PURDUE UNIVERSITY

PURDUE MATERIALS ENGINEERING

Materials Engineering Fall 2014 Seminar Series

Friday, Nov. 21st
9:15 am Coffee
9:30 am Seminar
ARMS 1109

Understanding Polymer Interfaces: Unique Measurement Strategies

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Many properties of polymeric systems are determined almost exclusively by the interfaces between various material components. This seminar will focus on two very different polymer interfaces and strategies to characterize their debonding behavior. First, we investigate the role of contact time on the adhesion of elastomeric materials. We present a method to quantify the dependence of adhesion on contact time by utilizing a custom-built testing apparatus that allows unprecedented control over key aspects of a contact adhesion test (approach and retraction velocities, maximum contact pressure, and contact time). We have investigated the contact time effects of three unique contact scenarios, which allow us to decouple the effects of intermolecular forces, wetting/contact area, and chain interpenetration. Careful observation of contact images upon separation has allowed the development of a phase map describing unique separation mechanisms dependent on dwell time and polymer dynamics. Our study has practical implications that will directly influence the development of future rubber manufacturing techniques where rubber-rubber interfacial strength is important. Second, we investigate the nature of the interface of a single fiber composite. Work has been performed to image the interfacial debonding of a single fiber silk/epoxy composite. Our approach has been to utilize a mechanically active dye molecule covalently bound across the interface. The goal is to develop a straightforward technique derived from commercially available materials that allows characterization of a composite interface by *in situ* mechanical deformation of single fiber model composites. Utilizing time correlated single photon counting (TCSPC) techniques, the local environment of the mechanophore can be determined through fluorescence lifetime imaging microscopy (FLIM). Initial results have shown that our mechanophore can be used to observe interfacial fracture and local stress concentrations before macroscopic failure is observed. This mechanophore/mechanical deformation approach allows an optical microscope to probe local interfacial features in a powerful way.

Dr. Davis received a B.S. degree in Textile Engineering from North Carolina State University in 2005. She obtained her M.S. and Ph.D. in Polymer Science and Engineering from the University of Massachusetts Amherst in 2007 and 2012, respectively. While at UMass, Dr. Davis was an NSF-IGERT Graduate Fellow. Her doctoral dissertation focused on the use of surface instabilities for adhesion control. From 2012-2013, Dr. Davis was a Michelin Postdoctoral Research Fellow at the ESPCI in Paris working on the development of an adhesion testing device to probe the impact of dwell time on polymer-polymer adhesion. She is now a National Research Council Postdoctoral Fellow in the Polymers and Complex Fluids Group at the National Institute of Standards and Technology investigating methods to probe the interface of composites and nanocomposites utilizing fluorescence microscopy techniques.