PennState College of Engineering | CHEMICAL ENGINEERING

# Chemical Engineering Seminar Series

## Assembling colloidal mixtures into functional soft materials


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The University of Texas at Austin


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350 Health & Human Development Building

10:50-11:50 a.m.


**Abstract**

Soft materials like colloidal dispersions and polymer solutions are widespread in many fields of science and engineering, including biotechnology, consumer products, and advanced materials. A key challenge for designing functional soft materials is to relate their controllable physicochemical makeup to their emergent macroscopic properties (e.g., structure, rheology), especially when the conditions for material processing or application are far from equilibrium. In this seminar, I will highlight recent progress made toward solving this challenge for two types of materials, thin-film coatings and colloidal gels, using large-scale molecular simulations. I will first show how solvent-borne multicomponent mixtures like paints or pesticides can, surprisingly, demix into two or more layers during film drying through a purely nonequilibrium mechanism. The distribution of components in the demixed film depends sensitively on both the solute size and the drying conditions, suggesting a general route to achieve complex structures by manipulating the solute interactions and film processing. I will then discuss strategies for fabricating tunable nanoparticle gels by introducing a ditopic oligomer ("linker") that bridges between particles. The linker concentration gives a facile experimental route to modulate the equilibrium phase behavior of the nanoparticle-linker mixture and make low-density gels that are resilient to aging, while the linker molecular weight further provides a handle to systematically control the gel microstructure. In future, these "forward" computational approaches can be inverted to design materials tailored for specific applications and to guide their experimental synthesis.


**Biosketch**

Michael Howard is a postdoctoral fellow at the University of Texas at Austin. He received a B.S. in Chemical Engineering from Penn State University in 2013 and a Ph.D. in Chemical Engineering from Princeton University in 2018. He was awarded a National Defense Science and Engineering Graduate Fellowship (2013), a National Science Foundation Graduate Research Fellowship (2013), and a Blue Waters Graduate Fellowship (2016) to support his research using multiscale models to study the structure and dynamics of colloid-polymer mixtures out of equilibrium. Michael's current work focuses on the computational design of reconfigurable nanomaterials and water-treatment membranes as part of the Center for Dynamics and Control of Materials and the Center for Materials for Water and Energy Systems at UT Austin.