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

Abstract:
Swollen polymer gels are used in a wide variety of applications ranging from bioimplants to food materials to drug delivery. 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 triblock gel formed by physical association of endblocks of a triblock copolymer, poly(methylmethacrylate)-poly(n-butylacrylate)-poly(methylmethacrylate) in a mid-block selective solvent. Both these gels display strain-stiffening behavior at large-strain, however, only the alginate gels exhibit negative normal force. Failure behavior of these gels initiated from a defect was investigated using cavitation rheology. It involves growing a cavity at the tip of a syringe needle (~10–1000 μm) located at any arbitrary location within the 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.