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Distinguished Seminar

Wednesday, February 12, 2020
Seminar Presentation: 11:00am – 12:00pm
SME room 248

"Interactions, microstructure, elasticity, and aging of colloidal gels"

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Abstract: In colloidal gels, the attractive interactions among suspended colloids drive a thermodynamic instability that promotes aggregation. Instead of phase separating, aggregates arrest into a space-spanning network structure. In many cases, aggregation is induced by the addition of non-adsorbing polymer to a suspension of repulsive colloids by the depletion interaction. In other instances, gels form when particles are destabilized by screened electrostatic interactions. As a result, colloidal gels are found in a wide number of industrial processes and products where fine solids are dispersed in polymer solutions, including agrochemicals, consumer care products, cement suspensions, mineral processing, and pharmaceuticals.

In applications, the rheology of a gel is its principle material property of interest, including its elasticity and yielding. While many studies have sought to understand the formation and properties of gels in a general framework of arrested phase separation, their microstructure and rheology in fact depend strongly on the nature of the interactions. At low volume fractions and strong interaction energies between particles, colloidal gels are effectively modeled as fractal flocs formed through diffusion-controlled kinetic processes. Flocs are the principal load bearing units of the gel and theories connecting the floc architecture to the gel modulus remain a state-of-the-art description. Until recently, there was no definitive micro-structural theory for the elasticity of colloidal gels formed at higher volume fractions and lower strengths of interaction. What are the fundamental structural units imparting elasticity to the network, and what physical principles govern their formation?

In this talk, I will present experiments form weak and strong gels that illustrate the profound differences that the interaction strength and its nature have on gel structure and rheology. One key experiment measures the bending rigidity of colloidal bonds using laser tweezers. The nature of the particle contacts or "bonds" plays a critical role in the microstructure, elasticity, and aging of colloidal gels and points to ways in which the surface chemistry of particles may be tuned to control the macroscopic gel rheology and stability.

Biosketch: Eric M. Furst is Professor and Department Chair of Chemical and Biomolecular Engineering at the University of Delaware. Furst received his BS with University Honors in Chemical Engineering from Carnegie Mellon University and his MS and PhD from Stanford University. Prior to joining the faculty at Delaware, he studied biophysics as a postdoctoral trainee at Institut Curie, Paris. His research interests span a range of topics in soft matter science and engineering, but focus in particular on colloid science and rheology. He recently co-authored the book Microrheology for Oxford University Press.

Furst is the recipient of the 2013 Soft Matter Lectureship Award, the NASA Exceptional Scientific Achievement Medal, and is a Fellow of the American Chemical Society.