DEPARTMENT OF MECHANICAL ENGINEERING
WILLIAM MAXWELL REED SEMINAR SERIES

"Illuminating interfacial mechanics: Coupling microscopy and mechanical testing to understand soft interfaces"

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Abstract: Many properties of polymeric systems are determined almost exclusively by the interfaces between various material components. Our work focuses on developing and strategies to characterize the contact formation and debonding behavior of various polymer interfaces. First, we utilize a mechanically-activated dye molecule covalently bound across the interface of a silk fiber-reinforced polymer composite (FRPC) to highlight interfacial stress transfer and debonding. The goal here was to develop a straightforward technique derived from commercially available materials that allows characterization of an FRPC interface by in situ mechanical deformation of single fiber model composites. Next, instrumented scratch experiments were performed on mechanophore-containing thermoset epoxy films to calibrate and quantify the fluorescence activation response of our mechanophore. This mechanophore/mechanical deformation approach allows a diffraction-limited optical microscope to probe nanoscale stress effects in a powerful new way.

Finally, recent experiments highlighting the use of thin film buckling mechanics to characterize glassy film adhesion and Young's modulus will be presented. We utilize buckling instabilities as a novel way to measure thin glassy film delamination from soft substrates. Quantifying the strength of a glassy film-compliant substrate interface is challenging due to the brittleness of glassy films which can greatly complicate sample preparation, handling, and testing. Here, we exploit surface buckling instabilities to measure the adhesion of polymer films to silicone substrates, specifically targeting the transition from wrinkling to delamination (W2D). The adhesion (given by the critical strain energy release rate (Gc)) for two model materials interfaces is quantified by determining the critical delamination strain for two polymer thin films (polystyrene (PS) and poly(methyl methacrylate) (PMMA)) and an elastomeric substrate (poly(dimethyl siloxane) (PDMS)). The Gc values determined for the PS-PDMS and PMMA-PDMS systems by W2D transition are 0.029 ± 0.01 J/m2 and 0.025 ± 0.01 J/m2, respectively. Overall, our work enables the development of new techniques to probe soft interfaces and deepen our understanding of polymer mechanics, reversible adhesion, and separation mechanisms.

Bio: Chelsea Davis received her B.S. in Textile Engineering from NC State University. She then obtained her M.S. and Ph.D. in Polymer Science and Engineering from the University of Massachusetts Amherst in 2007 and 2012, respectively. Dr. Davis was a Michelin Postdoctoral Research Fellow at the ESPCI in Paris (2012-2013) and then an NRC Postdoctoral Fellow in the Polymers and Complex Fluids Group at the National Institute of Standards and Technology (2013-2016). Dr. Davis joined the faculty of the School of Materials Engineering at Purdue University as an assistant professor in 2017 where her research lab focuses on the development of micromechanical characterization tools to investigate the interfacial and surface properties of soft materials.

Date: Friday, Dec. 6th **Time: 3PM**
Place: CB 106 **Contact: Dr. Alexandre Martin 257-4462**

Meet the speaker and have refreshments
Attendance open to all interested persons

College of Engineering

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