KAIST CBE
SPECIAL SEMINAR

Thursday
December 26, 2013

4:30PM

Room 1101
W1-3 Bldg.

Mechanical Properties of Nanoparticle Assemblies

Dr. Daeyeon Lee

Associate Professor

Department of Chemical and Biomolecular Engineering

University of Pennsylvania

Assembly of nanoparticles leads to the generation of multifunctional suprastructures with synergistic properties and performance that will drive the commercialization of nanoparticle-based products in energy conversion & storage, optics, photonics, display, water purification, sensing and biomedical applications. One of the key bottlenecks that impede the widespread utilization of nanoparticle assemblies is their poor mechanical reliability and durability. They tend to fracture and fail under small loads. In this talk, I will describe two types of nanoparticle assemblies our group is investigating: bubbles and films. In particular, I will discuss our strategies to tailor the mechanical properties of these nanoparticle assemblies and our efforts to understand their failure modes under mechanical loads. In the first part of this talk, I will present a new method for fabricating monodisperse nanoparticle-shelled bubbles with high mechanical properties. We demonstrate that nanoparticle shelled-bubbles, produced using microfluidics, can be reinforced using heat treatment. We characterize the mechanical properties and fracture mechanisms of nanoparticle-shelled bubbles at the single bubble level using *in situ* compression as well as *ex situ* nanoindentation. I will discuss the importance of thermal treatment on the deformation and failure modes of these nanoparticle-shelled bubbles. We also show some examples of lightweight hybrid materials that incorporate these nanoparticle shelled-bubbles. In the second part of the talk, I will present our efforts to understand the effect of particle shape anisotropy on the mechanical behavior of disordered nanoparticle packings. We study the mechanical response of disordered nanoparticle packings made of TiO_2 prolate ellipsoids with various aspect ratios using nanoindentation. We observe striking similarities in the deformation mechanism of disordered particle assemblies to that of metallic glasses, which are random packings of metallic atoms. It is demonstrated that anisotropic particles greatly suppress shear band formation and toughen particle packings without sacrificing their strength. Our results imply that tuning constituent-anisotropy may be a new strategy to enhance toughness in disordered solids.