College of Engineering, Architecture and Technology

Southwest Mechanics Lecture Series

Simulations of Electroactive Materials: Ferroelectric Switching and Elastomer Dielectrics

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Ferroelectrics are brittle piezoelectric ceramics that have a switchable polarization. They are used as sensor and actuator materials, with an example of the latter being the operation of the valves in fuel injectors. In the switching process, the polarization direction can be modified by high electric fields and large mechanical stresses. Experiments have been carried out at UCSB and elsewhere to characterize the switching response under uniaxial and multiaxial electromechanical loading. Further insights are gained through a microelectromechanical switching model for polydomain, polycrystalline ferroelectric aggregates. A phenomenological constitutive law also has been developed for polycrystalline ferroelectrics under the influence of applied electric field and mechanical stress, and has been applied in a finite element code. This code has been used to simulate the poling and operation of ferroelectric actuators, enabling assessment of design and reliability. Computational models also have been developed for the combined electrostatic and mechanical response of large strain elastomer dielectrics functioning as capacitors.

Robert M. McMeeking earned a B.Sc. in mechanical engineering at the University of Glasgow and his M.S. and Ph.D. in solid mechanics at Brown University. He was a post-doc at Stanford University for 2 years before joining the faculty of the Theoretical and Applied Mechanics Department at the University of Illinois at Urbana Champaign, where he served for seven years. Dr. McMeeking came to UCSB in 1985 as Professor of Materials and of Mechanical and Environmental Engineering, where he twice has been Department Chair. He has published over 220 papers on such subjects as plasticity, fracture mechanics, computational methods, glaciology, tough ceramics, composite materials, materials processing, powder consolidation and sintering, ferroelectrics, structural evolution, nanotribology, actuating structures, blast and fragment protection of structures, fluid structure interactions arising from underwater blast waves, and the mechanics of the cell and its cytoskeleton. He has been Visiting Fellow and Visiting Professor at Cambridge University and has been honored as a Visiting Scholar at Pembroke College. He received an Alexander von Humboldt Research Award in 2004. He has visiting appointments as Sixth Century Professor of Engineering Materials at the University of Aberdeen, Visiting Professor of Materials Engineering at the University of the Saarland, Germany, and External Member of the Leibniz Institute for New Materials, Saarbruecken, Germany. He has served as Associate Editor and now is Editor of the ASME *Journal of Applied Mechanics*. He is a Fellow of the American Society of Mechanical Engineers and the American Academy of Mechanics and was elected to the National Academy of Engineering in 2005.

Wednesday, February 11, 1:30 pm

(Refreshments at 1:00)

New Classroom Building, Room 303

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