Mechanics and Electrochemistry of Stimuli Responsive Polymer Gels: Theory and Applications

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ABSTRACT

Stimuli-responsive polymer gels can exhibit controlled and reversible shape changes in response to various environmental stimuli. Applications of these multifunctional materials include drug delivery, biosensing, tissue engineering, and mechanical actuation, among others.

In this talk I will discuss the formulation of continuum theories for stimuli-responsive polymer gels, with emphasis on a multidimensional theory that incorporates coupling between electrochemistry and mechanics and, thus, is capable of describing electro-responsive polymer gels. The proposed approach will be based on a clear separation between kinematics, basic laws of balance, and constitutive equations. Specifically, we will enrich the kinematical description of a continuum body to account for the additional non-mechanical processes. The coupling between the various processes will be incorporated via constitutive equations and, as appropriate, internal constraints. Regarding constitutive theory, we expect that electrochemomechanical coupling will be manifested not only in relations between dependent and independent equilibrium variables, which dictate the spectrum of global and local potential-energy minimizing states available to the system, but also in relations between dependent and independent dissipative variables, which dictate the dynamics of the system as it approaches equilibrium. The formulation of boundary conditions, which reflect the crucial interactions between the solid and its environment, will also be discussed. It will become clear that modeling stimuli-responsive polymer gels offers new opportunities and challenges to continuum mechanics.