MIT Industrial Liaison Program Faculty Knowledgebase Report

Digital Transformation in Metals Processing (Repeat)

November 10, 2020 7:30 pm - 10:00 pm

7:30pm

Welcome and Introduction
Jewan Bae

Program Director, MIT Corporate Relations

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Jewan John Bae comes to MIT Corporate Relations with more than 20 years of experience in the specialty chemicals and construction industries. He facilitates fruitful relationships between MIT and the industry, engaging with executive level managers to understand their business challenges and match them with resources within the MIT innovation ecosystem to help meet their business objectives.

Bae's areas of expertise include new product commercialization stage gate process, portfolio management & resource planning, and strategic planning. He has held various business leadership positions at W.R. Grace & Co., the manufacturer of high-performance specialty chemicals and materials, including Director of Strategic Planning & Process, Director of Sales in the Americas, and Global Strategic Marketing Director. Bae is a recipient of the US Army Commendation Medal in 1986.

Carl V. Thompson
Director, Materials Research Laboratory (MRL)

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Professor Thompson joined the MIT faculty in 1983. He is Director of MIT's Materials Research Laboratory and co-Director of the Skoltech Center for Electrochemical Energy Storage. His research interests include processing of thin films and nanostructures for applications in microelectronic, microelectromechanical, and electrochemical systems. Current activities focus on development of thin film batteries for autonomous microsystems, IC interconnect and GaN-based device reliability, and morphological stability of thin films and nano-scale structures. Thompson holds an SB in materials science and engineering from MIT and a PhD in applied physics from Harvard University.

View full bio

7:35pm

Rapid Alloy Design Concepts Enabled by Computation, Machine Learning, and High-Throughput Experiment
Christopher Schuh
Danae and Vasilis Salapatas Professor of Metallurgy

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Christopher A. Schuh is the Danae and Vasilis Salapatas Professor of Metallurgy in the Department of Materials Science and Engineering at MIT.

Schuh's academic training in Materials Science and Engineering focused on metals, including their processing, microstructure, and mechanics. He earned his B.S. from the University of Illinois at Urbana-Champaign in 1997, and his Ph.D. from Northwestern University in 2001. He held the Ernest O. Lawrence postdoctoral fellowship at Lawrence Livermore National Laboratory 2001-2002, prior to joining the MIT faculty in 2002.

Prof. Schuh's research is focused on structural metallurgy and seeks to control disorder in metallic microstructures for the purpose of optimizing mechanical properties; much of his work is on the design and control of grain boundary structure and chemistry. Prof. Schuh has published more than 250 papers and dozens of patents, and has received a variety of awards acknowledging his research accomplishments.

Prof. Schuh has co-founded a number of metallurgical companies. His first MIT spin-out company, Xtalic Corporation, commercialized a process from Schuh's MIT laboratory to control the internal structure in metal electroplated coatings down to the nanometer scale, producing exceptional mechanical and functional properties. These nanocrystalline coatings have been deployed in applications ranging from machine components, to automotive parts, to electronics, and are in wide and growing usage around the globe. Prof. Schuh also cofounded Desktop Metal, a metal additive manufacturing company producing 3D metal printers that address markets ranging from prototyping, to shop-scale, to production scale.

In 2011 Prof. Schuh was appointed Head of the Department of Materials Science and Engineering at MIT, a position he filled until the end of 2019. During his tenure as Head the department saw a significant expansion of the faculty ranks, a major reconfiguration of their physical spaces at the heart of the MIT campus, and the roll-out of online materials science courses that have expanded the exposure of MIT's Materials Science and Engineering program to learners from all over the globe. He also currently serves as the Coordinating Editor of the Acta Materialia family of journals, including Acta Materialia, Scripta Materialia, Acta Biomaterialia, and Materialia, the last of which he launched in 2018. Among his various awards and honors are his appointment as a MacVicar Fellow of MIT, acknowledging his contributions to engineering education, and his election as member of the National Academy of Inventors and the National Academy of Engineering.

(Christopher Schuh video starts at time stamp: 7:10)

Over the past several decades the iterative trial-and-error approach to alloy design has become dramatically 'digitally enhanced'. Physically-motivated computational models that incorporate thermodynamics, kinetics, and processing pathways can substantially narrow the search for optimum alloy compositions and configurations, while high-throughput experimental methods accelerate iteration. In advanced research areas where the controlling physics are not always known, computation can be augmented with data science and machine learning methods to span vast compositional spaces where few experiments exist. This talk will highlight projects of MIT faculty contributing to the digital transformation of the innovative 'front-end' of the metals industry—the design and reduction-to-practice of new alloys.

8:05pm

Next-Generation Metals Manufacturing: From Rapid Experimentation to the Factory Floor
John Hart

Director, Center for Additive and Digital Advanced Production Technologies (APT)
Director, Laboratory for Manufacturing and Productivity
Department Head and *Professor, MIT Department of Mechanical Engineering*

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John Hart is Professor of Mechanical Engineering, Director of the Center for Additive and Digital Advanced Production Technologies, and Director of the Laboratory for Manufacturing and Productivity, at MIT. John's research group at MIT, the Mechanosynthesis Group, aims to accelerate the science and technology of production via advancements in additive manufacturing, nanostructured materials, and precision machine design. In 2017 and 2018, respectively, he received the MIT Ruth and Joel Spira Award for Distinguished Teaching in Mechanical Engineering and the MIT Keenan Award for Innovation in Undergraduate Education. He is a co-founder of Desktop Metal and VulcanForms, and a Board Member of Carpenter Technology Corporation.

Manufacturing of metal components is essential to every major industry, consumes significant natural resources, and involves complex supply chains. The promise of a digital thread from alloy formulation to scaled production and potential re-use therefore has inspired new experimental approaches and manufacturing techniques that go hand-in-hand with computational methods. This talk will highlight MIT research in the "hands-on" side of metals processing—including high-throughput laboratory techniques, in situ characterization of deformation and microstructure, new additive manufacturing processes, and resource-efficient extraction. An outlook will be framed in terms of the value chains of key industries, pathways for commercialization, and business models enabled by digital transformation.

8:35pm

Invited Presentation Lightning Talks – Invited MIT Students and Postdocs

As part of the program for this webinar, we are offering breakout discussions with our presenting graduate students and postdocs. **In order to participate in these breakout rooms, you will need the latest version of Zoom (version 5.3.2)**. (If you need help determining your version of Zoom, please follow the instructions here.)

If you do not already have this version, **please update your Zoom client/application before joining the discussion**. Follow the instructions here to update Zoom.

8:55pm Parallel Lightning Presentation Break-out Discussions

Room #	Invited Presenter	Position	Title and Abstract	Supervisor
1	Austin Ward	Graduate Student	**Ultrasonic additive manufacturing of nanostructured composites** Nanostructured materials have attractive functional and mechanical properties and can be produced economically as powders or foils. However, consolidating nanostructured materials into bulk forms is challenging because their nanoscale structures tend to coarsen during high-temperature densification processes. To overcome this challenge, we have used a low-temperature net-shaping process, termed ultrasonic additive manufacturing, to fabricate bulk laminar composites from nanostructured feedstock. Through modeling and specialized experiments, we determined processing conditions that preserve the nanostructure of the feedstock while giving strong metallurgical bonding. This talk highlights the processing, properties, and potential applications of bulk nanostructured materials fabricated via ultrasonic consolidation.	Prof. Zachary Cordero
2	Clay Houser	Graduate Student	**TRIP Steels for Additive Manufacturing** Metal additive manufacturing (AM) for structural components is limited by low durability properties (toughness, fatigue strength) from microscale porosity inherent to the AM deposition process. TRIP steels have the potential to greatly enhance toughness while maintaining high strength and tolerate the porosity from AM. A parametric design approach utilizing CALPHAD methods and process-structure-property modeling was employed to computationally optimize composition and processing. The TRIP steel design presents high strength, optimal austenite stability, and solidification characteristics like known printable steels. The design approach represents a method that can be applied to a wide variety of material systems.	Prof. Gregory Olson
3	Malik Wagih	Graduate Student	**Machine Learning for Design of Grain Boundaries in Metals** In metals, the segregation of solute atoms at grain boundaries can strongly affect the macroscopic material properties, including mechanical, electrochemical, electrical, and magnetic properties. As such, controlling grain boundary segregation is an essential tool for many engineering applications. However, due to the complex disordered nature of grain boundary structures, there is generally a very limited understanding of the nature of solute segregation in polycrystalline alloys, and a lack of databases of segregation information relevant to them. In this talk, we discuss our combined high-throughput atomistic and machine learning	Prof. Chris Schuh

9:30pm	Wrap-up