



LMS Seminar

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On the Interaction between Mechanics and Chemistry in Electrochemical Systems

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ABSTRACT

Interaction between mechanical fields (stress, strain, ...) and chemical phenomena is familiar in a number of problems in mechanics of materials. Examples include stress corrosion cracking, dislocation interaction with its local environment, the role of stress in microstructure evolution in alloys, etc. The basic idea is that the contribution of the mechanical fields to the free energy and the chemical potential of certain species can tip the energy landscape to influence the chemical reaction rates in ways that can have practical implications. In this talk, coupling between mechanics and chemistry in electrochemical systems is examined, particularly in the context of lithium ion batteries. Specific examples include chemo-mechanical coupling in silicon electrodes and the role of the mechanical behavior of the solid electrolyte interphase (SEI) in the performance of electrode materials. In the former, experiments are conducted to subject partially lithiated silicon electrodes to controlled elastic strains while the corresponding change in cell potential is measured. In the latter, an experimental and modeling effort is presented to characterize the mechanical behavior of SEI and its implications for surface roughening during electrochemical cycling. An additional example of chemo-mechanical coupling in the context of electro-catalytic reactions is also discussed.

BIOGRAPHY

Prof. Guduru earned his Ph.D. in Aeronautics (Minor: Materials Science) from GALCIT in 2001. Following a postdoctoral position in the Division of Engineering at Brown University, he joined the Solid Mechanics faculty there, where he is currently a Professor of Engineering. Current problems of interest in his lab include those at the interface between mechanics and chemistry; mechanical behavior under extreme conditions; and multi-metal additive manufacturing for materials with meso-scale architectures. Prof. Guduru is a recipient of James R. Rice medal from the Society of Engineering Science (2019), PECASE - Presidential Early Career Award for Scientists and Engineers (2007); the National Science Foundation CAREER award (2006). He serves on the Editorial Advisory Boards of the Journal of the Mechanics and Physics of Solids and Acta Mechanica Sinica.