Spring 2019 Joint Colloquium
Materials Department & Materials Research Laboratory

Professor Megan Valentine
Department of Mechanical Engineering
University of California, Santa Barbara

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11:00 am, ESB 1001

Soft, Strong and Tough Materials, Inspired by Nature

Marine mussels create an array of adhesive contacts (the byssus) to secure themselves to rocks, wood, metals and other mussels in the harsh conditions of the intertidal zone. Their superb mechanical and adhesive performance has served as inspiration to create mussel-inspired materials for a wide range of applications ranging from surgical glues to primers and coatings. Historically, much of this success has relied on mimicry of the molecular properties of the mussel's adhesive interfacial proteins. By contrast, the translation of the meso- to macro-scale properties of the natural materials has been comparatively unexplored, providing rich opportunities for further property enhancement to create tough, durable, load-bearing materials. Here, I will present my laboratory's recent work characterizing the properties of natural mussel byssal plaques, and translating these discoveries to enable the design and manufacture of new materials. Experimentally, we observe the dynamics of mussel plaques as they debond from glass using a custom built load frame with integrated dual view imaging capabilities, under monotonic and cyclic loading. We pair these mechanical tests with ultrastructural analysis to understand the molecular origins of strength and toughness. Using insights from the natural materials, we then create high-performance synthetic materials that are extremely strong without compromising extensibility, as well as mussel-inspired 3D structures with tunable stiffness and strength. These innovations open new possibilities for applications of mussel-inspired materials in packaging, soft robotics, and connective tissue repair, and demonstrate the importance of understanding the multiscale, multiphase properties of biological materials.

Bio

Megan T. Valentine is a Professor of Mechanical Engineering at the University of California, Santa Barbara. Her interdisciplinary research group investigates many aspects of biological and bioinspired materials, including developing adhesives and tough polymeric materials that capture the extraordinary properties of marine-derived materials. She received her B.S from Lehigh University ('97), M.S. from UPenn ('99) and Ph.D. from Harvard ('03), all in Physics. She completed a postdoctoral fellowship at Stanford in the Department of Biological Sciences, where she was the recipient of a Damon Runyon Cancer Research Postdoctoral Fellowship, and a Burroughs Wellcome Career Award at the Scientific Interface. In 2008, she joined the faculty at the University of California, Santa Barbara, where she now serves as the Associate Director of the California NanoSystems Institute, and a co-leader of an IRG on Resilient Multiphase Soft Materials within the UC Santa Barbara Materials Research Laboratory, an NSF MRSEC. In 2013, she was awarded an NSF CAREER Award for her work on neuron mechanics, and in 2015 was awarded a Fulbright to study adhesion mechanics in Paris, France.

http://www.me.ucsb.edu/valentinelab/ Hosted by Phil Pincus.