New Design Space for 3D Electronics: Printing 3D Architected Electronic Materials

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Abstract Additive manufacturing has shown the promise of freedom of designs, enabling parts customization and tailorable properties where superior structural performances can be achieved by a fraction of weight density compared to bulk material. However, it is presently difficult to directly print different materials (structural, dielectric, conducting and ferroelectrics) to create a complex device with multiple functionalities that responds to multiple stimuli. Unlike biological systems where functions, including sensing, actuation, and control, are closely integrated, few materials have comparable system complexity.

In this talk, I will present a suite of new multi-material additive manufacturing processes and design methodologies to create materials with prescribed structural and functional behaviors. The structural materials consist of a network of micro-unit cells which collectively influence new mechanical behaviors (from high-strength, lightweight to toughening) not seen in their native counterpart. When combined with an electronic and functional phase, these materials turn themselves into a robot and is capable of programmed motions with self-sensing, feedback control and electromagnetic wave steering. I will present the manufacturing and synthesis of these materials, as well as their mechanics and design methods underpinning their novel behaviors.

Bio Xiaoyu "Rayne" Zheng directs the Advanced Manufacturing and Metamaterials Laboratory at University of California, Berkeley. His group develops the next generation additive manufacturing processes, material designs and synthesis approaches to create multi-functional materials and all-in-one devices with controlled architectures, compositions and multi-scale features. Their work on ultralight, ultrastrong and resilient metamaterials was featured on MIT Technology Review Top 10 Innovations and on the Cover of Science Magazine and Nature Materials. Prior to his faculty career, Zheng received his Ph.D. degree in Mechanical Engineering from Boston University with the Best Dissertation Award and subsequently worked as a mechanical engineer at the Lawrence Livermore National Laboratory (LLNL). Prof. Zheng has over 50 publications and multiple patents including multiple Science and Nature Materials articles. He has received multiple awards, including NSF CAREER Award, DARPA Young Faculty Award, DARPA Director's Fellowship, Office of Naval Research Young Investigator Award, Air Force Young Investigator Award, Outstanding Assistant Professor Award, 3M Faculty Award, and Freeform Fabrication and Additive Manufacturing Excellence (FAME) Award.