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JOM

JANUARY 2019

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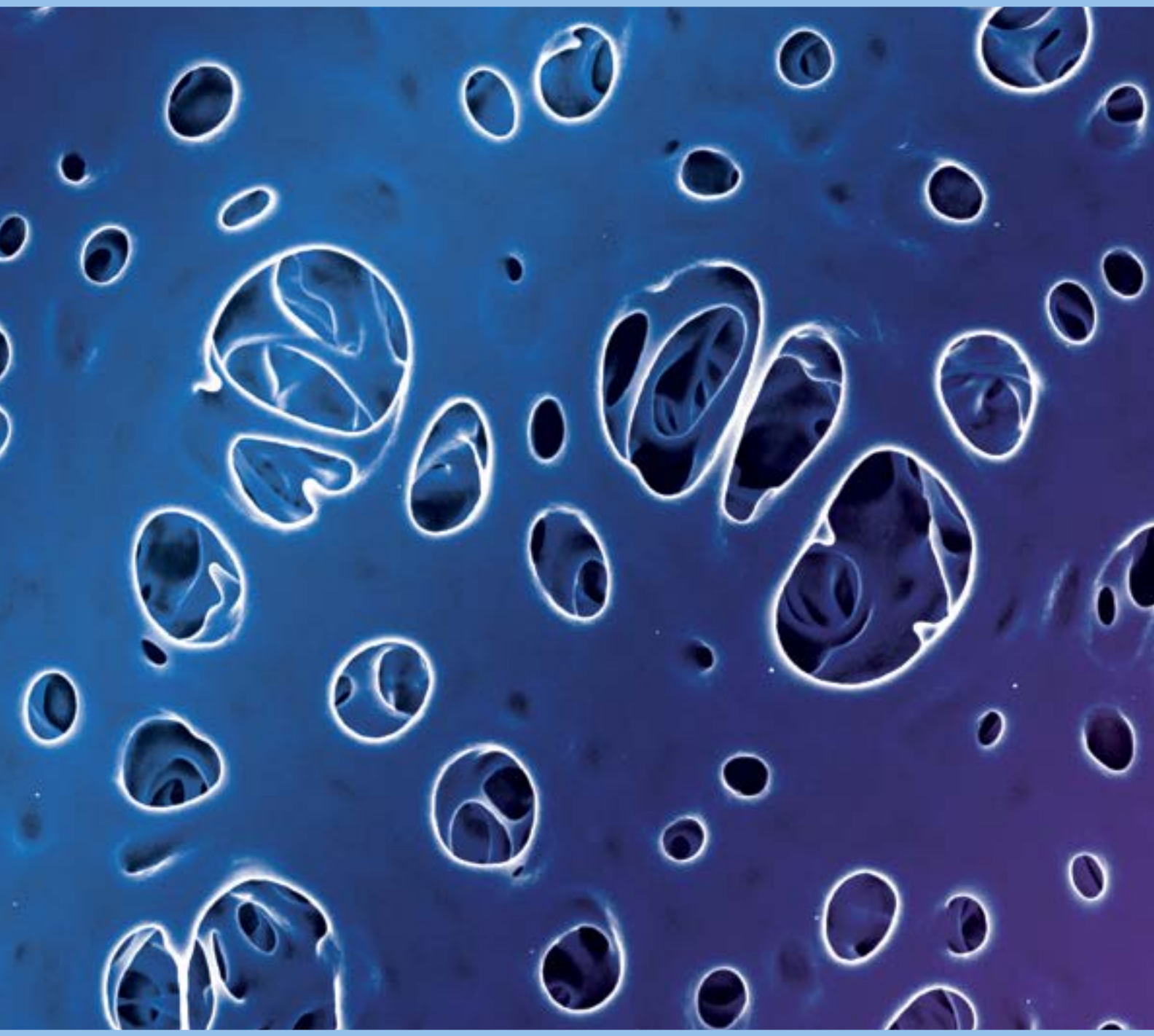
An official publication of The Minerals, Metals & Materials Society



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148th Annual Meeting & Exhibition

March 10–14, 2019
San Antonio, Texas, USA
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148th Annual Meeting & Exhibition

PRE-SHOW REPORT

March 10–14, 2019

HENRY B. GONZÁLEZ
CONVENTION CENTER
SAN ANTONIO, TEXAS, USA

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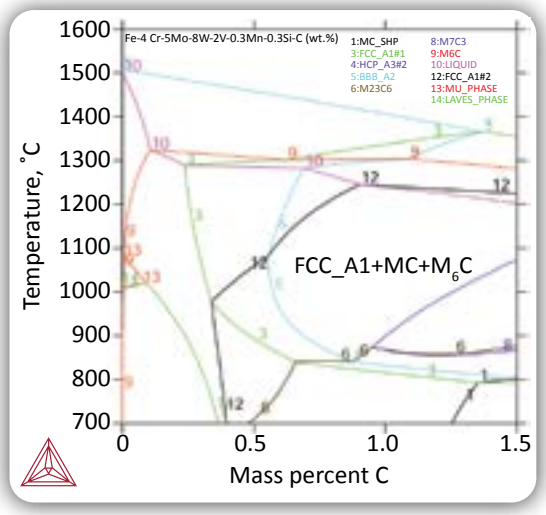
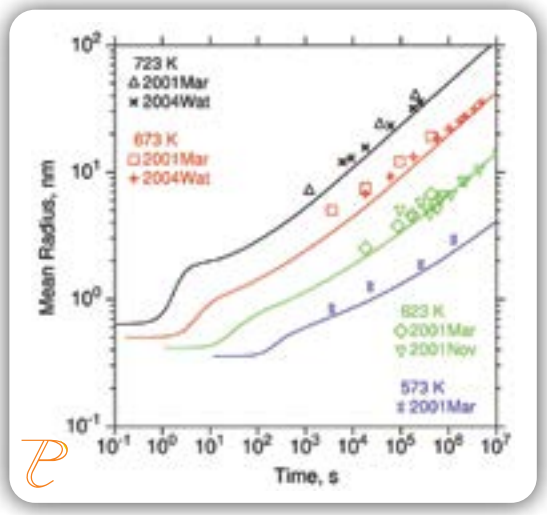


Multicomponent Phase Diagrams



Precipitation Kinetics

www.thermocalc.com

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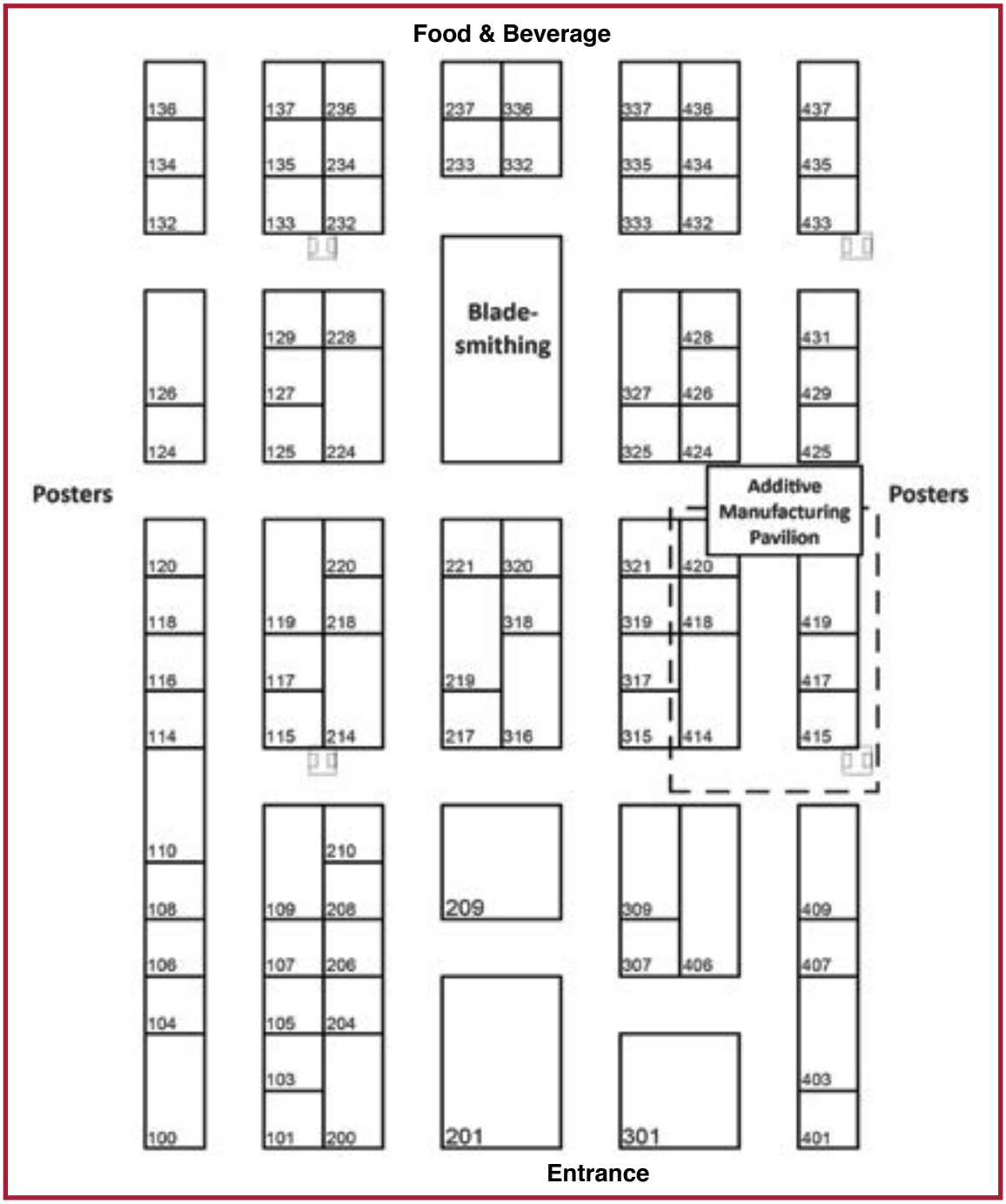

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PRE-SHOW REPORT

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USA

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Fax +1 (608) 203-8045
Email info@computherm.com
Web www.computherm.com

CompuTherm LLC, established in 1996, is a leading developer of software and databases for thermodynamic and phase diagram calculations as well as kinetic simulations based on the CALPHAD approach. Our products include the Pandat™ software, online iPandat, and thermodynamic databases for numerous alloy systems, such as Al-, Co-, Cu-, Fe-, Mg-, Mo-, Nb-, Ni-, Ti-, Zr-based alloys and high-entropy alloys. These products are currently being used by hundreds of users worldwide.

Pandat™ is a powerful software package with a robust thermodynamic calculation engine, a friendly graphical user interface, and a flexible post calculation table editing function which allows user to plot variety of diagrams. It is designed to create an integrated workspace for various of calculations. Current modules include:

PanPhaseDiagram: perform calculation of phase equilibrium and thermodynamic properties for technical important multi-component alloy systems. Calculated properties include stable and metastable phase diagrams, liquidus projection, stability diagrams, phase fraction and composition, phase transformation temperature, solidification path and heat evolution with the Scheil-Gulliver model, activity, driving force and much more. Highlight features include 3D diagrams, property contour diagrams, and High Throughput Calculation (HTC).

***PanPrecipitation*:** perform simulation of diffusion-controlled precipitation kinetics during heat treatment process. Langer-Schwartz theory and Kampmann-Wagner numerical approach are used to treat concurrent nucleation, growth/dissolution, and coarsening under isothermal and non-isothermal conditions. Simulated properties include temporal evolution of average particle size and number density, particle size distribution, and volume fractions and compositions of precipitates.

PanEngine API is Dynamic Linked Library (DLL) to be integrated with user's in-house codes to create custom applications such as solidification, heat-treatment, casting, welding, corrosion, phase field simulation and more.

PanDiffusion Module – This is a new module of Pandat™ software designed to simulate elemental diffusion under a variety of conditions. It is seamlessly integrated with the user-friendly Pandat™ Graphical User Interface (GUI) as well as thermodynamic calculation engine, PanEngine. This module can be used to simulate time evolution of composition profile, phase volume fraction and phase composition of diffusion couples. Variety of thermal history, boundary condition and geometry can be defined. Figure 1 shows an example diffusion simulation between multi-component nickel based superalloys: IN100 and Alloy 718 at 1150°C for 1000 hours. Figure 2 shows an example simulation of a sandwich diffusion couples for the Cr-Fe-Ni system at 1100°C for 1 hour.

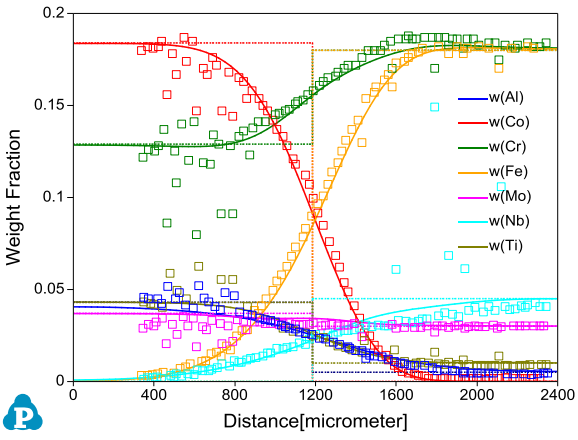

Figure 1: Diffusion between IN100 and Alloy 718 at 1150°C for 1000 hours, experimental data are from Campbell et al., Materials Science and Engineering, A 407 (2005), 135-146.

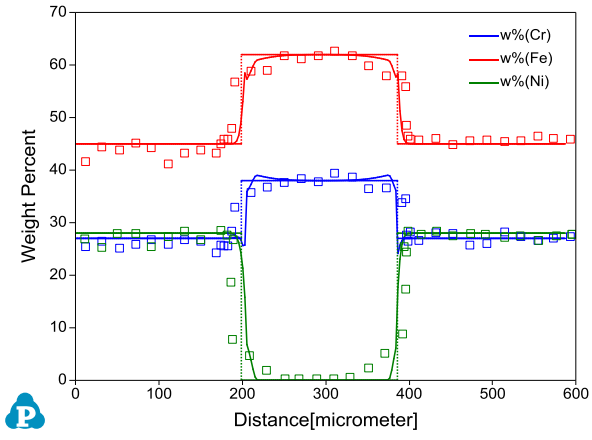

Figure 2: Diffusion of a sandwich diffusion couples for the Cr-Fe-Ni system at 1100°C for 1 hour, experimental data are from Kajihara et al., Acta Metall. Mater., 41(7) (1993), 2045-2059.

For more information, please visit us at Booth 336 and our website: www.computherm.com

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Time: **8:00 a.m. to Noon**

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Date: **Sunday, March 10**
Time: **1:30 p.m. to 5:30 p.m.**

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Date: **Sunday, March 10**
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POWDER HANDLING FOR SAFETY AND QUALITY

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Time: **8:00 a.m. to Noon**

Save on registration fees for all events when you sign up by February 1, 2019.

Learn more about TMS2019 professional development opportunities at
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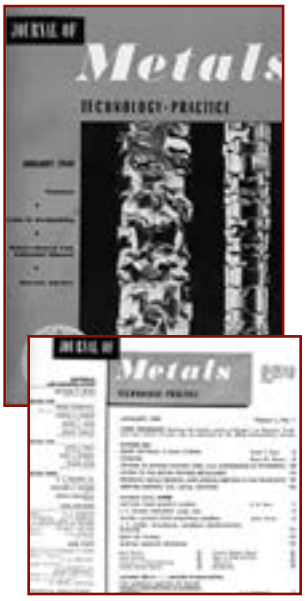
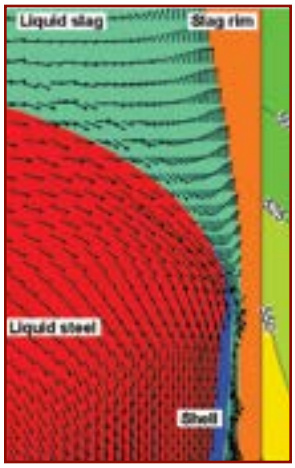


JOM: THE MAGAZINE



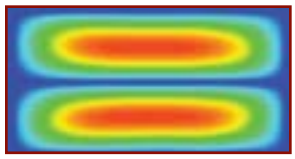
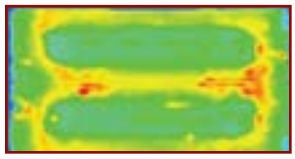
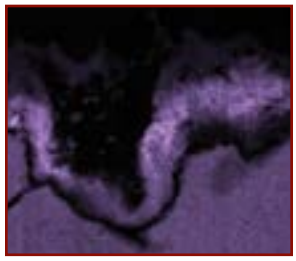
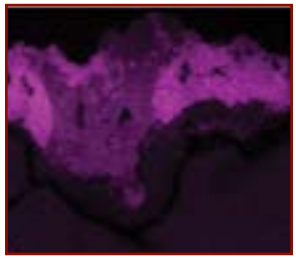
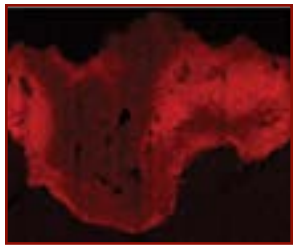
JOM: THE JOURNAL

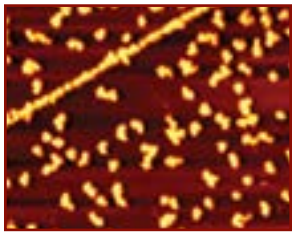
CFD Modeling and Simulation in Materials Processing: Part I

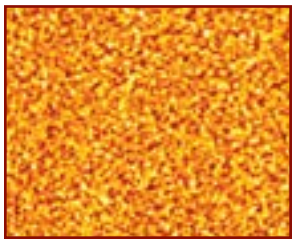
Advancement in Solid Oxide Fuel Cell Research

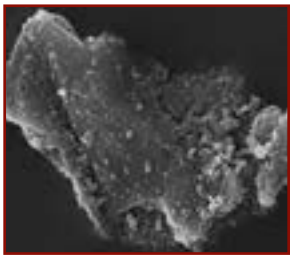
Advances in Electronic Interconnection Materials

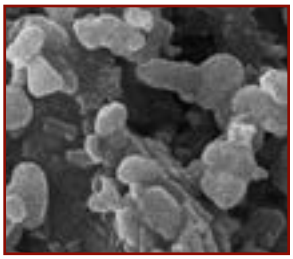
Application of Atomic Layer Deposition for Functional Nanomaterials

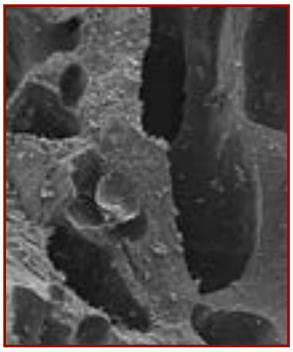










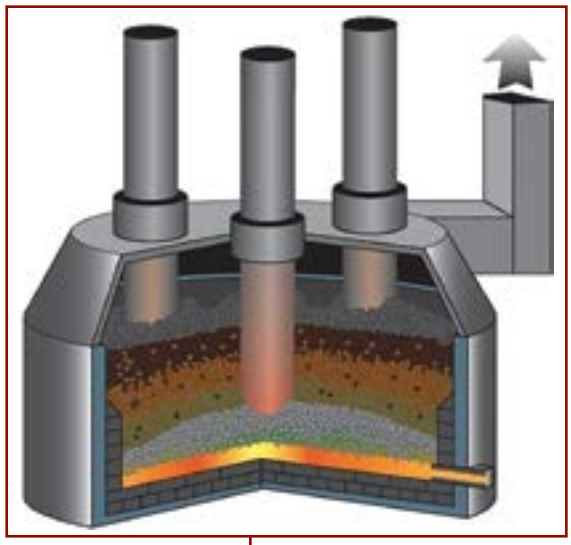




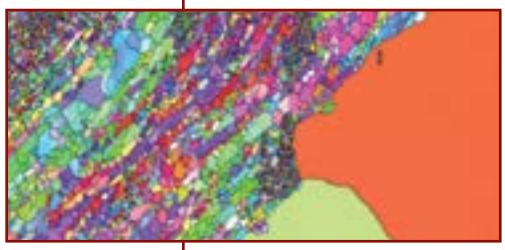


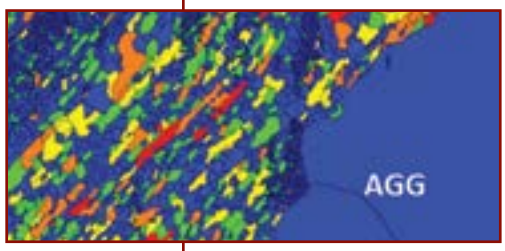
Materials in Nanomedicine and Bioengineering

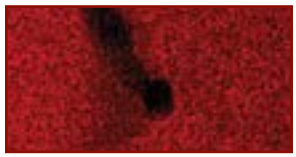
Electric Arc Smelting

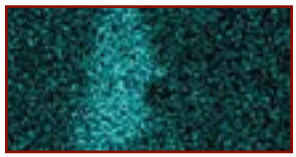


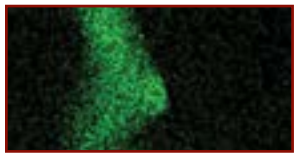
Aluminum: New Alloys and Heat Treatment: Part II











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About the Cover

Polymeric membranes such as this polyether sulfone material are ubiquitous in separation applications, but generally suffer from poor interfacial properties and chemical resistance. Growing inorganic materials within the near-surface region via sequential infiltration synthesis (SIS) offers a powerful and flexible route to engineer the interfacial properties without hindering fluid transport. Read details in "Sequential Infiltration Synthesis of Al_2O_3 in Polyethersulfone Membranes" by Ruben Waldman, Devika Choudhury, David J. Mandia, Jeffrey W. Elam, Paul F. Nealey, Alex B.F. Martinson, and Seth B. Darling.

January 2019 Guest Editors

CFD Modeling and Simulation in Materials Processing: Part I
Process Technology and Modeling Committee and Solidification Committee
Laurentiu Nastac, University of Alabama
Brian Thomas, Colorado School of Mines
Lifeng Zhang, University of Science and Technology Beijing
Adrian Sabau, Oak Ridge National Laboratory
Koulis Pericleous, University of Greenwich

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Energy Conversion and Storage Committee
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Advances in Electronic Interconnection Materials
Electronic Packaging and Interconnection Materials Committee
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Application of Atomic Layer Deposition for Functional Nanomaterials
Nanomaterials Committee
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Biomaterials Committee
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Electric Arc Smelting
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Joseph Grogan, Gopher Resource
Jesse F. White, Elkem Carbon A/S

Aluminum: New Alloys and Heat Treatment: Part II
Aluminum Committee
Dmitry Eskin, Brunel University

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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.

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

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in the final analysis

JOM
Volume 71
Number 1
January 2019

"If your plan is not working, pivot. If it is working, do more of it!"

—Amber Hurdle

James J. Robinson
Executive Director

Let me tell you about a plan that's been working for a long time and that's had some nifty pivots along the way.

This issue of *JOM* represents the 70th birthday of our TMS membership journal. Issue one of volume one arrived in mailboxes during January 1949. It was a revolutionary year for materials as it was also the year of the first test flight of the De-Havilland Comet. *Journal of Metals*, as *JOM* was known for decades, started as the member journal for those individuals affiliated with the Metals Branch of the American Institute of Mining, Metallurgical, and Petroleum Engineers (AIME). It would not be for eight years that The Metallurgical Society of AIME itself would be organized (1957) and another 37 years before The Metallurgical Society would became a separately incorporated, standalone association (1984).

Thirty years ago this month, The Metallurgical Society was renamed The Minerals, Metals & Materials Society, *Journal of Metals* was renamed *JOM,* and I published the first of what is now 361 installments of In the Final Analysis (and still counting). The pivot point of that January 1989 issue is quite the collector's item. (Bad news: It is not on eBay.)

In commemoration of *JOM* turning both 70 and 30 this year, we are marking the occasion in two ways. First, all attendees at the TMS 2019 Annual Meeting & Exhibition (TMS2019) can collect a free *JOM* 70th anniversary souvenir pin by visiting the Member Welcome Center. As shown on this page, the pin is the second in a series of pins being made available at annual meetings as we count down to the 150th anniversary of AIME's 1871 founding (2021). The first pin in the series was issued at TMS2018 and commemorated the 30th anniversary of the founding of the TMS Technical Divisions. The pin planned for TMS2020 will commemorate TMS's very early debut on the Internet with the establishment of www.tms.org in 1995. What was life like before the Internet?

"In commemoration of JOM *turning both 70 and 30 this year, we are marking the occasion in two ways."*

Speaking of the Internet, *JOM's* 70th anniversary is also being marked with the debut of another web interface designed to better serve TMS members. As regular readers know, each issue of *JOM* comprises The Magazine and The Journal sections. The technical articles of The Journal are easy to find by visiting the SpringerLink website. All 70 years of *JOM* are housed there. The site is efficient but lacks the charm of browse-ability that a print publication offers. I find this less convenient for browsing The Magazine. We are changing that this month by posting a complete PDF version of The Magazine on the *JOM* website—the cover, the articles, the ads, the works. As for the technical articles, they are not embedded in the PDF (the file would be overwhelming), but the table of contents within the PDF will allow you to click over to SpringLink. I like it—robust but reader-friendly in an easy-to-navigate PDF file. Such multi-platform vitality seems fitting for a publication that has reached its 70th birthday and seems to be just getting started.

Proud of the present while looking to the bright future of *JOM*, I must honor the work of all of those past contributors who have led us to this point over 70 years. Great credit goes to all of our past lead editors: Ernest Kirkendall (yes, that Kirkendall), Edward H. Robie, Winifred D. Gifford, T.W. Lippert, Thomas E. Lloyd, John V. Beal, Alvin S. Cohan, Rixford A. Beals, F. Weston Starratt, Richard L. Lehman, Leonard F. Griffing, Hurd Hutchins, Otto T. Johnson, Charles Moore, Lawrence G. Kuhn, Konrad J.A. Kundig, John B. Balance, Gail A. Oare, Kevin Marsden, and James J. Robinson. We have new leadership now, and our current editorial team may be our best ever: Justin Scott, Maureen Byko, Lynne Robinson, Kaitlin Calva, Shirley Litzinger, and Ed Herderick. I like what they are doing, a lot.

Oh, did I mention that along the way the *Journal of Metals*' "Transactions" section spun out of *JOM* into a new publication called *Metallurgical Transactions*? That's another pivot point that worked out quite well, too!

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JOM themagazine

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.

JOM Reaches New Milestones; TMS Members Recognized for Excellence

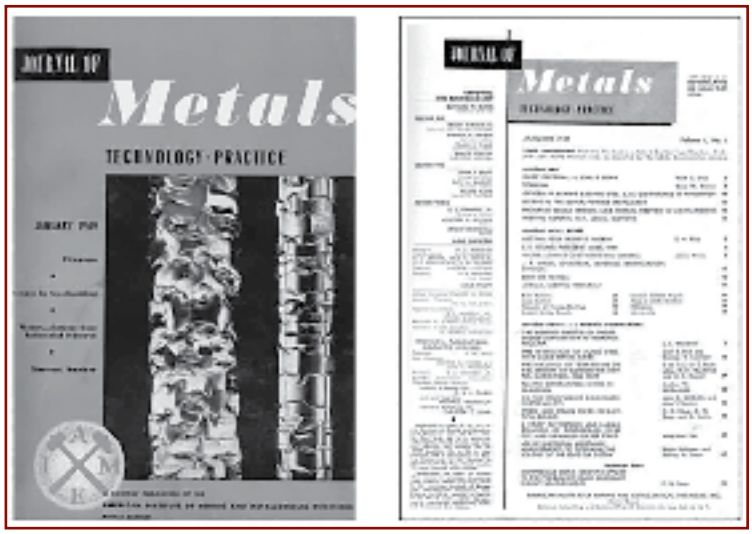
JOM Celebrates 70 Years

This month marks the 70th anniversary of *JOM*, originally known as *Journal of Metals*. The first issue, published in January 1949 under the leadership of inaugural editor Ernest Kirkendall, contained just 11 articles. (For more *JOM* and TMS history, read the January 2019 installment of "In the Final Analysis.")

JOM has experienced considerable growth throughout its lifetime, now incorporating both a membership magazine and peer-reviewed technical journal. In 2018, a total of 515 articles were published (including magazine content), averaging roughly 43 articles per issue.

In addition to celebrating 70 years, 2019 is a notable year for *JOM* for another reason; this issue also marks the first time TMS has published *JOM*: The Magazine online as one, complete PDF for an enhanced reader experience. The downloadable file includes covers, ads, magazine articles, and an interactive table of contents that links to all of that particular issue's technical articles housed on SpringerLink. TMS members must sign in using their TMS username and password to access technical content at no charge.

Visit jom.tms.org to explore the updated web page and to access the PDF and start reading *JOM*.



The cover and table of contents for the first issue of *Journal of Metals*, published in January 1949. The image above is excerpted from the January 1999 issue of "End Notes," where editor Ernest Kirkendall reflected on the first 50 years of JOM.

Tonya Stone (Photo courtesy of Mississippi State University.)

Tonya Stone Named MS State Diversity Professor

Mississippi State University (MS State) appointed Tonya Stone, associate professor in the Badgley College of Engineering, as its new Dr. Oswald Rendon-Herrero Diversity Professor. The endowed professorship was created in 2018 to honor Oswald Rendon-Herrero, a professor emeritus in the Civil and Environmental Engineering Department.

In this position, Stone will work with the college's Office of Diversity to "further cultivate an environment of inclusiveness and academic excellence," according to a MS State announcement, as well as mentor future recipients of the Jessie and Sarah L. Johnson Endowed Scholarship.

An active TMS member since 2012, Stone has been involved in several technical committees and currently serves as the chair of the Education Committee. Stone is also a member of the American Society of Mechanical Engineers (ASME) and is the faculty advisor for the Mechanical Engineering Minority Organization (MEMO) at MS State. She received her bachelor's degree (1995), master's degree (2006), and Ph.D. (2009) all in mechanical engineering from MS State.

Past TMS President Honored by DYMAT

George T. "Rusty" Gray III, Materials Science in Radiation & Dynamics Extremes, MST-8, Los Alamos National Laboratory (LANL), and 2010 TMS President, was honored as one of the 2018 recipients of the John S. Rinehart Award. Bestowed by the DYMAT Association, the award recognizes "outstanding effort and creative work in the science and technology of dynamic processes of materials," according to the DYMAT 2018 conference website. Award recipients are selected by an international jury of DYMAT members.

Gray is a 2013 TMS Fellow and has received both the Structural Materials Division's (SMD) Distinguished Service Award (2005) and Distinguished Scientist/Engineer Award (2002). Additionally, he is a member of the National Academy of Engineering and is a Fellow of the American Physical Society, ASM International, and LANL. His recent work at LANL includes leading critical science projects for its Stockpile Stewardship efforts. He also publishes research on materials science advances and advises institutions on materials dynamics in defense and manufacturing areas, acting as a liaison for the laboratory.

George T. "Rusty" Gray III accepts the 2018 John S. Rinehart Award at the 12th International DYMAT Conference, held September 9–14, 2018, in Arcachon, France.

Richard Sisson Receives Two Awards

Richard Sisson Jr., George F. Fuller Professor of Mechanical Engineering at Worcester Polytechnic Institute (WPI), earned top honors from two materials societies in 2018. The International Federation for Heat Treatment and Surface Engineering (IFHTSE) conferred its Fellow Award upon Sisson at the June 2018 International Conference on HTSE in Automotive Applications. Sisson delivered the talk "Challenges and Opportunities for the Heat Treating Community: Threats, Risks, and Benefits" as one of three keynote addresses during the event.

More recently, he received the Fellow Award from the American Ceramics Society (ACerS) during the 2018 Materials Science & Technology Conference (MS&T18) last October.

Sisson joined TMS in 1984, and has served as a reviewer for *Metallurgical and Materials Transactions A*. He is also a Fellow of ASM International and received the ASM Distinguished Life Membership Award in 2013.

A WPI faculty member since 1976, Sisson is the director of the Manufacturing and Materials Science & Engineering Programs, as well as director of the Center for Heat Treating Excellence of the Metals Processing Institute. His research on the application of the fundamentals of diffusion kinetics, modeling, and thermodynamics to the solution of materials problems, as well as the heat treatment of steels and aluminum alloys, and additive manufacturing of ceramics and metals, has garnered more than 250 publications and more than 250 presentations throughout his career.

Richard Sission Jr. in his office at Worcester Polytechnic Institute (WPI). Photo courtesy of WPI.

Michael Rawlings

Michael Rawlings Joins TMS Team

TMS welcomes Michael Rawlings to its staff as its new science and engineering lead. He will work in the New Initiatives, Science, and Engineering Department (NIScE; formerly the Technical Department) with department director George Spanos and technical project leader Justin Scott to support the Society's growth in the technology area of focus in the TMS strategic plan.

Rawlings earned his B.S. in applied physics at Morehouse College and his Ph.D. in materials science and engineering from Northwestern University. After his graduation, Rawlings worked as a postdoctoral researcher at Northwestern and metal shop manager at Open Works Makerspace. In September 2017, he began a one-year position as an American Association for the Advancement of Science (AAAS) Science and Technology Policy Fellow at the National Science Foundation (NSF). While there, he worked in the NSF's Civil, Mechanical, and Manufacturing Innovation Division of the Directorate for Engineering. A TMS member since 2015, Rawlings was a co-chair of the third TMS summit on Diversity in the Minerals, Metals, and Materials Professions, held in July 2018.

"One element that greatly adds to the organizational uniqueness of TMS is that our NIScE Department is equipped with three exceptional Ph.D. materials scientists and engineers. This team is reflective of our membership and works with our volunteer members and the broader materials community to do more than bring greater exceptionalism to the portfolio of TMS activities," said James J. Robinson, TMS Executive Director. "Our goal is to help identify and advance the issues and opportunities that will lift up the materials science and engineering community itself. Our team's extensive work to lead studies and develop roadmaps for the field are but some examples of how TMS volunteers and staff are impacting our tomorrows. I look forward to seeing how Michael introduces his vision of how TMS can even better serve the future of materials as well as the people who are working to bring that future into reality."

"The technical expertise and workplace experience that Michael brings to TMS will immediately strengthen our efforts in support of the strategic goals set by our board of directors and in serving our broader TMS membership and volunteer groups," added Spanos. "In particular, the breadth and depth of technical knowledge from his academic and professional experiences will strongly enhance the volume and capabilities of projects supported by our department. These efforts include leading highly impactful studies and workshops, supporting a wide array of TMS conferences and professional development activities, working with volunteer committees and other groups, and helping to develop new TMS initiatives across all of these domains. I am excited to see the impact that Michael will make in these areas."

"I'm excited to join the TMS staff at this particularly interesting time for the minerals, metals, and materials community," Rawlings said. "As technological advances continue to impact nearly all disciplines and industries, the role of materials—the imaginative repurposing of established minerals and metals as well as the development of new material classes—has become ever more critical. I look forward to utilizing my technical knowledge and professional experience to help TMS, its members, and volunteers remain leaders in their fields and at the forefront of addressing global issues."

Announcing the 2019 TMS Meeting of the Membership and Open Board of Directors Meeting

The Minerals, Metals & Materials Society, Inc. (TMS), in accordance with its bylaws (Article II, Section 2.6, and Article III, Section 3.7) will hold its 2019 Annual Meeting of the Membership with an open Board of Directors Meeting on Thursday, March 14, 2019, from 8:00 a.m. to 8:30 a.m. (CT) in the Mission B Room at the Grand Hyatt San Antonio during the TMS 2019 Annual Meeting & Exhibition. All TMS members are welcome to attend this meeting.

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In Case You Missed It:

Business News from the Field

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

Hexcel Opens New Carbon Fiber Plant

Isère, France: Advanced composite materials producer Hexcel opened a new facility in the Auvergne-Rhône-Alpes region of France, allowing the company to cover the entire carbon fiber production chain. The €200 million, 37-acre plant, located in Isère, will be used to make carbon fiber and polyacrylonitrile (PAN) precursor, with a goal of meeting the growing demand for carbon composite materials by aerospace customers. Hexcel also plans to launch a 3,500 square meter research and development center in the region in the first quarter of 2019, with a focus on new processes and out-of-autoclave technologies.

thyssenkrupp AG to Split into Two

Essen, Germany: Multinational industrial engineering conglomerate thyssenkrupp AG announced plans to split into two separate companies, thyssenkrupp Materials AG and thyssenkrupp Industrials AG. The plan, approved by their Supervisory Board on September 30, 2018, intends to allow the businesses to better develop and concentrate on their individual strengths. The new capital goods company, thyssenkrupp Industrials AG, will incorporate thyssenkrupp's elevator, automotive supplier, and core plant construction businesses. thyssenkrupp Materials AG will include materials services, 50 percent interest in the future steel joint venture, and the slewing bearings, forging, and marine businesses.

Total Announces Major Gas Find Offshore U.K.

Shetland, United Kingdom: French oil and gas company Total SA announced a major gas discovery on the Glendronach prospect, located offshore of the U.K., to the west of Shetland. The reservoir is under 300 meters of water and in a formation below the Edradour reservoir, allowing fast development due to existing infrastructure around the Edradour field and the Laggan-Tomore facilities of the Shetland Gas Plant. The reservoir, estimated at approximately one trillion cubic feet of recoverable resources, is operated by Total E&P U.K. with a 60 percent interest alongside partners Ineos E&P UK Limited and SSE E&P U.K. Limited (20 percent each).

Petrobras, Equinor to Jointly Pursue Offshore Wind Projects

Rio de Janeiro, Brazil: Semi-public Brazilian petroleum company Petrobras and Norwegian energy company Equinor have signed a memorandum of understanding (MOU) to evaluate a joint business development in the offshore wind energy industry in Brazil. The MOU includes plans to research other potential areas of cooperation, such as the development of renewable energy initiatives. While the agreement does not establish obligations for either party to undertake any business, it does indicate their intentions to develop offshore wind projects together.

Santiago, Chile: Major copper producer Codelco submitted an environmental impact assessment last October to finalize its Rajo Inca project. The project aims to extend the life of its aging Salvador mine, which is currently due to run out of ore by 2021. By changing from an underground mine to an open pit mine, Salvador plans to continue operations for an additional 40 years, increasing output by 30 percent. The expected investment for this project would be approximately one billion dollars, with production of refined copper increasing to 90,000 tonnes of refined copper from the 62,000 tonnes produced in 2017. The project is part of a $39 billion, 10-year upgrade plan. (Photo courtesy of Codelco.)

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The Story of a Century: Remembering Ray Smith

Lynne Robinson

TMS staff visited Ray Smith and his wife, Rachel, at their home in Arizona in May 2017 to congratulate Ray on his 100th birthday. Pictured with the customized birthday card signed by TMS members and staff are (from left): James J. Robinson, TMS Executive Director; Rachel; Ray; Stanley M. Howard, 2017 TMS President. Rachel passed away on May 29, 2018.

It was during the Great Depression when Raymond (Ray) L. Smith embarked on an adventure that would span generations and technological revolutions. That adventure came to a close on September 18, 2018, when Ray Smith passed away at the age of 101 at his home in Green Valley, Arizona.

Ray's first job was working log drives on the St. Croix River in his home state of Maine in 1933. "I was 16 years old. I was indestructible," he said in his May 2010 commencement address at the Michigan Technological University (MTU), where he served as president from 1965 to 1979. Times were hard and Ray soon found himself hitching rides on railroad box cars in search of work. He found it in Hartford, Connecticut, as a psychiatric aide for $30 a month. He saved his money, bought a 1928 Model A Ford, and headed for Alaska with hopes of new opportunities and a better life. The Ford collapsed in Seattle, Washington, so Ray and a friend scraped enough money together to buy steerage tickets on a steamship to Fairbanks, along with hunting and camping supplies.

Ray knocked around Alaska for about a year, prospecting for gold and living off of the land. When an offer came to dig ditches in exchange for dinner, Ray was more than eager for a change from game and foraged berries. The person who hired him, as it turned out, was the president of the recently established University of Alaska, Fairbanks. Impressed with Ray's intelligence and resourcefulness, he suggested that Ray enroll in the university's mining engineering program. "He really needed students," Ray quipped during a recent conversation with *JOM*. "I had never thought of going to college, but he overcame all of my objections. Lucky for me."

Ray earned his bachelor's degree in mining engineering, with a minor in metallurgy, from the University of Alaska in 1943. He immediately joined the U.S. Army Ordnance Corps where, among other duties, he served as the lead engineer for building airfields in isolated locations. After World War II, he pursued graduate work in metallurgical engineering at the University of Pennsylvania in Philadelphia, receiving his master's degree in 1951 and his Ph.D. in 1953. He remained in Philadelphia to join the Franklin Institute as a senior research metallurgist. Within five years, he was the technical director of the institute's Solid State Division of Research.

In 1959, Ray was recruited to the Michigan College of Mining and Technology (now Michigan Technological University) to serve as the head of the Department of Metallurgical Engineering. One year later, he took on the additional duties of coordinator of research, and in 1965, was installed as MTU's sixth president.

Ray's tenure at MTU was marked by exponential growth resulting from his tireless promotion of the university and fundraising efforts. "When I first started at Tech, I was told 'You can't talk about money,'" he told *JOM*. "'You can talk about hockey, but we don't raise money.' We only had about $30,000 a year in contributions when I first got there." Ray made it a priority to change that thinking in order to secure

As a member of a volunteer corps of hazardous abandoned mine finders, Ray Smith uses a pickaxe to chip away at an underground mine, with a rope tied around his waist to potentially break his fall down the shaft in case the ground gave way. He was 92 at the time of this photo.

the university's future. He established a foundation and by the time he retired in 1979, had raised the millions required to build ten new buildings; add faculty, equipment, and programs to grow enrollment from 3,400 to more than 7,600; and increase research funding by 250 percent.

Throughout his career, Ray was an active TMS member, having joined the American Institute of Mining, Metallurgical, and Petroleum Engineers (AIME) in 1943 and serving as a vocal supporter of the formation of The Metallurgical Society of AIME as a semiautonomous society in 1957. (The Metallurgical Society would eventually become separately incorporated as TMS in 1984.)

"The old memories are hazy, but I worked with a small group to start a new division of AIME—one that emphasized the importance of metallurgy," Ray wrote in a 2017 letter to TMS. "What I do remember is that we were successful in getting TMS. I became very active with this group and we expanded rapidly. I became deeply involved in TMS over time and it became a major factor in my technical life."

In a follow up discussion, Ray said, "TMS opened my eyes to the need for technical friends—to learn from them, to help them, and above all, to discuss technical subjects with them. It has given me a way to interact and to realize that there are many people smarter than me." In 1973, Ray was inducted as a TMS Fellow for his service and professional contributions.

Retiring to Arizona, Ray continued to contribute his skills and seemingly boundless energy. Most notably, he established a hazardous abandoned mine finder group with eight other retired engineers in Arizona. For more than 20 years, he and his colleagues would traipse the south central Arizona desert to pinpoint mines and holes, record environmental data, and erect safety signs. He also served in leadership positions with other community initiatives, such as water conservation.

As he had been throughout his long life and career, Ray was plain-spoken and straightforward when asked by *JOM* to offer his advice to the generations of TMS members that followed him: "Learn to articulate briefly and clearly; share technical credit; reject jealousy, accept criticism; admit errors."

And, above all, he said, "Find adventure in your life."

A Gathering of Metallurgists

George J. Binczewski

Ray Smith will be remembered well for his many professional accomplishments. Many of these went beyond his service as president of Michigan Technological University (MTU) or his numerous research contributions. For instance, *JOM* readers might recall Ray Smith's post-retirement letters to the editor on his work in finding, exploring, and recording the location of the multitude of long abandoned copper mines in Arizona. As an authority on the history of gold, he was the invited keynote speaker at the state of Alaska's 100th anniversary celebration commemorating the 100th anniversary of the Klondike gold discovery.

What I would like to recall is Ray's involvement with the creation of a special educational course at MTU in 1977. He also took the time to teach sessions while serving as MTU president. The course was designed for updating the technological awareness of practicing metallurgists at Kaiser Aluminum who received their degrees at least 20 years earlier.

A 1979 photo of the Kaiser metallurgists attending the educational program at Michigan Technological University organized by Ray Smith. Ray is in the middle row, last person on the right.

In addition to providing a refreshing review of earlier topics, there was an objective introduction of changing and emerging concepts of metals and affiliated processes. When and where applicable, there was a focus on aluminum.

The typical class size was 18 to 20 individuals who were nominated by their respective location managements. The course was conducted at the MTU campus for a two-week period after the regular student body had left for the summer. The course registrants stayed in the vacated dormitories and were taught by MTU subject professors, including Ray Smith. The MTU professors often commented that they themselves learned from the experiences of the students, many of whom had already worked in the industry for more than 30 years.

There were other subtle, but tangible, program benefits in addition to the educational aspects. Personal relationships were established among class members who had previously only known their counterparts through correspondence or as a name in a company directory. Each class compiled its own "yearbook" with photographs and appropriate comments, many of the humorous kind. In later years, these provided many pleasant memories.

The Kaiser Aluminum summer program extended over a five-year period and involved nearly 100 metallurgists. I'm sure many of the alums of the program remember Ray fondly.

A TMS member since 1952, George J. Binczewski is a technical advisor for SC Systems in Moraga, California. His is a long-time friend and colleague of Ray Smith.

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Nominate your Colleagues for TMS Awards and Treat Yourself to a TMS Life Membership

Kevin Hemker, 2018 TMS President

Kevin Hemker

"You can tell a lot about a society by the way it celebrates its successes."

"The awards process starts with nominations, and TMS awards recipients can only truly represent the full breadth of our membership if nominations come from across the full spectrum of TMS members."

I vividly recall my first graduation ceremony at Johns Hopkins University. During the faculty procession I was paired with one of our most prestigious medical school faculty, a man widely regarded as the father of medical genetics. As we entered into the tent filled with joyful students and their parents he smiled at me and said, "You can tell a lot about a society by the way it celebrates its successes."

To this day, I am not sure that I fully comprehend the depth of his statement, but I love the sentiment and have never forgotten his words. I think it means we should pursue our passions with gusto and pause once in a while to appreciate and celebrate what we have achieved. The memory of that encounter has compelled me to attend more than two dozen graduation ceremonies and to fete my students and my sons when they reach personal milestones. I am writing today to encourage you, valued members of the TMS community, to do the same.

Each year at the Annual Meeting & Exhibition, TMS bestows a variety of awards and pauses to fete its members and celebrate their successes. You might assume that TMS award recipients are senior sages with a lifetime of accomplishments, and in some cases, you would be right. But in recent years the TMS Board of Directors and Foundation Board of Trustees have worked hard to create and fund awards at all levels of membership. TMS now confers more than 85 Society, Division, Young Professional, and Student Awards in total. In addition to our pinnacle awards and the distinction of being named TMS Fellow, the Society now offers the Brimacombe Medal for mid-career materials practitioners, the Julia and Johannes Weertman Educator Award, the Application to Practice Award, the Frank Crossley and Ellen Swallow Richards Diversity Awards, and many more.

The 2018 TMS Strategic Plan states that TMS seeks to be a highly inclusive Society where all members can aspire to the full suite of honors, awards, engagement, and leadership opportunities that the Society has to offer. The awards process starts with nominations, and TMS awards recipients can only truly represent the full breadth of our membership if nominations come from across the full spectrum of our members.

I am writing to ask for your help. **Award nominations are due on April 1, 2019**, and once submitted most are active for three years. Over the next month or so, I invite you to visit the full list of TMS awards at awards.tms.org and consider nominating a student, direct report, colleague, friend, or mentor for a TMS award.

While I have your attention, may I also suggest that you reward yourself with a TMS lifetime membership? Over the past year, countless people have shared with me that TMS is their home Society, but only a small fraction of current TMS members are aware that TMS offers a lifetime membership. By signing up for a lifetime membership and paying a one-time fee of $1,800 you can avoid the need for annual renewals and know that you will be a TMS member for the rest of your life. Financially this is a slam dunk for anyone below 50 years old, but the greatest benefit comes from the bonds that this creates within the TMS community. Please consider rewarding yourself with a TMS lifetime membership by visiting www.tms.org/Membership today.

The statement that, "You can tell a lot about a society by the way it celebrates its successes" is as true today as it was when I first heard it. I hope that you will agree that TMS has much to celebrate and that you will help us fete a TMS member by nominating them for an award this year.

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Gregory Poole Talks Progress in Metallurgical Processing

Kaitlin Calva

Gregory M. Poole

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.

"Never be afraid to say 'I don't know,'" said Gregory M. Poole, co-author of "Comparison of Coil Configuration and Position on Flow Characteristics of A319 Aluminum in Electromagnetically Stirred Solidification Systems," published in the January 2019 CFD Modeling and Simulation in Materials Processing *JOM* topic. "Today, there is an unreasonable apprehension to utter those words, either out of pride or the fear of looking incompetent in our fast-paced world. But those three words have done more to spur progress and the creation of our modern way of life than any others."

An assistant professor of mechanical engineering at the University of South Alabama, Poole has two other pieces of advice for young scientists and engineers. First, "Be sure to take a few hours each week for self-care…rest time is essential to reach each successive peak." The second is something Poole tells his own students. "Three strikes and you're *not* out. Just because you make mistakes does not mean you are not well-prepared for the future. What it takes, above all, is contentiousness and maintaining a sense of wonder about the world around you."

He has managed to keep his own sense of wonder about the world of metallurgy since an early age with the help of David Nikles, having found his calling to teach others and to perform science and engineering research during a high school internship with Nikles at the University of Alabama. As he continued on to pursue his B.S., M.S., and Ph.D., all in metallurgical engineering, Poole noted that it was Nagy El-Kaddah, his graduate advisor and friend, and Laurentiu Nastac, his co-author on the January 2019 *JOM* paper, who "deepened my love for metallurgy and molten metal processing, and emphasized that my classmates and I always master the fundamentals in answering scientific questions." During his postdoctoral work at Purdue University, Matthew J.M. Krane helped Poole become a better educator. "I learned how to demand excellence both of myself and those I mentor," he said. "To not ask the best of individuals is to hinder them from achieving their full potential."

Poole's current research is an extension of his graduate work in the use of electromagnetic fields in solidification processing. "This article is a culmination of work in magnetohydrodynamics and the role that operating parameters have on heat and momentum transfer within solidifying castings," Poole said. "I hope it will provide valuable insight on which parameters take precedence in electromagnetic stirring of semisolid melts."

Recently, Poole has expanded his work with the help of his colleagues in the Chemistry Department to include the "development of new stereolithography resins with tunable mechanical and thermal properties." Poole counts new ventures like these as milestones along the road of his academic career. "Being able to realize the usefulness of knowledge gained through my professional life in mechanical behavior, metallurgy, and materials science has been such a blessing." Looking to the future of the field, Poole notes that "One of our greatest challenges will be making metalcasting and downstream processes environmentally sustainable for the coming generations as we look for ways to enact material and energy savings."

A TMS member since his undergraduate days, Material Advantage helped expose Poole to different materials classes while keeping him engaged in the field. And now, as a professional member, Poole still finds a "true community" in the Society: "Attending TMS conferences allows you to connect with individuals who are likewise fascinated with metallurgy but whose specialty differs from your own. There is no truly isolated area in metallurgy/materials science, and as scientists and engineers we all have something to learn from one another."

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Faster: Accelerating the Transition from Materials Discovery to Commercial Deployment

A TMS Member Perspective

Alexander H. King

Alex King

Do You Have a Perspective to Share?

JOM: *The Magazine is seeking case studies, member perspectives, and non-technical project overviews with strong industrial applications. To suggest an article idea, contact Kaitlin Calva,* JOM *Magazine Managing Editor, at kcalva@tms.org.*

The Challenge

According to popular wisdom, it takes 20 years or more to commercialize a material after its discovery in the lab, and this is used to justify all sorts of research efforts to speed up the process.

The 20-year rule was probably first introduced by Tom Eagar, in a paper in the Massachusetts Institute of Technology's *Technology Review*[1] that cites nine examples of 20-year gaps between discovery and commercialization, over a time period from the mid-nineteenth to the late twentieth century. Others have added to the list.

The Response

It would be easy to conclude that 20 years is the norm, but in fact, it is not. It is not even clear that it is the mode. The examples selected by Eagar clearly identify an opportunity for improvement, but if it were possible to conduct a study of *all* materials that have been developed in the lab we would certainly find many examples of materials that have taken longer than 20 years to achieve commercial success (if they ever do) and not just a few that have taken significantly less time. Recent efforts by the National Institute of Standards and Technology (NIST) to set standards for measuring the time between discovery and commercialization provide a basis for making the measurements,[2] but my thesis is that we should spend more effort assessing why some materials go from the lab to the production line much faster, than finding and bemoaning all the cases that take 20 years or more.

In the course of leading the Critical Materials Institute (CMI) for its first five years, I observed at close hand the development and commercialization of a handful of "fast-track materials." I also studied a few other cases that exemplify commercial success in considerably less time than two decades. These all occurred in relatively recent years, but I do not have sufficient data to determine if this represents a trend toward shorter commercialization times. Nevertheless, if we understand these cases and recognize their attributes when they occur elsewhere, perhaps we can take advantage of them and turn fast-tracking into a trend.

Learning from Success

Each of the following materials, along with several more, are worthy of detailed case studies. They all have different attributes and paths to commercial success, but they also illustrate a few key features and all share one major distinction from the 20-year cases cited by Eagar. These materials were developed to meet specific needs, rather than being developed because their properties or performance were expected to find revolutionary applications.

- A solder alloy of tin, silver, and copper was invented in 1994[3] and adopted as the worldwide standard for electronics in 2006—*twelve years*.
- A series of aluminum casting alloys based on the Al-Ce eutectic[4] was conceived in 2014 and achieved its first commercial sales in 2017—*three years*.
- Permanent magnets based on the $Nd_2Fe_{14}B$ composition were

discovered in 1984[5,6] and went into commercial production in 1986—*two years*.

- In 2014, Apple introduced the iPhone 6 with an aluminum alloy body that could be bent with bare hands. In 2015 it introduced the iPhone 6S with a newly developed and patented 7000-series alloy that was much stiffer. We do not know when the development of the new alloy began, but we can assume a development-to-commercialization time on the order of *one year*.

The tin, silver, and copper alloy solder was invented in response to environmental pressure to eliminate lead and its use was mandated by regulations introduced in both the European Union and in Japan in 1997—the year that the alloy was patented. The Al-Ce-X alloys were invented to provide highly castable aluminum without the need for distortion-inducing post-solidification heat treatment. $Nd_2Fe_{14}B$ was invented because the production of samarium-cobalt magnets was challenged by a cobalt shortage in 1978. And Apple's stiff aluminum alloy was invented to meet a specific commercial need. All of the materials considered by Eagar provided great new capabilities but there were no products that immediately needed them: their use depended on the development and commercialization of new products and devices that eventually took advantage of the new materials' properties.

Some fast-track materials are only used in the application for which they were initially developed, but some, notably the neodymium magnet composition, have achieved much broader success as their new properties have come to be appreciated, modifications have been developed and new uses have emerged. Early adoption in a single application certainly helps in this process, and this is one of the keys to fast-track commercialization of a new material.

Key Lessons

Rapid adoption of a material in any specific application depends on several factors. It helps considerably if the material can be used directly in the existing manufacturing process—if it is a "plug-in substitute" for an existing material. Process-compatible substitutes are rare, however, but the smaller the number of process changes that are required, the more easily a new material is adopted. The lead-free solder invented by Miller, Anderson, and Smith melts a few degrees hotter than the lead-tin solder that it replaced, and the higher re-flow temperatures called for other adjustments in the production of integrated circuits. Those process changes were within reach and could be adopted in the designs of next-generation devices, the new solder was quickly adopted.

In a nearly ideal plug-in case, a red-emitting phosphor material has been developed as an alternative to europium-based red phosphors for fluorescent lamps.[7] This is a product where declining demand and the absence of product updates makes almost any change to the manufacturing process prohibitive, so a plug-in substitute is imperative. Tolerance of the need for process adjustments ultimately depends on the manufacturer's ability to invest in adopting a new material. Adoption is easier in growing markets with frequent product redesigns where new processes are always under development, and harder in stable or shrinking markets with unchanging products. The flexibility of dynamic markets adds another challenge, however. If a material is being developed to target a product with a short redesign cycle like a smart-phone, then that material will have to meet some tough deadlines.

New materials need applications. Without an application, there is no opportunity for commercialization, so we need to assess the opportunities for new materials according to their properties *and* their potential uses to see which ones might break through the "Eagar barrier." I have tried to do this in a generic form in Table 1, based on the cases described previously.

Research and development efforts aimed at developing new materials are streamlined when they are focused on a single end-use, especially if a manufacturer is involved from the beginning of the process. Developing a new material is, at least at the outset, a process of elimination; and the input from the manufacturer can eliminate candidate materials very quickly,

"New materials need new applications. Without an application, there is no opportunity for commercialization..."

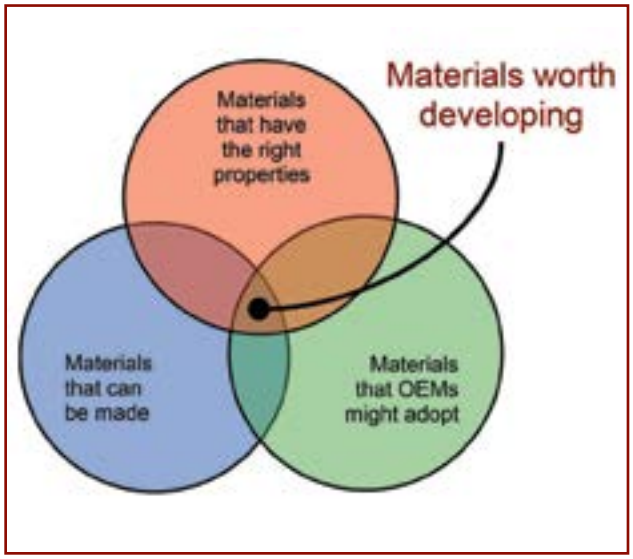

Figure 1. Materials design is a process of down-selection that reduces the burden of materials development efforts. A good strategy is to apply all filters as early as possible in the process. This summarizes the experience of CMI in developing phosphors for efficient lighting: without input from an industrial partner, synthesis and testing of 12 material systems would have been undertaken. A short review by the manufacturer cuts this to just three, with the other nine being eliminated for a range of technical and business reasons, reducing the projected experimental work by 75% and accelerating the R&D effort by a factor of four.

Material Properties & Processing Requirements relative to existing materials	Application: Does Not Exist	Application: Rapidly Evolving	Application: Stable or Declining
New never been seen before **(a)**	Very Low	Low	Zero
Better than existing materials **(b)**	Very Low	Moderate to High	Very Low
Identical to existing materials **(c)**	Very Low	Moderate If there are advantages other than material properties	Moderate If there are advantages other than material properties
Similar to existing materials **(d)**	Very Low	Moderate	Low
Different from existing materials **(e)**	Very Low	Low	Zero

Notes:
a. Materials with entirely novel properties, such as high-temperature superconductors or topological insulators, which call for new applications to take advantage of the new properties
b. Materials that exceed the properties of existing materials in at least one functionally significant area, and do not fall below them in any regard
c. Materials that match the properties of existing materials in every functional property and processing need—true plug-in substitutes
d. Materials that match the properties of existing materials in most regards, but call for some design adjustments because of minor differences—for example, lead-free solders
e. Materials that meet one functional requirement of an application but need design workarounds in many areas

curtailing the need to synthesize and test a large palette of contenders, as illustrated as a Venn diagram in Figure 1. The process of down-selection—the systematic rejection of unacceptable solutions—is achieved by applying filters to the pool of candidates. The sooner we make a No-Go decision, the more the resources that can be applied to the remaining candidates and the early application of available filters accelerates the process.

In one view of the commercialization process, materials are first developed in the lab and then offered to the commercial sector. Progress along the path is characterized by the Technology Readiness Level (TRL)[2] with research work at low TRL values traditionally being thought of as the domain of research labs, increasingly in universities and national labs, and development work at high-TRL values being the domain of the commercial sector. The standard view of the transition from the lab to the factory is illustrated schematically in Figure 2(a), but many of the materials that have made the transition on the fast track have taken a path more like Figure 2(b), in which there is early involvement from industry, setting the goals and limiting the scope of the low-TRL efforts. At the "back end" of the process, there is also substantial input from the research lab, overcoming barriers to success on the production line, based on detailed understanding of the relationships between structure, properties, and processing of the material. Industry involvement at low TRLs, and researcher

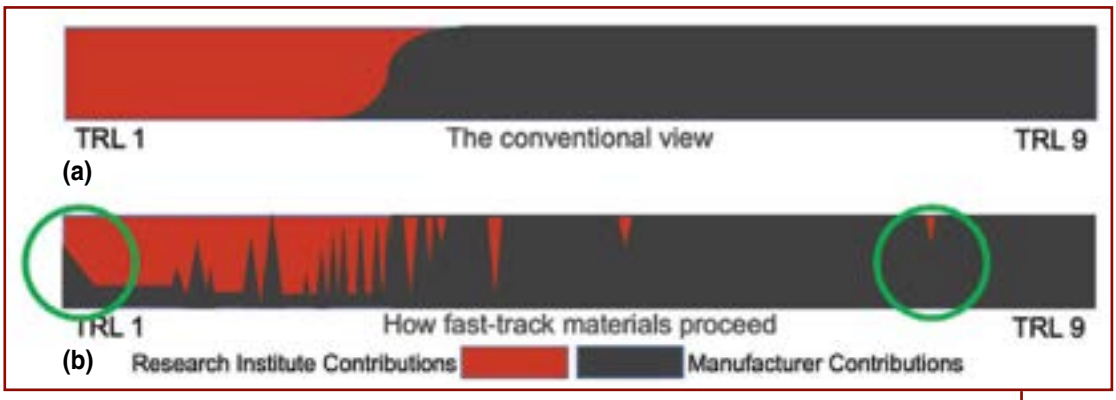

Figure 2(a) and (b) Schematic views of how research institutes and manufacturers contribute to the development of new materials across the spectrum to technology readiness levels. Top: the conventional view, which may have a more or less sharp transition. Bottom: the profile seen in fast-track materials.

input at higher TRLs are common features of materials whose commercialization succeeds on the fast track.

As seen in Table 1, there are some sweet spots and not-so-sweet spots for the rapid commercialization of new materials, and the sweet spots largely relate to meeting *existing* manufacturing needs. This is not to cast shade on the value of research aimed at discovering or developing entirely novel materials like high-temperature superconductors, fullerenes, quasicrystals, conducting polymers, ductile ceramics, transparent aluminum, or other Nobel-worthy discoveries: these have great potential in the long term, but it takes a long time to develop the applications in which they will have commercial success.

Among the cases of meeting existing needs, however, there are some hints of what might be done to accelerate the commercialization of the truly revolutionary materials: mostly, working closely with end-users as early as possible. What does not work is to invent something and metaphorically throw it over the lab wall in the form of a publication or a patent, expecting investors and manufacturers to find it. The far side of that wall is where the valley of death begins.

What Next?

The commercialization of new materials can be accelerated if we study the cases where it happens quickly, as opposed to simply cataloging the cases where it does not. I have drawn lessons from a small number of fast-track materials here, but there is plenty of scope to expand on this. There are certainly more lessons in other cases, so I would welcome suggestions about materials that have made it from the lab to the production line in less than Eagar's canonical 20 years. If you have an example to share, ideally including the discovery and commercialization dates, earliest known research publications, patents, and the names of the commercializing entities, please feel free to contact me at alexking@iastate.edu.

References

1. T.W. Eagar, *Technology Review*, 98, 43 (1995).
2. Nexight Group, *Quantitative Benchmark for Time to Market (QBTM) for New Materials Innovation: An Analytical Framework*. 2016, National Institute of Standards and Technology, https://www.nist.gov/document/qbtmfinalanalyticalframework011216pdf
3. C.M. Miller, I.E. Anderson, and J.F. Smith, *Journal of Electronic Materials*, 23, 595 (1994).
4. Z.C. Sims, O.R. Rios, D. Weiss, P.E.A. Turchi, A. Perron, J.R.I. Lee, T.T. Li, J.A. Hammons, M. Bagge-Hansen, T.M. Willey, K. An, Y. Chen, A.H. King, and S.K. Mccall, *Materials Horizons*, 4, 1070 (2017).
5. J.J. Croat, J.F. Herbst, R.W. Lee, and F.E. Pinkerton, *Journal of Applied Physics*, 55, 2078 (1984).
6. H. Onodera, Y. Yamaguchi, H. Yamamoto, M. Sagawa, Y. Matsuura, and H. Yamamoto, *Journal of Magnetism and Magnetic Materials*, 46, 151 (1984).
7. N.J. Cherepy, S.A. Payne, N.M. Harvey, D. Aberg, Z.M. Seeley, K.S. Holliday, I.C. Tran, F. Zhou, H.P. Martinez, J.M. Demeyer, A.D. Drobshoff, A.M. Srivastava, S.J. Camardello, H.A. Comanzo, D.L. Schlagel, and T.A. Lograsso, *Optical Materials*, 54, 14 (2016).

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MS&T18 Convenes in Columbus

Ashley-Anne Bohnert

High-quality technical programming, valuable networking opportunities, exciting student competitions, and a robust exhibition attracted more than 3,100 scientists and engineers to Columbus, Ohio, for Materials Science & Technology 2018 (MS&T18) from October 14–18.

The 2018 meeting brought together 1,800 presentations, nearly 100 exhibitors, and five leading materials societies: the American Ceramic Society (ACerS), ASM International, the Association for Iron & Steel Technology (AIST), the Metallurgy & Materials Society (MetSoc) of the Canadian Institute of Mining, Metallurgy and Petroleum (CIM), and TMS. NACE International also contributed to the success of the event as a co-sponsor.

One of the many highlights of MS&T18 was the All-Conference Plenary which featured lectures from three award recipients. A common theme across all of the presentations was the impact that materials science and engineering can have on advancing society, from medical applications to the steel industry.

Lynnette D. Madsen of the National Science Foundation was named the ASM/TMS Distinguished Lecturer in Materials and Society "for crossing boundaries between countries, academia and industry, and traditional disciplinary areas to create cooperation, partnerships and new frontiers of materials science." Her address, "The Ecosystem of Research, Education, and Community," explored the interdependence of these three factors and the importance of each for future advancements.

Madsen also challenged her audience to consider the role materials scientists and engineers should play in solving societal problems through areas such as sustainable product designs, STEM (science, technology, engineering, and mathematics) outreach, or the promotion of science literacy. Madsen encouraged attendees to strive for increased diversity and reduced inequalities in STEM fields. She noted, "the students of today are tomorrow's workforce. Everyone with an interest in STEM should be encouraged, advised, mentored, and trained into such a career."

The session also featured John G. Speer, Colorado School of Mines, as the AIST Adolf Martens Memorial Steel Lecturer. In his presentation, "Steel—A Lot to Learn," he highlighted the continuing importance of steel to a variety of markets and the role of materials science in developing new steel products. Speaking directly to the students in the audience, Speer outlined the improvements in auto body

Lynnette Madsen, National Science Foundation, is honored as the ASM/TMS Distinguished Lecturer in Materials and Society by Frederick E. Schmidt, 2017 ASM International President, (left) and Kevin J. Hemker, 2018 TMS President (right).

Start Planning for MS&T19
Share Your Work

The Materials Science & Technology (MS&T) partner societies are now accepting abstracts for MS&T19, which will be held September 29–October 3, 2019, in a new location—Portland, Oregon. More than 85 symposia are planned in 13 topic areas covering a broad range of materials-related topics. Abstracts are due by March 15, 2019. For more information, visit the Technical Program section of **www.matscitech.org**.

In addition to a comprehensive technical program, MS&T19 will feature a dynamic exposition where attendees will have direct access to the latest products and services used in the materials science professions.

Save the date for future conferences:

MS&T20 Pittsburgh, Pennsylvania, *October 4–8, 2020*
MS&T21 Columbus, Ohio, *October 17–21, 2021*

steel product development over time and noted, "these are not your grandfather's steels. The steels we use today have been in constant development over the last 50 years… but there's still a lot to learn and I hope we have students out there who are excited to make the next generation of improvements."

The ACerS Edward Orton Jr. Memorial Lecture was delivered by Cato T. Laurencin of the University of Connecticut. His talk, "Regenerative Engineering: Materials in Convergence," outlined the importance of materials science to the field of regenerative engineering, which he defined as "the convergence of advanced materials science, stem cell science, physical and developmental biology, and clinical translation towards the regeneration of complex tissue, organs, and organ systems." Drawing upon examples of his research into limb regeneration, Laurencin noted that much of his team's work is directed at "finding solutions, or giving others the tools to find the solutions to help people. After all, it only means something if it means something."

John G. Speer, Colorado School of Mines and 2017 President of the American Institute of Mining, Metallurgical, and Petroleum Engineers (AIME), presented one of three plenary lectures during MS&T18.

Three Choices for Success

What if finding happiness and fulfilment in your career was determined by just three sets of choices? According to Daniel B. Miracle of the Air Force Research Laboratory, it is. Miracle outlined these choices in his Young Professionals Tutorial Lecture, "Three Essential Decisions for a Successful Career."

Decision #1: What You Decide to Work On

Miracle offered three suggestions for choosing projects that will lead to a satisfying and successful career. The first is to choose big, important problems. Miracle advised: "Ask yourself—in five years, am I going to be proud of what I worked on?" The second is to choose problems you enjoy working on. Finally, be open to learning new things since a varied background will help you gain unique insights when working in new areas.

Daniel B. Miracle (standing), Air Force Research Laboratory, delivers a presentation as the Young Professionals Tutorial Lecturer at MS&T18.

Decision #2: Who You Decide to Work With

Another crucial factor in a fulfilling career is surrounding yourself with mentors you respect, colleagues you can learn from, and individuals you enjoy working with. Miracle noted that, "when you're working closely with people you respect you get to watch how they do things. It's a completely different mentoring experience."

Decision #3: How You Choose to Use Your Time

"It's important to set aside time to think," Miracle argued. "It's a critical part of what we do in our job and if we don't have enough time to do it, then there's a problem." To accomplish this, Miracle advised attendees to follow three steps: schedule time to think, giving it the same priority as commitments to others; set time limits on required tasks to make yourself work more efficiently; and, learn to say no, recognizing that you can't do everything.

The Main Takeaway

Remember that when it comes to your career, you decide. As Miracle notes, "this is your career and there should be a wonderful partnership between your objectives and those of the place you work. If they're not aligned, don't be afraid to think about looking for somewhere they will be."

Scenes from MS&T

MS&T18 featured a bustling exhibition where attendees connected with nearly 100 exhibitors over 11,700 square feet of exhibit space.

Amy Clarke, TMS Membership & Student Development Chair, spoke at the MS&T Women in Materials Science Reception. Clarke noted that "leading progress in diversity and inclusion has been a top priority for the Society for the last several years," and highlighted some of TMS's diversity initiatives.

During the From Diversity to Inclusion session, Jonathan D. Madison of Sandia National Laboratories delivered an invited talk titled, "Observations, Learnings, and Outlooks from the 3rd TMS Summit on Diversity." Drawing on the insights obtained from the recent TMS Summit, Madison noted that, "regardless of your professional level or the population for which you have a passion, there is work you can do to advance the goals of diversity and inclusion." He emphasized the importance of combatting unconscious bias and using available assessment models "to measure where we are and where we are going."

The Material Advantage title of 2018 Most Outstanding Chapter was awarded to Colorado School of Mines for demonstrating overall excellence in chapter programming, career development, service, social activities, and chapter management.

A meeting of the TMS Industrial Advisory Committee was held during MS&T18. The committee is charged with developing society activities to enhance the engagement of industrial members and companies in TMS.

Jeffrey Fergus, Auburn University, spoke on changes in ABET engineering criteria 3 and 5 during the Elizabeth Judson Memorial Symposium, "Curricular Innovations and Continuous Improvement of Academic Programs (and Satisfying ABET along the Way)." The symposium is organized each year by the TMS Accreditation and Education committees.

Throughout the week, attendees were invited to take a break from programming at the Society's member lounge and grow the TMS Word Cloud by identifying a word that embodies TMS. Many words highlighted a spirit of innovation, a range of collaborative opportunities, and a strong sense of community. Words featured in the top row, left to right, are: Bladesmithing; Collaboration; Exchanging Ideas; Innovation!; Materials; Nanocomposites; and Networking. Bottom row, left to right: Family; Pride!; Opportunity; Connections; and Development.

Announcing the 2018 Symposium on Superalloys Scholarship Recipients

Each year two students are selected for the prestigious TMS International Symposium on Superalloys Scholarship for their work in metallurgical and/or materials science and engineering with an emphasis on all aspects of the high-temperature, high-performance materials used in the gas turbine industry and all other applications.

The first of the two 2018 recipients, Adam Ladd of the University of Illinois, noted, "I've worked hard my entire academic career to be the best engineer and scientist that I could be, so it's nice to know that some of that hard work has paid off. This scholarship will help me leave college with less debt and allow me to start my future career on the right foot. Being a part of Material Advantage has been very impactful. I've made many friends, learned about different companies and career paths, and grown from a student to a professional. I can't wait to make meaningful, world-changing contributions to our society after I graduate."

The second recipient, Hari Krishnan Rajendran of Texas A&M University, added, "I am incredibly humbled and honored to have been selected for this prestigious scholarship. This recognition is an encouragement for my doctoral study. I would credit my advisor, Jean-Briac le Graverend, for instilling in me a passion for this line of research and motivating me to strive for better contributions to the field. I would also like to thank the TMS Foundation, the Organizing Committee of the International Symposium on Superalloys, and the Material Advantage student program for the motivation and opportunities they provide to young researchers like me."

The scholarship is funded by the TMS Foundation and issued under the generosity of the TMS International Symposium on Superalloys Committee. It provides each student with a $2,000 scholarship and up to $250 in travel assistance. For further information on this and other scholarships, visit the TMS Honors & Awards website at awards.tms.org.

Adam Ladd (right), University of Illinois, receives his award from Sammy Tin (left), Chair of the 14th International Symposium on Superalloys (Superalloys 2020).

Hari Krishnan Rajendran (right) of Texas A&M University receives his award at the Material Advantage Student Award Ceremony.

TMS Members Honored at MS&T18

TMS congratulates its many members whose outstanding contributions to their fields earned them distinction from the American Ceramic Society (ACerS), ASM International, and the Metallurgy & Materials Society (MetSoc) of the Canadian Institute of Mining, Metallurgy and Petroleum (CIM) during MS&T18.

ACerS 2018 Honors and Awards Banquet
Monday, October 15

ACerS/EPDC Arthur Frederick Greaves-Walker Lifetime Service Awards
Lynnette Madsen,
National Science Foundation

Richard M. Fulrath Award—U.S. Academic
John McCloy,
Washington State University

2018 Class of Fellows
S. Pamir Alpay,
University of Connecticut
John McCloy,
Washington State University
Julie M. Schoenung,
University of California, Irvine
Richard D. Sisson Jr.,
Worcester Polytechnic Institute

2018 ASM International Awards Dinner
Tuesday, October 16

2018 Class of Fellows
Amy J. Clarke,
Colorado School of Mines
Robert W. Hyers,
University of Massachusetts
Ibrahim Karaman,
Texas A&M University
G. Robert Odette,
University of California, Santa Barbara
Eugene A. Olevsky,
San Diego State University
Mark E. Schlesinger,
Missouri University of Science and Technology
Beth Matlock Snipes,
TEC Materials Testing
Katsuyo Thornton,
University of Michigan
Sammy Tin,
Illinois Institute of Technology
Mark Tschopp,
U.S. Army Research Laboratory
Christopher M. Wolverton,
Northwestern University

Marcus A. Grossman Young Author Award
Wanlin Wang,
Central South University

Henry Marion Howe Medal
Eric Lass,
National Institute of Standards and Technology
Lyle E. Levine,
National Institute of Standards and Technology
Daniel Ng,
Northwestern University
Thien Q. Phan,
National Institute of Standards and Technology
Mark R. Stoudt,
National Institute of Standards and Technology

Alpha Sigma Mu Lecturer
Ronald J. O'Malley,
Missouri University of Science and Technology

TMS/ASM Distinguished Lectureship in Materials and Society
Lynnette D. Madsen,
National Science Foundation

Edward DeMille Campbell Memorial Lecturer
Julie M. Schoenung,
University of California, Irvine

Bradley Stoughton Award for Young Teachers
Josh Kacher,
Georgia Institute of Technology

Albert Easton White Distinguished Teacher Award
Enrique V. Barrera,
Rice University

J. Willard Gibbs Phase Equilibria Award
John E. Morral,
Ohio State University

William Hunt Eisenman Award
Louis W. Lherbier,
Carpenter Technologies (retired)

Albert Sauveur Achievement Award
S. Lee Semiatin,
US Air Force Research Laboratory

Engineering Materials Achievement Award
Christopher Hahin,
Illinois Department of Transportation

Silver Medal Award
Erik M. Mueller,
National Transportation Safety Board

Gold Medal Award
Steven J. Zinkle,
University of Tennessee

Distinguished Life Membership
Michael F. Ashby,
University of Cambridge

MetSoc of CIM 2018 Awards Banquet
Monday, October 15

Sherritt Hydrometallurgy Award
Tzong T. Chen,
CanmetMINING (retired)

CIM Fellowship
Daolun Chen,
Ryerson University
Greg Richards,
Teck Metals Limited

CIM Distinguished Lecturer
Mary Wells,
University of Guelph

MetSoc Brimacombe Award
Jun Song,
McGill University

MetSoc Airey Award
Sam Marcuson,
Vale (retired)

Editor's note: Carol Matty, TMS Marketing Assistant, contributed to this article.

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TMS meeting headlines

View all upcoming meetings online at www.tms.org/Meetings.

Other Meetings of Note

Offshore Technology Conference (OTC) 2019
May 6–9, 2019
Houston, Texas, USA

ALTA 2019 Nickel-Cobalt-Copper, Uranium-REE-Li and Gold-PM Conference & Exhibition
May 18–25, 2019
Perth, Australia

5th World Congress on Integrated Computational Materials Engineering (ICME 2019)
July 21–25, 2019
Indianapolis, Indiana, USA

The 10th Pacific Rim International Conference on Advanced Materials and Processing (PRICM 10)
August 18–22, 2019
Xi'an, China

11th International Conference on Porous Metals and Metallic Foams (MetFoam 2019)
August 20–23, 2019
Dearborn, Michigan, USA

Materials Science & Technology 2019 Technical Meeting and Exhibition (MS&T19)
September 29–
October 3, 2019
Portland, Oregon, USA

14th International Symposium on Superalloys (Superalloys 2020)
September 13–17, 2020
Seven Springs,
Pennsylvania, USA

TMS 2019
148th Annual Meeting & Exhibition

March 10–14, 2019
Henry B. González Convention Center
San Antonio, Texas, USA
Discount Registration Deadline: February 1, 2019
www.tms.org/TMS2019

- The International Roundtable on Materials Criticality will be held on Thursday, March 14, as part of the REWAS 2019 symposium at TMS 2019 Annual Meeting & Exhibition (TMS2019). The topic of the roundtable will be "How Does Industry Manage Criticality in Product Development?"
- Special invited sessions for TMS2019 include: Science Policy within the Materials Research Community, Diversity in STEM, and Effective Business Improvement Methodologies for the Minerals, Metals, and Materials Industries.

LMPC 2019

***New Dates:* September 8–11, 2019**
University of Birmingham Edgbaston Park Hotel and Conference Centre
Birmingham, United Kingdom
Abstract Submission Deadline: January 14, 2019
www.tms.org/LMPC2019

- Liquid Metal Processing & Casting (LMPC) 2019 will be focused on primary and secondary melt processing, including vacuum induction melting (VIM), vacuum arc remelting (VAR), electroslag refining (ESR), and electron beam cold hearth remelting (EBCHR). Additional topics of focus include, but are not limited to physical property measurements of liquid metals, casting and solidification, and modelling of metallurgical processes.

WORLD CONGRESS ON HIGH ENTROPY ALLOYS HEA2019

November 17–20, 2019
Hyatt at Olive 8
Seattle, Washington, USA
Abstract Submission Deadline: April 15, 2019
www.tms.org/HEA2019

- The World Congress on High Entropy Alloys (HEA 2019) is a new, cross-disciplinary technical forum designed to share the latest research advances in metallic, intermetallic and ceramic high entropy materials, including single-phase and multiphase (compositionally complex) alloys.
- This program will feature highly focused technical talks on topics that include fundamental theory of alloy design, mechanical and functional properties, and computational modeling and simulation. Visit the congress website for a more complete list of technical topics.

ICTP 2020

July 26–31, 2020
The Ohio State University
Columbus, Ohio, USA
Abstract Submission Deadline: August 1, 2019
www.tms.org/ICTP2020

- ICTP 2020: The 13th International Conference on the Technology of Plasticity will convene the breadth of the metal forming community to share the latest improvements and innovations.
- Topics under consideration for this program include forming processes, materials characterization and testing, computational modeling, and process control.

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JOM themagazine Classifieds

Whether you are seeking a new job opportunity or needing to fill an open position, the *JOM* Job Board provides companies, academic institutions, and other organizations with a valuable resource to post and search for job openings. For $125 per column inch, your ad can be posted, searched, and viewed by thousands of qualified candidates. Questions on placing a *JOM* classified advertisement?

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Michigan Technological University

FACULTY POSITION

Materials Science and Engineering

As part of the cluster hire at the interface of artificial intelligence, big data, and computation **(https://www.mtu.edu/engineering/hire/index.html)**, the Department of Materials Science and Engineering at Michigan Technological University invites applications for a tenure-track faculty position at the assistant professor level. Senior level individuals with exceptional records will also be considered. Research thrust areas of interest include (but not limited to): (i) computer vision for microstructure analysis and feature extraction (ii) machine learning for automated mining of big data generated from digital instrumentation, including '5 V' problems associated with atomic to nanometer scale collection, manipulation and interpretation from atomic resolution STEM (iii) computer simulation for interpretation of imaging, diffraction, property measurements, etc. (iv) expert system development for accelerated design of new material compositions and discovery of processing-microstructure-property relationships. We seek candidates who will help define their discipline by creating and exploiting new digital tools and techniques and collaborate across experimental and computational materials research.

Applications should be submitted online at **https://www.jobs.mtu.edu/postings/7342**. For more information about this hire **(https://www.mtu.edu/engineering/hire/materials.html)** and the department **(www.mtu.edu/materials/)**, please contact the Department Chair Dr. Stephen L. Kampe at kampe@mtu.edu.

Michigan Tech is an ADVANCE Institution receiving two National Science Foundation grants to increase the participation and advancement of women and underrepresented/under-served individuals in STEM. Candidates are invited to bring a guest to an on-campus interview; additional details on dual career explorations in our Partner Engagement Program can be found here:

http://www.mtu.edu/provost/programs/partner-engagement/index.html.

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call for papers

***JOM* is seeking contributions on the following topics for 2019. For the full Editorial Calendar, along with author instructions, visit the *JOM* website at jom.tms.org.**

July 2019:
Manuscript Deadline: February 1, 2019

Topic: Second-Phase Particles in Magnesium Alloys: Engineering for Properties and Performance
Scope: Alloy and process design to control second-phase particle distribution is a key aspect of the future of magnesium alloys. This special topic is a holistic review of advances in the understanding of second-phase effects on magnesium alloy behavior.
Guest Editors: Victoria Miller and Petra Maier
Sponsor: Magnesium Committee

Topic: Composition-Processing-Microstructure-Property Relationships of Titanium Alloys
Scope: This topic seeks papers addressing emerging or novel uses of titanium, and investigations with an emphasis on the interplay between processing, microstructure, properties, and performance are encouraged. Titanium and titanium alloys, including beta, alpha+beta, intermetallic alloys as well as titanium matrix composites will be applicable.
Guest Editors: Benjamin M. Morrow, Carl J. Boehlert, Kayla L. Calvert, Yufeng Zheng, and Peter C. Collins
Sponsor: Titanium Committee

Topic: Urban Mining: Characterization and Recycling of Solid Wastes
Scope: Since the solid wastes in urban areas have become significant environmental concerns, the recycling and reuse of these waste materials is attracting great attention both in the public and in the materials industry. This topic will focus on the characterization of urban waste materials and the effective extraction of metals from the materials.
Guest Editors: Mingming Zhang and Bowen Li
Sponsors: Materials Characterization Committee and Recycling and Environmental Technologies Committee

Topic: Advanced Manufacturing for Nuclear Energy
Scope: Of interest for this topic are papers on additive manufacturing, advanced welding and cladding techniques, powder metallurgy, high performance concrete and rebar, surface modification, in-situ quality control, inspection, and advanced machining.
Guest Editors: Xiaoyuan Lou and David Gandy
Sponsor: Nuclear Materials Committee

Topic: ICME 2019
Scope: The 5th World Congress on Integrated Computational Materials Engineering (ICME 2019) convenes leading researchers and practitioners of ICME to share the latest knowledge and advances in the discipline. This congress is the recognized hub of interaction among software developers and process engineers along the entire production chain, as well as for materials scientists and engineers developing new materials. Only submissions from congress attendees will be considered for publication in *JOM*.
Sponsor: Invited

August 2019:
Manuscript Deadline: March 1, 2019

Topic: Solidification Defects in Additive Manufactured Materials
Scope: Solidification defects, such as porosity and hot cracking, are commonly observed in a variety of metal additive manufacturing processes, not limited to powder bed fusion, direct energy deposition, and binder jet processes. New scientific discoveries and/or industrial applications to understand and/or control solidification defects are welcome for publication.
Guest Editor: Lang Yuan
Sponsor: Solidification Committee

Topic: Characterization of Advanced Sintering Materials
Scope: Sintering is one of the major processes for synthesis and production of various materials such as ceramics, polycrystalline alloys, sintered ores, iron ore pellets, calcined minerals, slags, and organic metals. This topic will focus on the sintering process, phenomenon, and mechanisms of a material by heating at high temperature.
Guest Editors: Mingming Zhang and Bowen Li
Sponsor: Materials Characterization Committee

Topic: Multiscale Computational Strategies for Heterogeneous Materials with Defects

Scope: Multiscale modeling is a familiar theme, integral to heterogeneous materials. Challenges are encountered in the presence of evolving defects at multiple scales leading to extreme behavior. Such complexities may be addressed by a combination of hierarchical (bottom-up) and concurrent (top-down coupling) strategies. This topic is devoted to approaches addressing these issues.
Guest Editors: Somnath Ghosh and David McDowell
Sponsor: ICME Committee

Topic: Precipitation Mechanisms in Non-ferrous Alloys

Scope: This topic addresses the range of phase transformation behavior and mechanisms across a series of different non-ferrous metal alloys. The papers will address the implications of such phase changes on microstructure and associated properties.
Guest Editors: Gregory Thompson, Deep Choudjuri, Rajarshi Banerjee, and Eric Lass
Sponsor: Phase Transformations Committee

September 2019:

Manuscript Deadline: April 1, 2019

Topic: Aluminum: Recycling and Environmental Footprint

Scope: This topic covers recycling of aluminum and its alloys as well as the environmental ramifications of both primary and secondary aluminum.
Guest Editors: David Wong and Pascal Lavoie
Sponsors: Aluminum Committee and Recycling and Environmental Technologies Committee

Topic: Advanced Electronic Interconnection

Scope: Papers are invited for this special topic covering recent advances of bonding technologies for 2.5D and 3D IC, wide-band-gap (WBG) semiconductors, and flexible electronics.
Guest Editor: Shih-kang Lin
Sponsor: Alloy Phases Committee

Topic: Advances in Processing, Manufacturing, and Applications of Magnetic Materials

Scope: Papers are invited on novel magnetic materials, advances in processing or relevant property measurement, and circular manufacturing of magnetic materials. Of interest are permanent and soft magnets and magnetocaloric materials, and also multifunctional magnetic materials such as magnetoelastic, magnetoelectric, and magnetoresistive materials.
Guest Editors: Orlando Rios and Ikenna Nlebedim
Sponsors: Magnetic Materials Committee and Energy Conversion and Storage Committee

Topic: Comparison of Recycling Methods for Industrial Metals

Scope: This topic will compare recycling methods for different metals which will stimulate thinking about similarities and differences and engender improvements in recycling processes and in the use of metals.
Guest Editor: Dirk Verhulst
Sponsor: Recycling and Environmental Technologies Committee

Topic: Sustainable Pyrometallurgical Processing

Scope: This topic covers the development of recycling and bio-based fuel technologies to meet current environmental standards as well as sourcing issues. Fields include but are not limited to: process optimization, alternative material sourcing, by-product utilization, and energy efficiency.
Guest Editors: Joseph Grogan and Camille Fleuriault
Sponsor: Pyrometallurgy Committee

October 2019:

Manuscript Deadline: May 1, 2019

Topic: New Developments in Nanomechanical Methods

Scope: This special topic will focus on the advances used to measure mechanical properties of small-volume and low-dimensional materials, as well as bulk nanostructured materials. Of particular interest are new instrumentation, methods, and environmental control to evaluate mechanical behavior in terms of size effects, time scales, environmental testing, as well as in-situ experimental methods.
Guest Editors: Megan Cordill and Janelle Wharry
Sponsor: Nanomechanical Materials Behavior Committee

Topic: Microstructure Evolution During Deformation Processing

Scope: Understanding how deformation processing techniques can control the microstructural evolution in metals is vital for alloy development. Papers are invited that investigate aspects of microstructural evolution during deformation processing.
Guest Editor: Daniel Koughlin
Sponsors: Shaping and Forming Committee and Advanced Characterization, Testing, and Simulation Committee

Topic: Progress in High-Entropy Alloys

Scope: High-entropy alloys (HEAs) loosely refer to multi-principal-element solid solution alloys due to their high configurational entropy. This special topic on high-entropy alloys invites contributions from authors working in the various fields of HEAs to disseminate the rapid progress in this fascinating and expanding class of advanced materials.
Guest Editors: Chuang Zhang, Michael C. Gao, and Shih-kang Lin
Sponsor: Alloy Phases Committee

Topic: Modeling and Simulation of Composite Materials

Scope: This topic will highlight modeling and simulation currently used in advancing the understanding of the complex interactions and structure-property relationship in composite materials by ab-initio methods, atomistic methods, mesoscale simulations, finite element methods, and multi-scale modeling.
Guest Editors: Rakes Behera, Dinesh Pinisetty, and Dung Luong
Sponsor: Composite Materials Committee

TMS Division Honors & Awards

A Recognition of Excellence

Nominations Due April 1

EXTRACTION & PROCESSING DIVISION (EPD)
- Distinguished Lecturer Award
- Distinguished Service Award
- Nagy El-Kaddah Award for Best Paper in MHD in Material Processing
- Science Award
- Technology Award

FUNCTIONAL MATERIALS DIVISION (FMD)
- Distinguished Scientist/Engineer Award
- Distinguished Service Award
- John Bardeen Award

LIGHT METALS DIVISION (LMD)
- Distinguished Service Award
- Technology Award

NEW THIS YEAR: EPD/LMD *Journal of Sustainable Metallurgy* Best Paper Award

MATERIALS PROCESSING & MANUFACTURING DIVISION (MPMD)
- Distinguished Scientist/Engineer Award
- Distinguished Service Award

STRUCTURAL MATERIALS DIVISION (SMD)
- Distinguished Scientist/Engineer Award
- Distinguished Service Award

"TMS has been invaluable in pursuing my academic interests both as a venue for communicating with researchers with similar interests and as a vehicle for the development of many productive professional collaborations in this area."

—**Stephen Foiles**, 2018 SMD Distinguished Scientist/Engineer Award Recipient

View award criteria and access the "Tips for Preparing Nominations" guide by visiting awards.tms.org. Nominations may be submitted to awards@tms.org.

You do not have to be a member of TMS to nominate individuals for these prestigious awards.

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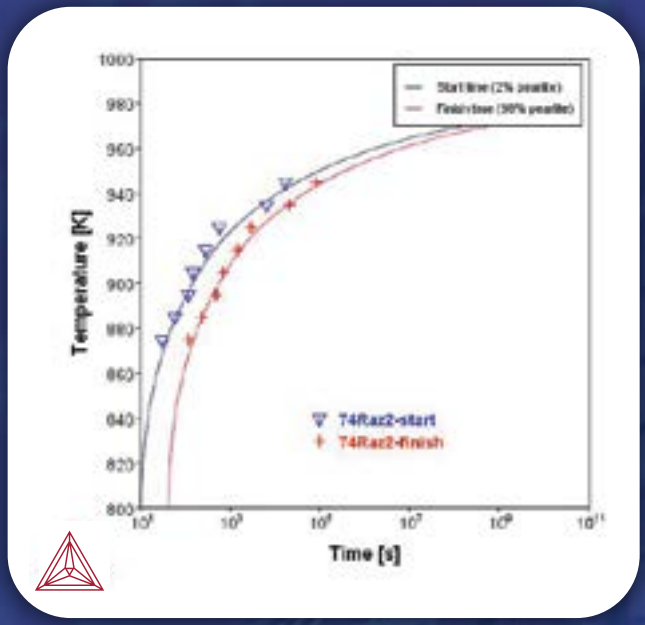
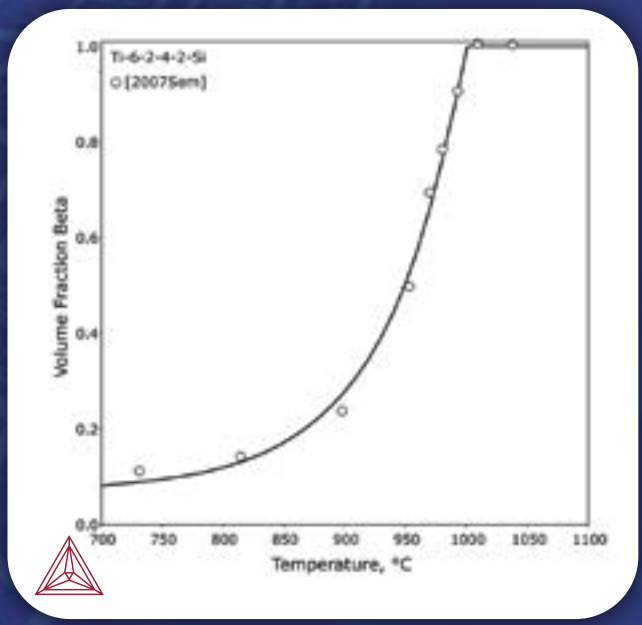


TTT Diagram for pearlite formation in a eutectoid steel with 2wt% Mn

Highlights for 2019a:

- ✓ **New Martensite + Pearlite Models** - calculate Ms and Mf temperatures and predict pearlite growth kinetics
- ✓ **New TC-Python API** - link Thermo-Calc, DICTRA, and TC-PRISMA to other packages using easy to learn Python language
- ✓ **New Databases TCTI2, TCNI9, TCAL6** - Major updates to the Titanium, Nickel, and Aluminum thermodynamic and their corresponding mobility databases



Beta approach curve for Ti-6-2-4-2

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