

**Soft Materials for Unconventional Machines and Electronics**

**Prof. Michael D. Bartlett**

**Department of Materials Science Engineering  
Iowa State University**

**Seminar on February 20, 2018 at 11:00 am in 2004 Black**

**Abstract**

Multifunctional soft materials create intriguing new opportunities to enhance performance and enable innovative designs. I will discuss two examples of this approach, one that utilizes material composition through liquid-solid hybrid composites for soft machines and deformable electronics and another inspired by Kirigami, the art of paper cutting, where material structures are manipulated to create materials with tunable functionality. For hybrid composites, I will present an all-soft matter approach that combines soft elastomers with dispersions of liquid-phase eutectic Ga-In (EGaIn) metal alloy microdroplets. Experimental and theoretical investigations show that liquid metal droplets incorporated into elastomers greatly enhance dielectric constant and thermal conductivity while preserving a low elastic modulus ( $< 250$  kPa) and large extensibility ( $\sim 600$  % strain). Furthermore, I will show how thermodynamically metastable particles enable autonomous stiffness tuning. For kirigami, I will present a framework for designing materials with highly tunable mechanical and adhesive properties. This is demonstrated with hybrid cut architectures to create highly tunable mechanical properties, stretchable conductors, and rapid magnetoactive soft actuators which elongate to 330 % in  $\sim 0.1$  s. Furthermore, by incorporating kirigami-inspired structures at interfaces, we can enhance adhesive force by a factor of  $\sim 100$  across a spatially patterned sheet while tuning adhesion in different directions for high capacity yet easy release interfaces. These approaches provide model systems to study fundamental material properties while enabling functionalities such as electronic skins and artificial muscles for a variety of soft matter systems.

Dr. **Michael Bartlett** is an Assistant Professor of Materials Science and Engineering at Iowa State University. His research lies at the intersection of soft materials, mechanics, and multifunctional composites where he aims to investigate and create soft materials with unconventional properties, including deformable electronics and soft robotics, adaptive materials, and 'smart' adhesives. He received his BSE in Materials Science and Engineering from the University of Michigan in 2008 and completed his Ph.D. in Polymer Science and Engineering at the University of Massachusetts Amherst in 2013 under the guidance of Professor Alfred Crosby studying bio-inspired adhesion. After obtaining his Ph.D. he worked as a Senior Research Engineer in the Corporate Research Laboratory at 3M and as a Postdoctoral Fellow at Carnegie Mellon University with Professor Carmel Majidi before joining Iowa State in 2016. His research has resulted in publications, patents, extensive media coverage through outlets such as the Discovery Channel, and awards including an Outstanding Faculty Award from the Iowa State Engineering Student Council (student nominated) in 2017 and a 3M Non-Tenured Faculty Award in 2017.

***This seminar counts towards the ME 600 seminar requirement for Mechanical Engineering graduate students.***

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