UC RIVERSIDE | UNIVERSITY OF CALIFORNIA | Materials Science and Engineering

WINTER 2020 COLLOQUIUM SPEAKER

4D+ Printing via Metal Additive Manufacturing

The flexibility brought about by additive manufacturing (AM) goes beyond the ability to produce components of otherwise excessively complex geometries. One of the most attractive capabilities of AM is its potential to produce parts/components with engineered local properties. 4D Printing, for example, enables the fabrication of complex objects––built generally from shape memory polymers and (reversibly-swelling) hydrogels that transform over time when subject to external stimuli. Similarly, research on Functionally Graded Materials focuses on the spatial tailoring of the properties of the fabricated part by controlling feedstock and/or process conditions. However, 4D Printing has never been achieved in metals and alloys to the best of our knowledge. Moreover, combination of 4D printing and functional grading has not been attempted. Recently, we combined these two state-of-the-art techniques to control the voxel level properties in stimuli-responsive materials, and developed, so-called, 4D+ printing technique. In particular, we exploit the extreme sensitivity of the mechanical and functional response of NiTi shape memory alloys (SMAs) to composition and microstructure––facilitated in turn by local process control in AM––to enable the design of new parts with completely different mechanical responses at different locations, and capable of actuating at different temperatures in a single monolithic structure. In this talk, we introduce 4D+ printing and its application to NiTi SMAs and beyond. We further discuss the application of AM NiTi as a sensory material for exploring microstructure-related variability in metallic AM processes. Finally, we will discuss simultaneous AM of dissimilar materials and functional grading from one material to another without forming detrimental phases.

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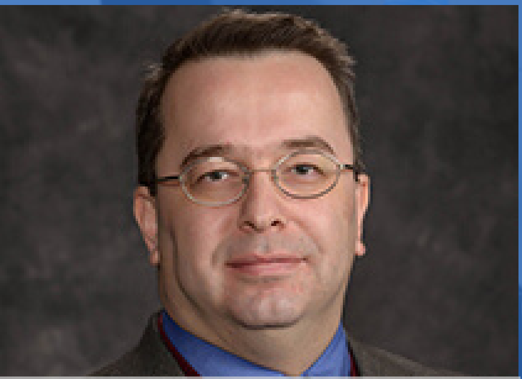

Dr. Ibrahim Karaman

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Ibrahim Karaman is the Chevron Professor and Department Head of Materials Science and Engineering at Texas A&M University. He received his Ph.D. from University of Illinois at Urbana-Champaign in Mechanical Engineering in 2000. He joined the faculty of Department of Mechanical Engineering at Texas A&M University in 2000. He was promoted to the rank of Professor in 2011. He has served as the Chair of the Interdisciplinary Graduate Program in Materials Science and Engineering (MSEN) from 2010 to 2013. The MSEN program became a new department in 2013, where Dr. Karaman serves as the inaugural head. His main research interests are processing-microstructure mechanical/functional property relationships in metallic materials and composites including 1) ultrafine and nanocrystalline materials, and 2) conventional, high temperature and magnetic shape memory alloys; micro-mechanical constitutive modeling of crystal plasticity; twinning and martensitic phase transformation. Dr. Karaman received several national and international awards including the NSF CAREER Award, ONR Young Investigator Award, The Robert Lansing Hardy Award from The Minerals, Metals and Materials Society (TMS), an Honorable Mention for the Early Career Faculty Fellow Award from TMS, Gary Anderson Early Achievement Award from ASME and AIAA, and TMS 2018 Brimacombe Medalist. He is the Fellow of ASM International. He is an author or co-author over 300 refereed journal articles, 3 patents, 2 of which licensed by two start up companies.

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