Midwest Mechanics Seminar
School of Mechanical Engineering and School of Aeronautics and Astronautics

Thermodynamics of large deformation in soft active materials
Professor Zhigang Suo
School of Engineering and Applied Sciences, Harvard University
Friday November 21, 2008 ME256 3:30

Soft materials can be made active in that they can greatly change shape and volume in response to diverse stimuli. A dielectric elastomer may strain more than 100% under an electric field. A gel may imbibe solvent molecules to swell a thousand times its initial volume when physiological variables (e.g., pH and salt concentration) change. These soft active materials have broad applications in medical devices, robotics, energy harvesters, microfluidics, and oil wells.

My group has recently started to study the mechanics and thermodynamics of soft active materials. We formulate a nonlinear field theory that address commonly asked questions. How do stress, electric field, and chemical potential interplay to cause large deformation? Why do abrupt changes, or instabilities, occur?

In this talk I’ll outline the basic theory, using dielectric elastomers as an example. I’ll show that the notion of Maxwell stress, which is widely used in the literature of deformable dielectrics, has no theoretical basis. Furthermore, the free-energy functions of dielectric elastomers are often non-convex, leading to electromechanical instabilities. I’ll discuss implications of these findings for the design of dielectric elastomer actuators.

Zhigang Suo is Allen E. and Marilyn M. Puckett Professor of Mechanics and Materials at Harvard University. He earned a bachelor degree from Xi’an Jiaotong University in 1985, majoring in Engineering Mechanics. Upon earning a Ph.D. degree in Engineering Science from Harvard University, in 1989, Suo joined the faculty of the University of California at Santa Barbara, and established a group studying the mechanics of materials and structures. The group moved to Princeton University in 1997, and to Harvard University in 2003.

Suo teaches courses in solid mechanics and applied mathematics. His research centers on the mechanical behavior of materials and structures. Basic processes include fracture, deformation, polarization, and mass transport, driven by various thermodynamic forces (e.g., stress, electric field, electron wind, chemical potential). Applications are concerned with microelectronics, large-area electronics, and active materials.

With Teng Li, Suo co-founded iMechanica, the web of mechanics and mechanicians. iMechanica now has over 8,000 registered users and over 12,000 entries. He is a member of the Executive Committee (2005-2010) of the Applied Mechanics Division, of the American Society of Mechanical Engineers (ASME), and is a member at large of the US National Committee on Theoretical and Applied Mechanics (2006-1010).

Suo won the Pi Tau Sigma Gold Medal and the Special Achievement Award for Young Investigators in Applied Mechanics, both from ASME. He is a member of the US National Academy of Engineering.

Reception at 3:00 in ME 254

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