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Time: 2:30 - 4:00 PM
Location: CBB 104

Mechanics of Interfaces with Switchable Adhesion

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ABSTRACT:

Traditionally, adhesive interfaces are optimized to realize strong and permanent bonds. However, emerging robotics and manufacturing applications require interfaces with tunable and switchable adhesion. Interfaces with switchable adhesion need to be engineered to realize high adhesion strength in one state and low adhesion in the other. The effective adhesion strength of an interface can be modulated through control of the surface interactions as well as the local stress state at the interface. Here, a general mechanics-based framework for designing interfaces with switchable adhesion is presented, and several implementations are investigated and experimentally demonstrated. In one class of systems, structured elastic heterogeneity is used to tailor the stress distribution at the interface and, hence, the effective adhesion strength. Analytical and computational fracture mechanics-based models are used to design systems that can be tuned passively via loading direction or actively via stiffness modulation. In a second class of systems, electrostatic forces are used to control interface behavior. Mechanics modeling is critical for the designing of electroadhesive systems, and we show that an understanding of interface mechanics can be exploited to realize electroadhesive devices with higher performance.

BIOGRAPHY:

Kevin T. Turner is a Professor and the John Henry Towne Department Chair of Mechanical Engineering and Applied Mechanics at the University of Pennsylvania. Professor Turner also holds a secondary appointment in the Department of Material Science and Engineering and serves as the research director for the NSF-funded Engineering Research Center for Internet of Things for Precision Agriculture (IoT4Ag). Turner received his BS from the Johns Hopkins University and SM and PhD from MIT. Prior to joining the University of Pennsylvania in 2011, he was on the faculty of the University of Wisconsin-Madison. He has received numerous awards, including the Lindback Award for Distinguished Teaching, the ASME Sia Nemat-Nasser Early Career Award, the SME Outstanding Young Manufacturing Engineer Award, the Adhesion Society Young Adhesion Scientist Award, and the NSF Career Award. He is a member of ASME and IEEE, and Vice President of the Adhesion Society. He has published more than 190 peer-reviewed articles. Turner's research is at the nexus of mechanics, manufacturing, and materials. Ongoing research efforts in Turner's group include the development of materials with tunable adhesion and stiffness, engineering fracture-resistant heterogeneous and architected materials, and design and manufacturing of low-cost printed sensors for IoT applications.