Self-Assembly, Nonlinearity, and Elastic Instabilities of Swollen Gels

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Abstract:

Swollen polymer gels are used in a wide variety of applications ranging from bioimplants to food materials to drug delivery to tissue engineering. In this presentation, the non-linear mechanical response, elastic instability, and failure behavior of two different gels: a physically crosslinked gel (triblock gel) and an ionically crosslinked gel (alginate gel) will be presented. The physical gel is thermoreversible in nature and consists of a triblock copolymer poly(methylmethacrylate)-poly(n-butylacrylate)-poly(methylmethacrylate) in a mid-block selective solvent. The gel structure evolution as a function of temperature captured using small angle neutron scattering will be discussed. Both small and large amplitude oscillatory shear experiments were used to investigate the rheological properties of these gels. Alginate gels display negative normal force, which has not been reported in for polysaccharide gels earlier. Failure behavior of these gels initiated from a defect was investigated using cavitation rheology, a custom designed characterization technique. It involves growing a cavity at the tip of a syringe needle (~10 -1000 μm) located at any arbitrary location within a gel and monitoring the pressure at the onset of instability and fracture. The onset or critical pressure is directly related to the local mechanical properties of the material. The effect of graphene nanoplatelets on the self-assembly and mechanical properties of the triblock gel will also be presented.

About the Speaker:

Santanu is a faculty member in Chemical Engineering at Mississippi State University, and a recipient of a prestigious NSF CAREER award. Santanu conducts his research on experimental mechanics of various synthetic and biological soft materials, particularly, nature and origin of network structure for these materials and how do these materials interact with complex interfaces, deform under stress, and can be processed into useful products. He previously worked in the Polymers Division at the National Institute of Standards and Technology (NIST) as well as a postdoc in Polymer Science and Engineering at the University of Massachusetts at Amherst.

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