Undergraduate Research Seminar
Wednesday, February 5th 5:30 p.m.
Leigh 309

Clayton Cozzan

"Two step polarization reversal in biased ferroelectrics"

Ferroelectric materials can exhibit a spontaneous strain, and this spontaneous strain can be exploited to develop non-volatile random access memory devices, millimeter-scale robots, and vibrational energy harvesters. These applications depend on constant switching of the strain state. There is no clear definition for switching ability, so the switching behavior in ferroelectrics is modeled by testing the materials in an already switched state. This process is referred to as polarization reversal and involves reorienting spontaneous polarization by applying an electric field in an opposite direction. The microscopic response of polarization reversal is dependent on the crystal structure of the material. In the present work, the domain switching kinetics associated with polarization reversal are studied in the tetragonal perovskite crystal system. Reversal in electrically poled, or biased, materials with large internal stresses was investigated using time-resolved in situ high-energy x-ray diffraction. A unique high-speed detection system was used in conjunction with ex situ macroscopic electromechanical strain measurements. Unexpectedly, a two-step reversal process is observed that can be modeled using two distinct time constants. The unique combination of these measurements provides evidence of the underlying physical mechanism of the two-step behavior, thereby improving the existing understanding of polarization reversal. This information is then used to develop a new mathematical model for domain reorientation during polarization reversal in ferroelectric/ferroelastic ceramics.