Polymer Program

INSTITUTE OF MATERIALS SCIENCE

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Liquid Metal Elastomer Composites for Soft Machines & Electronics

Abstract: Nature teaches us that soft materials and fluids can be integrated to create highly robust systems that are capable of an extraordinary combination of intrinsic functionalities – from sensing and actuation to self-healing, enery storage, and intelligence. Engineering artificial skin, nervous tissue, and muscle with a similar range of "embodied" properties requires exploration of new ways to pattern and integrate various classes of soft matter into cohesive multifunctional systems. In this talk, I will present several new techniques to create soft multifunctional materials that exhibit embodied sensing, actuation, and energy harvesting properties. These methods include progress in the development of novel material architectures that contain some combination of the following: liquid crystal elastomer (LCE), eutectic gallium indium (EGaIn) liquid metal alloy, and a variety of soft elastomers. I will begin by describing efforts to use EGaIn to tailor the electrical properties of soft elastomers in order to create highly stretchable electronics. This includes mechanically robust circuity that can remain electrically functional even when damaged by tearing or puncture. Next, I will present recent work on embedding percolating networks of EGaIn microdroplets within LCE to create an elastomer composite that functions like a "soft machine" capable of sensing, self-healing, shape morphing, and dynamic response to mechanical damage. Lastly, I will describe efforts to create integrated soft material systems with LM-embedded elastomers that harvest energy from heat and mechanical motion.

Bio: Carmel Majidi is the Clarence H. Adamson Professor of Mechanical Engineering at Carnegie Mellon University, where he leads the Soft Machines Lab. His lab is dedicated to the discovery of novel material architectures that allow machines and electronics to be soft, elastically deformable, and biomechanically compatible. Currently, his research is focused on fluid-filled elastomers that exhibit unique combinations of mechanical, electrical, and thermal properties and can function as "artificial" skin, nervous tissue, and muscle for soft robotics and wearables. Carmel has received grants from industry and federal agencies along with early career awards from DARPA, ONR, AFOSR, and NASA to explore challenges in soft-matter engineering and robotics. Prior to arriving at CMU, Prof. Majidi had postdoctoral appointments at Harvard and Princeton Universities and received his PhD in Electrical Engineering at UC Berkeley.