Additive Manufacturing of Structures and Electronics:

Robotic metamaterials that walk, talk and listen

Associate Professor, Xiaoyu (Rayne) Zheng, Ph.D.

Department of Material Science and Engineering, University of California, Berkeley

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 motions with multiple degrees of freedom and amplification of displacement in a prescribed direction in response to an electric field (and vice versa), and thus, programmed motions with self-sensing and feedback control. I will present the manufacturing and synthesis of these materials, as well as their mechanics and design methods underpinning their novel behaviors.