Chemical and Biomolecular Engineering

Fall 2021 Seminar Series

Professor Roseanna Zia

Stanford University

Date: Thursday, November 4, 2021

Time: 10:30 a.m.

Join Zoom Meeting

Meeting ID: 999 7571 3314

Passcode: 442921

Phase Mechanics of Colloidal Gels (*Corrsin Memorial Lecture*)

Abstract: Colloidal gels, glasses, and suspensions form over 95% of biological fluids, most pharmaceutical fluids, and are ubiquitous across personal-care, agricultural, and industrial-coating materials. Despite the pervasiveness of these fluid-suspended, microscopically small particles (colloids), many of their behaviors have defied explanation – such as the sudden collapse of colloidal gels, vitrification that thwarts crystallization, and their physical role in biological cell function. Today I will focus on our fundamental studies of colloidal gels, with vignettes connecting to biological cell function. Colloidal gels form when phase separation fails, freezing a condensing region into a bonded network of strands via a kinetic process thermodynamic theory cannot predict. The consensus view had labeled colloidal gels as static, arrested materials that rupture like solids. However, this resulted in long-standing shortfalls in the ability to predict and engineer their behavior. My group has developed a model of gel "Phase Mechanics" that explains these behaviors, recasting gel mechanics in the context of non-equilibrium phase separation.

Bio: Roseanna N. Zia is an Associate Professor of Chemical Engineering at Stanford University and, by courtesy, Mechanical Engineering. She received her Ph.D. from the California Institute of Technology in Mechanical Engineering in 2011 with Professor John F. Brady, for development of theory in colloidal hydrodynamics and microrheology. Zia subsequently conducted post-doctoral study of colloidal gels at Princeton University, in collaboration with Professor William B. Russel. Zia began her faculty career at Cornell University in January 2013, then subsequently moved her research group to Stanford University in 2017.

Dr. Zia's research includes developing micro-continuum theory for structure-property relationships of flowing suspensions, elucidating the mechanistic origins of the colloidal glass transition, and microscopic modeling of reversibly bonded colloidal gels, which resulted in discovery that gel aging is actually ongoing but very slow phase separation and the finding that mechanical yield of colloidal gels is actually a non-equilibrium phase transition, triggered by changes in osmotic pressure. More recently, her research group has begun to unlock the fundamental connections between colloidal-scale physics and life-essential processes in biological cells using theoretical colloid physics, biological modeling, and high-fidelity computational models. One ultimate vision of the group is to create a generalized platform for uncovering disease mechanisms and pathways for physics-based therapeutics.

Dr. Zia's work has been recognized by several awards, including the PECASE Award, the Office of Naval Research (ONR) Director of Research Early Career Award, the ONR Young Investigator award, the NSF CAREER Award, the NSF BRIGE Award, the Publication Award from the Society of Rheology, and the Engineering Sonny Yau ('72) Teaching Award. Most recently she was named an Otterson Faculty Fellow at Stanford.

Dr. Zia serves as an Associate Editor for the Journal of Rheology, and on the Advisory Board of the AIChE Journal.