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Gel Mechanics: A Coupled Theory of Fluid Permeation and Large Deformations of Elastomeric Materials

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ABSTRACT:

There are numerous elastomeric materials which can absorb large quantities of suitable fluids without the essential skeletal network structure of the elastomer being disrupted by the action of the fluid. Such a polymer network, together with the fluid molecules, forms a swollen aggregate called an elastomeric gel. Elastomeric gels are ubiquitous; they are found in foods and medicines, and they find use in several important and diverse applications including valves for microfluidic devices, and tissue engineering. Indeed, many body parts in humans and other animals are gel-like in constitution. We have formulated a continuum-mechanical theory to describe the various coupled aspects of fluid permeation and large deformations (e.g., swelling and squeezing) of elastomeric gels. We have also numerically implemented our theory, and solved several interesting boundary-value problems of engineering interest. If the concentration of the solvent or the deformation is increased to substantial levels, especially in the presence of flaws, then the gel may rupture. The understanding and modeling of the effects of fluid diffusion on the damage and fracture of polymeric gels is still in its infancy. Time-permitting I will also discuss a thermodynamically-consistent theory for fracture of polymeric gels --- a theory which accounts for the coupled effects of fluid diffusion, large deformations, damage, and also the gradient effects of damage.

BIOGRAPHY:

Lallit Anand is the Warren and Towneley Rohsenow Professor of Mechanical Engineering at MIT. He received his B.Tech from IIT Kharagpur in 1970, and earned his PhD degree in 1975 from Brown University. The same year he joined the Fundamental Research Laboratory of the U.S. Steel Corp., and served successively as Research Scientist and Senior Research Scientist till 1981. He joined the MIT faculty in 1982. For two years, during 1989-1991, he served as the Program Director for the Mechanics of Materials Program, as well as the Manufacturing Processes Program in the Engineering Directorate of the National Science Foundation. At MIT he has served as the Head of the Area for Mechanics (2008-2013). The honors he has received include: Eric Reissner Medal, 1992, Fellow of American Society of Mechanical Engineers, 2003, Khan International Plasticity Medal, 2007, Distinguished Alumnus Award from Indian Institute of Technology Kharagpur, 2011,Daniel C. Drucker Medal, 2014, J. P. Den Hartog Distinguished Educator Award, 2017 and William Prager Medal, 2018.