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SPEAKER SERIES

PRESENTS

Towards 3D+ Printing of Metals and Alloys

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LECTURE ABSTRACT

The current paradigm that guides much materials and manufacturing research is to optimize a materials' (hierarchical) structure to accomplish a specific function and to then assemble different components made with different materials into ever more complex arrangements in order to realize multi-functional devices. This one material-one function paradigm, however, considerably constrains the space of what is truly possible. Moving beyond the one material-one function paradigm can potentially transform the way in which we conceptualize the solution to important technological challenges. Novel pairings of materials and manufacturing technologies can potentially be exploited to realize spatially-tailored properties and behavior in monolithic materials and materials systems. The concept of 4D printing of polymeric and other soft materials is but an example of an enabling paradigm that can potentially be deployed over a wider materials palette.

Metal Additive Manufacturing (AM) has emerged as a transformative technology that enables the fabrication of parts and components of intricate shapes and topologies for highly customized applications. Most efforts on metal AM to date, however, have focused on controlling process conditions in order to minimize the onset of manufacturing defects and thus enhance the reliability of the manufactured parts. In our group, we have gone beyond that and have been exploring the control of process conditions and composition in order to locally tailor the chemistry, microstructure, properties and behavior of 3D printed metals and alloys. In this talk, I will discuss some recent advances on the design of functionally graded materials (FGMs) in which chemistry and properties are spatially tailored by controlling deposited composition on a layer by layer basis. I will also discuss our recent work on metal 4D printing in which we demonstrate spatial control over the transformation characteristics of the printed component by tailoring the thermal histories during 3D printing. I will close the talk by providing some ideas on the direction of these research thrusts in the near and medium terms, particularly when it comes to novel approaches to multi-materials design in order to satisfy otherwise impossible materials design tradeoffs.

SPEAKER BIOSKETCH

Dr. Arróyave obtained his BS degrees in Mechanical and Electrical Engineering from the Instituto Tecnológico y de Estudios Superiores de Monterrey (México) in 1996. He got his MS in Materials Science and Engineering in 2000 and his PhD in Materials Science in 2004 from MIT. After a postdoc at Penn State, he joined the Department of Mechanical Engineering at Texas A&M University in 2006. He is currently a Professor in the Department of Materials Science and Engineering and holds courtesy appointments in the Departments of Mechanical Engineering and Industrial and Systems Engineering.

Dr. Arróyave's area of expertise is in the field of computational materials science, with emphasis in computational thermodynamics and kinetics of materials. He and his group use different techniques across multiple scales to predict and understand the behavior of inorganic materials (metallic alloys and ceramics). The techniques range from ab initio methods, classical molecular dynamics, computational thermodynamics as well as phase-field simulations. Dr. Arróyave's group recent focus has been on simulation and data-enabled materials discovery and design in a wide range of contexts, including Additive Manufacturing.

Dr. Arróyave has been co-author of more than 185 publications in peer-reviewed journals, 20 conference proceedings as well as close to 120 conference papers and 75 invited talks in the US and abroad. He is the recipient of several awards, including NSF CAREER Award (2010), TMS Early Career Faculty Fellow (2012, Honorable Mention), TMS Brimacombe Medal (2019), ASM Fellow (2020). He has been named Texas A&M Presidential Impact Fellow (2017) and Texas A&M University System Chancellor EDGES Fellow (2019).

He is an Associate Editor of Materials Letters, Integrating Materials and Manufacturing Innovation (IMMI) and the Journal of Phase Equilibria and Diffusion. He is involved in ASM and TMS, having served as Chair of the ASM Alloy Phase Diagram Committee, Chair of the TMS Functional Materials Division as well as member of the Board of Directors of TMS. He has chaired or co-chaired more than 15 symposia and has been the lead organizer and co-organizer of several international conferences.

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