UCLA ENGINEERING
Chemical and Biomolecular Engineering

SEMINARS IN CHEMICAL AND BIOMOLECULAR ENGINEERING

Friday, March 16th, 2018 | 10:00AM Penthouse

Presented by:
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"Microstructure-Rheology Relationship in Complex Fluids: Towards Design of Soft Materials with Tunable Properties"

Complex fluids are a wide class of materials which exhibit unusual mechanical responses to an applied stress or strain. In virtually all complex fluids, this rich and unusual mechanical response originates from a microstructure that responds to different applied stresses or strains in specific and varied ways; Thus understanding the microstructure – macroscopic behavior relationship is a crucial step for systematically designing complex fluid materials for novel applications. Although we have seen a tremendous progress towards employing different techniques for tuning the properties of nano-particle systems, most of these techniques have failed to materialize, due to a large gap between our scientific understanding at the micro-scale and collective physics and dynamics of particles at larger scales. I will present a computational approach based on statistical mechanics and preserving proper hydrodynamics to study physics and dynamics of particulate systems in and far from equilibrium.

I will begin with the well-known non-Newtonian behavior observed in dense colloidal systems, Shear-Thickening. I will discuss the role of hydrodynamics, friction and particle geometry/deformability in dense and crowded environments. I will then discuss the role of microstructural evolutions and structural heterogeneities in defining the macroscopic properties of a self-assembled network of attractive particles: A distinct hallmark of attractive Brownian particles, even at small and intermediate concentrations, is their ability to self-assemble into percolated networks that span over the sample size. These structures show a rich time and rate dependent response to applied deformation/forces such as yielding, shear banding, microphase separation, etc. Finally, new methods for bottom-up design of materials using colloids as primary building blocks will be discussed.

I am an Assistant Professor in the department of Mechanical and Industrial Engineering, at Northeastern University in Boston, MA since summer of 2017. Prior to joining Northeastern, I worked in the departments of Chemical Engineering and Mechanical Engineering, and Energy Initiative at Massachusetts Institute of Technology, on computational rheology of structured fluids and their applications in oil and gas industry. I received my Ph.D. in Macromolecular Science and Engineering from Case Western Reserve University in 2015, focusing on rheology of colloidal suspensions and developing computational tools capable of studying transport processes in colloidal systems. My current interests span over a broad range of problems in complex fluids in and far from equilibrium. Current projects include, transport-informed targeted assembly of nano particles, colloidal particles for electrochemical processes, soft-particles at soft interfaces, etc.