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University Seminar Series

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Tailoring the Mechanical Properties of Nanoparticle Assemblies

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ABSTRACT: Assembly of nanoparticles leads to the generation of multifunctional suprastructures with synergistic properties and performance and applications 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. In this talk, I will describe two types of nanoparticle assemblies our group is investigating, bubbles and films, and discuss our strategies to tailor the mechanical properties of these assemblies and understand their failure modes under mechanical loads. First, 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. We also show some examples of lightweight hybrid materials that incorporate these nanoparticle shelled-bubbles. Then, I will present efforts to understand the effect of particle shape anisotropy on the mechanical behavior of disordered nanoparticle packings. We study the mechanical response of disordered 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 toughens particle packings without sacrificing their strength. Our results imply that tuning constituent-anisotropy may be a new strategy to enhance toughness in disordered solids.

BIOGRAPHY: Daeyeon Lee received his B.S. in Chemical Engineering from Seoul National University in 2001 and his Ph.D. in Chemical Engineering at MIT in 2007 co-supervised by Robert E. Cohen and Michael F. Rubner. Daeyeon was then a post-doc with David A. Weitz at Harvard University prior to joining Penn in 2009, where he is currently an associate professor. His awards and recognitions include the 2010 Victor K. LaMer Award from ACS Colloid and Surface Chemistry Division, the NSF CAREER Award (2011), the 2011 Korean-American Scientists and Engineers Association Young Investigator Award, the 2012 KIChE President Young Investigator Award, the 2013 3M Nontenured Faculty Award, and the 2013 Van Ness Award from RPI.

EVENT DETAILS

DATE:
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