The Department of Mechanical Engineering/College of Engineering and Applied Sciences
Stony Brook University

Mechanical Engineering Seminar

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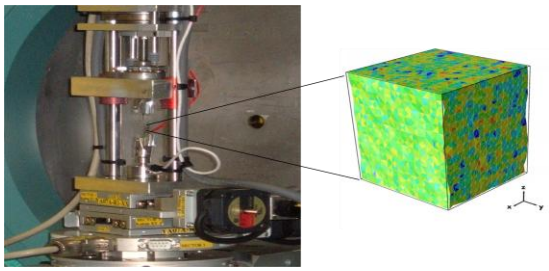
Lecture Title: Determination of Single Crystal Elastic Moduli Using Measured Lattice Strain Tensors and Computed Mechanical Response

Monday, June 20, 2011, 11AM, Room 173 Light Engineering

Abstract

Whether it's measuring the slope of a stress-strain curve or the wave speed in materials, experimental determination of elastic constants requires both mechanical stimuli and an accurate model of the system. Typically, the determination of single crystal elastic moduli involves testing millimeter sized single crystals. However, some engineering alloys are unavailable in single crystal form. The current research was aimed at developing a new combined experimental and simulation based approach to establish the single crystal elastic moduli from polycrystalline specimens. To establish the single crystal elastic moduli, high energy synchrotron X-ray diffraction techniques were used to measure the components of the full lattice strain tensor of several grains embedded within the bulk of a polycrystalline specimen. The components of the strain tensor were subsequently used to calculate initial estimates of the single crystal elastic moduli using an iso-stress approximation. Then, companion finite element simulations were used to predict the components of the lattice strain tensor of each grain for a given set of elastic moduli. The elastic moduli were then varied in a systematic way until the optimal set was obtained which minimized the difference between the experiment and simulation results. This new combined method was used to establish the single crystal elastic moduli of a beta phase titanium alloy which previously unavailable.



In situ loading frame at APS Argonne National Laboratory, and the finite element mesh used to simulate the mechanical behavior of the specimen

Biography

Christos Efstathiou's research interests are in the area of materials, solid mechanics, and materials characterization. He has concentrated on experimental characterization of strain heterogeneities due to phase transformations, twinning, and slip deformation using full-field image based measurement techniques, and most recently he has focused on diffraction based methods to study grain-scale interactions. Dr. Efstathiou received his PhD from the University of Illinois at Urbana-Champaign in 2008. Subsequently he joined the Deformation Processes Laboratory at the Mechanical Engineering Department at Cornell University as a post-doctoral research associate. He has co-authored more than twenty publications.

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