light Metals, Volume 4, Electrode Technology for Aluminum Production*.



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



Julien Lauzon-Gauthier is a senior research scientist at Alcoa within the Operational Excellence smelting technology development group. He has been involved with TMS as a member of the Aluminum Committee and helped with the organization of electrode technology sessions and symposium.

EXPLORING INNOVATIONS: A RECAP OF THE TMS SPECIALTY CONGRESS 2024

Megan Enright



TMS SPECIALTY CONGRESS 2024

2nd World Congress on
**ARTIFICIAL INTELLIGENCE IN
 MATERIALS & MANUFACTURING 2024**

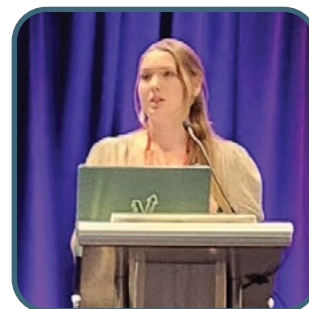
Symposium on
**DIGITAL & ROBOTIC
 FORMING 2024**

**ACCELERATING DISCOVERY
 FOR MECHANICAL BEHAVIOR
 OF MATERIALS 2024**

"The Congress has been very interesting." "The meeting was inspiring." "It was fantastic." These were just some of the comments attendees of the TMS Specialty Congress 2024 noted in the congress survey. From June 16–20, 2024, participants gathered in Cleveland, Ohio, for four days of robust technical programming, networking and social events, and more. This inaugural iteration of the TMS Specialty Congress series featured the following three co-located events: the 2nd World Congress on Artificial Intelligence in Materials and Manufacturing (AIM 2024), Digital and Robotic Forming 2024, and Accelerating Discovery for Mechanical Behavior of Materials 2024. This unique format allowed attendees to explore their technical interest in a focused, small-event environment, while also having access to cross-disciplinary learning and collaboration opportunities with aligned materials communities. "I really liked the ability to float between the three topics," said one survey participant.

ALL-CONGRESS PLENARY SESSION

On Monday morning, four seasoned experts delivered presentations at the All-Congress Plenary Session. The plenary speakers included **Chris Eberl** (pictured, top left), Fraunhofer Institute and University of Freiburg, who delivered the presentation, "Navigating the Digital Transformation in Materials Science and Engineering and Your Role in Shaping Tomorrow." **Charles Ward** (pictured, top right), Air Force Research Laboratory (retired), explored "Thriving in the Digital Epoch of Materials and Manufacturing," in his talk. **Ian Foster** (pictured, bottom left), Argonne National Laboratory and the University of Chicago, gave a talk entitled, "Advancing Materials Science: Intelligent Agents in Datadriven Discovery." **Emily Molstad** (pictured, bottom right), VALIS Insights, discussed "Recovering Resources from the Past: How AI Can Enable a More Circular Future."



KEYNOTE PRESENTATIONS

Two of the co-located meetings featured keynote presenters from experts in their areas. One attendee noted that there were “great talks in this new and emerging area. [The] keynote was great to put things into perspective.” For Digital and Robotic Forming 2024, **David Furrer** (pictured, right), Pratt & Whitney, delivered the keynote presentation. **Somnath Ghosh** (pictured, left), Johns Hopkins University, gave the keynote talk for Accelerating Discovery for Mechanical Behavior of Materials 2024.



PROGRAM OFFICER PANEL DISCUSSION

Wednesday morning featured a panel discussion with distinguished leaders from prominent government programs dedicated to funding research in materials science and engineering. Attendees gained insights into the funding landscape for materials research, as panelists discussed the strategic priorities of their respective agencies and shared tips for navigating the grant application process. The panelists included: **Alexis Lewis** (moderator), National Science Foundation (NSF); **Khershed Cooper**, NSF; **Glenn Daehn**, HAMMER, The Ohio State University; and **Philseok Kim**, Advanced Research Projects Agency–Energy (ARPA-E), U.S. Department of Energy (DOE).

MDISCOVERY CHALLENGE ANNOUNCEMENT

James Saal, Citrine Informatics, lead the announcement of the MDiscovery Challenge to be held at TMS Specialty Congress 2025 during an informational session to introduce the program. The purpose of this challenge is two-fold: to predict properties from process and/or microstructural data streams and to identify methodologies and machine-learning practices that yield the best predictions. The MDiscovery Challenge provides participants with an exciting opportunity to tackle real-world problems in materials and manufacturing. Participants will predict various properties, including hardness, electrical resistivity, and fracture toughness, utilizing provided data for training and calibration. Interested in participating? Learn more at www.tms.org/MDiscoveryChallenge.

NETWORKING AND SOCIAL EVENTS

On Sunday evening, attendees gathered at the President’s Welcome Reception where they met the 2024 TMS President, **Srini Chada**, and mingled with fellow attendees to kickstart the meeting. In addition to the President’s Welcome Reception, this meeting featured several networking and social events.

On Tuesday evening, attendees explored the latest research on display during the Poster Session and Reception. They enjoyed light refreshments while talking with the presenters.

TMS Specialty Congress 2024 also featured Congress Luncheons for networking and conversing, as well as extended networking breaks between sessions. These informal, longer breaks offered the chance to engage in discussions with colleagues and foster meaningful connections.

“I really liked the break room being open throughout the day with always available coffee, etc. It allowed for us to meet and network with colleagues without having to look for somewhere else (often away from the events). . . . I hope TMS retains this for future Specialty Congresses,” said one attendee.



TMS leaders meet with attendees during the Sunday evening President’s Welcome Reception. Pictured left to right: **Dan Miracle**, 2024 TMS Vice President; **Brad Boyce**, 2023 TMS President; **James Robinson**, TMS Executive Director; and **Srini Chada**, 2024 TMS President.

SUBMIT AN ABSTRACT FOR 2025

The call for abstracts is open for TMS Specialty Congress 2025. Scheduled for June 15–19, 2025, in Anaheim, California, this meeting will feature the following three co-located events: the 3rd World Congress on Artificial Intelligence in Materials and Manufacturing (AIM 2025), the 8th World Congress on Integrated Computational Materials Engineering (ICME 2025), and the 7th International Congress on 3D Materials Science (3DMS 2025). Abstracts are being accepted through October 30, 2024.

Learn more and share your work today at www.tms.org/SpecialtyCongress2025.

PREVIEW THE TMS FALL MEETING AT MS&T24

Kelly Zappas

TMS FALL 2024

@ MATERIALS SCIENCE & TECHNOLOGY



Nine symposia on additive manufacturing, four professional development workshops, a symposium in honor of a corrosion science leader, and a plenary talk focused on more sustainable selection, design, and discovery of materials are among the highlights of the TMS Fall Meeting 2024 (TMS Fall 2024), which will be held as part of the Materials Science & Technology 2024 (MS&T24) technical meeting and exhibition, October 6–9 in Pittsburgh, Pennsylvania.

The TMS Fall Meeting explores the intersections of development, synthesis, and application within the broader context of MS&T, an event jointly organized by TMS, the American Ceramic Society (ACerS), and the Association for Iron & Steel Technology (AIST). MS&T is also co-sponsored by the Society for Biomaterials, which organizes additional programming for the meeting, and will be co-located with the Advanced Materials Show, an expo showcasing the latest in high-performing materials technology.

TMS Fall 2024 will feature a collection of 38 symposia spanning 12 topic tracks related to TMS members' interests. Among these are nine symposia related to additive manufacturing topics (compared to six held at the TMS Fall 2023 meeting). TMS symposia will also examine topics related to artificial intelligence; biomaterials; fundamentals and characterization; iron and steel (ferrous alloys); lightweight alloys; materials–environment interactions; modeling; nanomaterials; nuclear energy; and sustainability, energy, and the environment.



TMS PLENARY SPEAKER:

Julie M. Schoenung



"Materials benefit society because they enable new technologies, such as those that address climate change. But materials also contribute to environmental pollution and the burden of human disease. As materials scientists and engineers, we need to broaden

our range of design attributes to account for these potential negative consequences," said **Julie M. Schoenung**, professor and holder of the Wofford Cain Chair III, Department of Materials Science & Engineering and J. Mike Walker '66 Department of Mechanical Engineering at Texas A&M University. Schoenung has been selected as the recipient of the 2024 TMS/ASM Joint Distinguished Lectureship in Materials and Society Award and will be the TMS plenary speaker at MS&T24.



MS&T24 PROGRAM COORDINATING COMMITTEE

John Carpenter (left), Los Alamos National Laboratory, and **Eric Lass** (right), University of Tennessee, Knoxville, serve as the chairs and TMS representatives to the MS&T24 Program Coordinating Committee.

Her talk, "Saving the Planet through Sustainability-Informed Selection, Design and Discovery of Materials," will look at how materials science and engineering can reduce what she calls the "chemical footprint." This chemical footprint arises from the consumption of goods, which require the production of materials, which in turn requires the use of resources such as minerals, energy, and water and can lead to emissions of toxic substances into the air, water, and soil.

"There are now methods and tools for sustainability-informed materials selection: to reduce the embodied energy materials represent, the toxins they emit into the environment and the workplace, and the waste they create when not reused or recycled, while still retaining functional performance and economic feasibility," said Schoenung.

For more than twenty years, Schoenung has conducted research in collaboration with colleagues with expertise in toxicology, environmental chemistry, public health, public policy, decision-theory, and, more recently, in the fields of informatics, data science, and machine learning/artificial intelligence, to enhance the tools and methodologies available to inform materials selection and design decisions on the basis of these important sustainability metrics. She has also been teaching classes on these topics.

"I'm excited to see early career scientists and engineers embracing these concepts and applying them in real-world applications," said Schoenung.

Her talk will be held on Monday, October 7, from 2:00 p.m. to 3:00 p.m. at MS&T24. No additional TMS programming will be held during this time slot to allow all attendees to attend this presentation.

TMS HONORARY SYMPOSIUM:



Brian Gleeson

As part of the Materials-Environment Interactions programming planned at MS&T24, TMS will hold the symposium, **Advances in High-Temperature Oxidation and Degradation of Materials for Harsh Environments**.

This symposium, sponsored by the

TMS Structural Materials Division and TMS Functional Materials Division, will honor **Brian Gleeson**, the Harry S. Tack Chaired Professor of Materials Science and chair of the Department of Mechanical Engineering and Materials Science at the University of Pittsburgh.

"For over thirty-five years, Professor Brian Gleeson has been a leader in corrosion science advancing understanding of the high-temperature oxidation and degradation of alloys and coatings," said symposium organizers **Kinga Unocic**, North Carolina State University, and **Wei Xiong**, University of Pittsburgh. "Brian has illuminated key thermodynamic and kinetic aspects controlling the degradation of materials in harsh environments, from gas/solid reactions to diffusion in the alloy and everything in between."

The symposium serves to recognize the exceptional quality of research and mentorship that Gleeson has demonstrated throughout his career, say the organizers, and it will cover all aspects of the high-temperature corrosion process.

Speakers for the symposium will include:

- **David Young** (Emeritus, University of New South Wales, Sydney, Australia), who will address high-temperature corrosion of mixed gasses
- **Gerald Meier** (Emeritus, University of Pittsburgh, USA), who will talk about 50+ Years of high-temperature corrosion at the Department of Mechanical Engineering and Materials Science at the University of Pittsburgh
- **Michael Schütze** (MSSC, Germany), who will focus on aspects of high-temperature chlorine corrosion as part of the development of technical plants for hydrogen and synfuel production from biomass
- **Bruce Pint** (Oak Ridge National Laboratory, USA), who will present his research on the formation of adherent alumina scales
- **Elizabeth Opila** (University of Virginia, USA), who will discuss the oxidation of silicon (Si) bond coat in SiC-Composite Yb₂Si₂O₇ Systems

"This will be a fantastic opportunity for individuals of all ages, particularly the younger generation, to meet high-caliber leaders in the field of high-temperature oxidation and degradation of alloys and coatings," said Unocic and Xiong.

PROFESSIONAL DEVELOPMENT EVENTS

On Sunday, October 6, TMS will present three courses in conjunction with MS&T24. Meeting participants can add one or more of the following to their MS&T registration in advance of the meeting:

- Metal Additive Manufacturing Processes
- Powder Materials for Additive Manufacturing and Beyond: Powder Properties and Handling to Improve Part Quality and Overall Safety
- Standards in Additive Manufacturing

In addition, the TMS Professional Development Committee will present the **Navigating U.S. Immigration: Overcoming a Barrier for Materials Professionals Workshop** on Monday evening, October 7. No additional fees or advance registration are required to attend this workshop, which will feature a presentation by an immigration lawyer delving into the U.S. immigration process, first-hand stories from immigrant materials engineers, and an interactive panel discussion.

REGISTER AND BOOK HOUSING TODAY

Visit www.matscitech.org/MST24 to register and book housing for MS&T24. Registration includes access to all TMS Fall Meeting events, as well as to programming by the other MS&T sponsoring societies and the Advanced Materials Show expo. TMS members are encouraged to reserve rooms at the Westin Pittsburgh (the TMS headquarters hotel) through the MS&T website by September 12.

COPPER
2025




Metals for a Sustainable Future: A Preview of Copper 2025

Gerardo Alvear Flores



In a world of increasing complexity, facing paramount and multiple challenges, metals are a cornerstone in the path to creating a more prosperous, sustainable society. The **12th International Copper Conference (Copper 2025)**, scheduled for November 16–22, 2025, in Phoenix, Arizona, USA, will be the platform to discuss how copper can help this goal become a reality.

In 1987, the Institute of Mining Engineers of Chile (IIMCH), together with The Metallurgy and Materials Society (MetSoc) of the Canadian Institute of Mining, Metallurgy, and Petroleum (CIM), organized the first technical encounter between Chilean and Canadian metallurgical professionals to discuss topics of critical interest. That time was crucial and well-recognized as the “golden era” of the copper industry in which the development of new technologies was the focus of many international mining companies.

Since then, many other professional societies have joined the effort, and in 2025, TMS and the Society for Mining and Exploration (SME) will have the privilege of organizing Copper 2025. The Copper Conference Series has also brought together the Society for Metallurgists and Miners from Germany (GDMB); the Mining and Materials Processing Institute of Japan (MMIJ); the South African Institute of Mining and Metallurgy (SAIMM); and the Nonferrous Metals Society of China (NFSOC). All of these societies are collaborating with one goal: to promote the technical exchange required to ensure metals in general, and



FEATURING:



**NOVEMBER 16–22, 2025
PHOENIX, ARIZONA, USA**

Copper 2025 will be co-located with the **Extraction 2025 Meeting & Exhibition** and the **6th International Symposium on Nickel and Cobalt (Ni-Co 2025)**. Learn more about each event and submit your abstract by November 1, 2024, at www.ExtractionMeeting.org/Extraction2025.

Watch for an upcoming issue of *JOM: The Magazine* for a closer look at Ni-Co 2025 and look back at the July 2024 issue for an overview of the cross-cutting symposia at Extraction 2025 in the article, “Something for Everyone at Extraction 2025.”

copper in particular, can help create a sustainable future.

The 2025 iteration of the Copper Conference series will also coincide with the 6th International Symposium on Nickel and Cobalt (Ni-Co 2025) under the umbrella of a joint effort of TMS, MetSoc, and SME: Extraction 2025. With the inaugural Extraction

meeting held in 2018, this platform was created to encourage cross-functionality between commodities while also bringing together researchers and practitioners in these fields to discuss global issues facing the industry. This not only encompasses technical issues, but also involves environmental, social, and governance challenges.

The extractive metallurgy community has the responsibility not only to generate technical solutions to sustainably extract and process metals, but also to put forward an overarching view on how metals are extracted, processed, used, and recycled back to the value chain after materials face the end-of-life in their economic cycle.

“Copper 2025, along with Ni-Co 2025 and Extraction 2025, is a once-in-a-decade opportunity to exchange our technical, commercial, and societal views to make possible our goal: metals for a more sustainable solution.”

—Gerardo Alvear Flores

Copper 2025 aims to discuss how metals in general, and copper in particular, will respond to the challenges of a green economy. This involves the full value chain—from exploration to end-of-life and recycling of metals. It also incorporates a critical analysis of the market views and the bullish vision of growing production to unseen levels in the past.

This involves education; if we need metals, we also need to foster education of new process materials as well as new metallurgical engineers and scientists to support these new technical challenges. This also involves the market and marketing efforts. How do we price the product? How is the value in use of these metals perceived by the market and consumers? These questions and topics, along with many others, will guide discussion at Copper 2025. The technical program for this event will cover the following areas:

- Mining Projects
- Mineral Processing
- Pyrometallurgy
- Hydrometallurgy
- Electrowinning & Electrorefining
- Process Control & Optimization
- Recycling & Waste Management
- Economics & Markets
- Environmental, Control, Safety & Hygiene
- Auxiliary Processes & Acid Plants

All of the above symposia intersect with the Ni-Co 2025 program and the Extraction 2025 cross-cutting symposia to help our community in finding holistic solutions for promoting efficient production and responsible use of metals.

Copper 2025, along with Ni-Co 2025 and Extraction 2025, is a once-in-a-decade opportunity to exchange our technical, commercial, and societal views to make possible our goal: metals for a more sustainable solution.



Gerardo Alvear Flores, president & principal pyrometallurgist at CaEng Associates, is the Copper 2025 Co-Chair. He has been a TMS member since 1994.

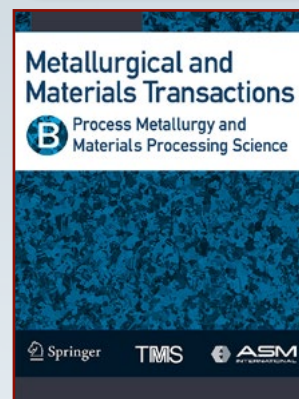
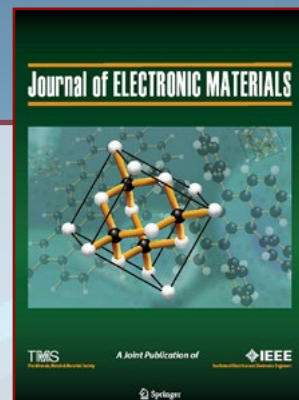
STAY TUNED FOR MORE

More details will be added to the website as events are confirmed for the conference. This includes, but is not limited to, poster sessions, networking events, industry tours, and short courses.

In the meantime, start preparing your work to participate in Copper 2025. Visit www.ExtractionMeeting.org/Copper2025 to find the abstract guidelines and to submit an abstract for Copper 2025, the 6th International Symposium on Nickel and Cobalt (Ni-Co 2025), and the Extraction 2025 cross-cutting symposia. Abstracts for oral and poster presentations must be submitted by **November 1, 2024**.

2023 PERFORMANCE METRICS ANNOUNCED FOR TMS JOURNALS

Matt Baker



In June 2024, the release of the 2023 Journal Citation Reports (Clarivate, 2024) included various performance metrics for the six TMS journals: *Integrating Materials and Manufacturing Innovation* (IMMI); *JOM*; *Journal of Electronic Materials* (JEM); *Journal of Sustainable Metallurgy* (JSM); *Metallurgical and Materials Transactions A* (MMTA); and *Metallurgical and Materials Transactions B* (MMTB). MMTA had the most total citations (33,599) and total downloads (1,357,429) among TMS journals in 2023. *JOM* also eclipsed one million downloads for the first time in the journal's history.

Table I shows an overview of some of the key metrics—including Impact Factor—for the journals. A journal's Impact Factor is the average number of citations counted in a given Impact Factor year for articles published in the two preceding years. It is based on the number

of citations of a journal's content divided by the number of citable articles published by that journal.

Impact Factor is just one of many measures considered by TMS and Springer Nature when evaluating journal performance. While Impact Factor can vary from year to year for a variety of reasons, TMS journals have generally tracked in a positive direction (see Figure 1) and achieved strong placement in Clarivate's category rankings (see Table II). In communication with publishers after release of the new Impact Factors, Clarivate acknowledged a downward trend in the 2023 numbers across all disciplines compared to the previous year.

To access TMS journals, visit www.tms.org/Journals. TMS members should log in to the TMS website before clicking on the individual journal links to ensure full access to content on the Springer website (<https://link.springer.com>).

Overview of 2023 Key Metrics Across TMS Journals

Journal	Impact Factor 2023 ¹	5-year Impact Factor ¹	Total Cites 2023 ¹	Cite-Score 2023 ²	Total Downloads 2023 ³
<i>IMMI</i>	2.4	3.3	1,022	5.3	151,531
<i>JOM</i>	2.1	2.5	15,422	4.5	1,028,443
<i>JEM</i>	2.2	1.9	16,504	4.1	691,789
<i>JSM</i>	2.5	3.0	2,076	4.0	311,941
<i>MMTA</i>	2.2	2.6	33,599	5.3	1,357,429
<i>MMTB</i>	2.4	2.6	12,337	4.9	651,608

Table I. Overview of 2023 key journal metrics.

¹ Source: Clarivate

² Source: Elsevier

³ Source: Springer Nature

TMS Journal Impact Factors

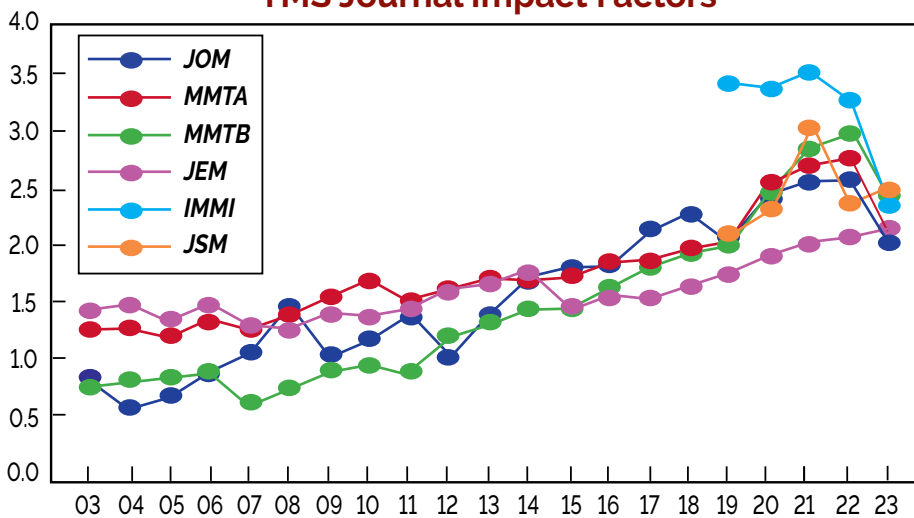


Figure 1. This chart shows 20 years (2003-2023) of TMS journal Impact Factors. *IMMI* and *JSM*, TMS's two newest journals, received their first Impact Factors in 2019.

Category Rankings by Journal Impact Factor

Category Name	Total Journals 2023	2023 Rank					
		<i>JOM</i>	<i>MMTA</i>	<i>MMTB</i>	<i>JEM</i>	<i>JSM</i>	<i>IMMI</i>
Materials Science, Multidisciplinary	438	286	280	267	280	-	267
Metallurgy & Metallurgical Engineering	90	35	33	29	-	28	-
Mineralogy	30	12	-	-	-	-	-
Mining & Mineral Processing	31	14	-	-	-	-	-
Engineering, Electrical & Electronic	352	-	-	-	183	-	-
Physics, Applied	179	-	-	-	104	-	-
Green & Sustainable Science & Technology	91	-	-	-	-	67	-
Engineering, Manufacturing	68	-	-	-	-	-	39

Table II. This table presents the subject categories assigned to the TMS journals and the 2023 rank of the journals within these categories based on Impact Factor. Journals in the same category with the same Impact Factor are now given the same rank position for that subject category ranking, skipping positions for the subsequent journal in the ranking.

TMS MEETING HEADLINES

Meeting information is current as of June 17, 2024. For the most recent updates on TMS-sponsored events, visit www.tms.org/Meetings.

TMS Fall Meeting 2024 at Materials Science & Technology (MS&T24)



October 6–9, 2024
Pittsburgh, Pennsylvania,
USA

Register Now

The MS&T24 Plenary Session will feature, "Saving the Planet through Sustainability-Informed Selection, Design, and Discovery of Materials," by TMS member Julie M. Schoenung, Professor and Wofford Cain III Chair, Texas A&M University.

www.tms.org/TMSFall2024

TMS 2025 Annual Meeting & Exhibition (TMS2025)



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

Book Housing Now

Reserve your room today at the MGM Grand Las Vegas Hotel & Casino, the venue for all TMS2025 sessions, networking events, and social activities.

www.tms.org/TMS2025

TMS Specialty Congress 2025



June 15–19, 2025
Anaheim, California,
USA

Abstract Submission Deadline: October 30, 2024

The 3rd World Congress on Artificial Intelligence in Materials and Manufacturing will be one of three co-located meetings featured at TMS Specialty Congress 2025. The event will address key issues and identify future pathways in artificial intelligence implementation in materials science and engineering and related manufacturing processes.

www.tms.org/SpecialtyCongress2025

OTHER MEETINGS OF NOTE



TMS Fall Meeting 2025 at Materials Science & Technology (MS&T25)

September 28–
October 1, 2025
Columbus, Ohio, USA

www.tms.org/TMSFall2025



Extraction 2025 Meeting & Exhibition (Extraction 2025)

November 16–22, 2025
Phoenix, Arizona, USA

www.extractionmeeting.org/Extraction2025



TMS 2026 Annual Meeting & Exhibition (TMS2026)

March 15–19, 2026
San Diego, California, USA

www.tms.org/TMS2026

CO-SPONSORED MEETINGS

Offshore Technology Conference (OTC) 2025

May 5–8, 2025
Houston, Texas, USA
Co-sponsored by TMS

OTC Brasil 2025

October 28–30, 2025
Rio de Janeiro, Brazil
Co-sponsored by TMS

COPPER 2025



12th International COPPER CONFERENCE

November 16–22, 2025
Sheraton Grand at Wild Horse Pass
Phoenix, Arizona, USA
#Copper2025

The Copper Conferences Series is a global effort involving the collaboration of:



SUBMIT AN ABSTRACT

BY NOVEMBER 1, 2024

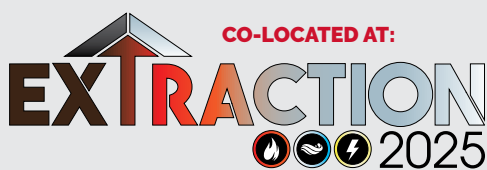
Copper 2025—the largest copper technical conference with a tradition of more than 30 years—will once again feature sessions on mining, mineral processing, pyrometallurgy, hydrometallurgy, electrometallurgy, process control, and instrumentation. Co-located with the Extraction 2025 Meeting & Exhibition, Copper 2025 will feature cross-functional discussions from a societal perspective and multi-commodity dialogue to develop more critical thinking across all fields.

Proposed symposia include:

- Mining Projects
- Mineral Processing
- Pyrometallurgy
- Hydrometallurgy
- Electrowinning & Electrorefining
- Process Control & Optimization
- Recycling & Waste Management
- Economics & Markets
- Environmental Control, Safety & Hygiene
- Auxiliary Processes/Acid Plants

Submit an abstract by November 1, 2024, to be part of this robust conference.

www.ExtractionMeeting.org/Copper2025



CO-LOCATED AT:



ALSO FEATURING:

6th International Symposium on
NICKEL AND COBALT



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ELEMENTS**

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3 Li 6.941 Lithium	4 Be 9.012182 Beryllium											5 B 10.811 Boron	6 C 12.0107 Carbon	7 N 14.0067 Nitrogen	8 O 15.9994 Oxygen	9 F 18.9984032 Fluorine	10 Ne 20.1797 Neon
11 Na 22.98976928 Sodium	12 Mg 24.305 Magnesium											13 Al 26.9815386 Aluminum	14 Si 28.0855 Silicon	15 P 30.973762 Phosphorus	16 S 32.065 Sulfur	17 Cl 35.453 Chlorine	18 Ar 39.948 Argon
19 K 39.0983 Potassium	20 Ca 40.078 Calcium	21 Sc 44.955912 Scandium	22 Ti 47.867 Titanium	23 V 50.9415 Vanadium	24 Cr 51.9961 Chromium	25 Mn 54.938045 Manganese	26 Fe 55.845 Iron	27 Co 58.933195 Cobalt	28 Ni 58.6934 Nickel	29 Cu 63.546 Copper	30 Zn 65.38 Zinc	31 Ga 69.723 Gallium	32 Ge 72.64 Germanium	33 As 74.9216 Arsenic	34 Se 78.96 Selenium	35 Br 79.904 Bromine	36 Kr 83.798 Krypton
37 Rb 85.4678 Rubidium	38 Sr 87.62 Strontium	39 Y 88.90585 Yttrium	40 Zr 91.224 Zirconium	41 Nb 92.90638 Niobium	42 Mo 95.96 Molybdenum	43 Tc (98.0) Technetium	44 Ru 101.07 Ruthenium	45 Rh 102.9055 Rhodium	46 Pd 106.42 Palladium	47 Ag 107.8682 Silver	48 Cd 112.411 Cadmium	49 In 114.818 Indium	50 Sn 118.71 Tin	51 Sb 121.76 Antimony	52 Te 127.6 Tellurium	53 I 126.90447 Iodine	54 Xe 131.293 Xenon
55 Cs 132.9054 Cesium	56 Ba 137.327 Barium	57 La 138.90547 Lanthanum	58 Ce 140.116 Cerium	59 Pr 140.90765 Praseodymium	60 Nd 144.242 Neodymium	61 Pm (145) Promethium	62 Sm 150.36 Samarium	63 Eu 151.964 Europium	64 Gd 157.25 Gadolinium	65 Tb 158.92535 Terbium	66 Dy 162.5 Dysprosium	67 Ho 164.93032 Holmium	68 Er 167.259 Erbium	69 Tm 168.93421 Thulium	70 Yb 173.054 Ytterbium	71 Lu 174.967 Lutetium	
87 Fr (223) Francium	88 Ra (226) Radium	89 Ac (227) Actinium	90 Th 232.03806 Thorium	91 Pa 231.03688 Protactinium	92 U 238.02891 Uranium	93 Np (237) Neptunium	94 Pu (244) Plutonium	95 Am (243) Americium	96 Cm (247) Curium	97 Bk (247) Berkelium	98 Cf (251) Californium	99 Es (252) Einsteinium	100 Fm (257) Fermium	101 Md (258) Mendelevium	102 No (259) Nobelium	103 Lr (262) Lawrencium	
		104 Rf (261) Rutherfordium	105 Db (268) Dubnium	106 Sg (271) Seaborgium	107 Bh (272) Bohrium	108 Hs (277) Hassium	109 Mt (276) Meitnerium	110 Ds (281) Darmstadtium	111 Rg (283) Roentgenium	112 Cn (285) Copernicium	113 Nh (284) Nihonium	114 Fl (289) Flerovium	115 Mc (288) Moscovium	116 Lv (293) Livermorium	117 Ts (294) Tennessine	118 Og (294) Oganesson	

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