THE FLUIDS, THERMAL AND CHEMICAL PROCESSES GROUP
OF
THE DIVISION OF ENGINEERING
AND
CENTER FOR FLUID MECHANICS
SEMINAR SERIES

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Droplets and Defects: Microscale Flows of Microstructured Materials

Soft materials are critical to the function of numerous engineering technologies that impact our lives, from consumer products and pharmaceuticals to optical devices and energy solutions. Common to all soft materials is the presence of an underlying structure, whether droplets, topological defects, or macromolecules. These materials interact readily with surfaces and with external fields such as flows, leading to unique and tunable properties. For example, colloidal particles of precise size and composition are effective vectors for targeted drug delivery. Rapid, precise alignment of liquid crystal molecules determines the quality of the LCD display on your laptop. Spreading of complex liquids on surfaces and within porous media controls the efficiency of processes from inkjet printing to carbon sequestration and oil recovery.

Microfluidics has revolutionized our approach to synthesis of soft materials and our approach to characterization of the underlying physics by enabling precise fabrication at length scales that interact with the microstructure. The first part of this talk will focus on our current research in generating monodisperse emulsions with microfluidic devices. In particular, the addition of surfactant molecules leads to the observation of a tipstreaming-like phenomenon that provides a mechanism to form sub-micron droplets. Uniform droplets at this scale can form the basis for synthesis of nanoparticles for drug delivery, biomedical imaging, and other applications. The interaction of surfactant-laden interfaces with strong flows leads to highly nonlinear behavior, and this talk will describe our approach to understanding this interaction through experimentation, scaling, and analytical modeling.

The second part of this talk will introduce our work to develop techniques for measuring microscale dynamics of complex liquids. For example, changing the length scale of the flow device enhances control over defect microstructures that are ubiquitous in layered liquid crystals. Precise fabrication and high speed videography enables us to probe pore-level dynamics during invasion of a fluid into a saturated porous medium. Overall, our efforts in the Micro Complex Fluids Laboratory aim to synthesize and characterize complex fluids via novel experimentation and modeling.

Biography: Dr. Shelley L. Anna is an Assistant Professor of Mechanical Engineering at Carnegie Mellon University. She received her Ph.D. in 2000 from Harvard University for research on rheology of polymer solutions. Prior to joining the faculty at Carnegie Mellon University in 2003, she worked at Solutia, Inc., a major manufacturer of polymer films and coatings, and she completed a postdoctoral fellowship at Harvard University in microfluidics and complex fluids. Dr. Anna is a faculty member in the Center for Complex Fluids Engineering and a courtesy faculty in the Departments of Chemical Engineering and Physics. She has received a National Science Foundation CAREER Award and the George Tallman Ladd Research Award.