DREXEL UNIVERSITY
Materials Science and Engineering
College of Engineering

Department of Materials Science and Engineering,

Ph.D. Defense

Wednesday, June 15th, 2022 11:00AM
In-Person: Hill Conference Room
Online: https://drexel.zoom.us/j/84495060733

The Bulk Photovoltaic and Space-Charge Effects in Epitaxial $BaTiO_3$ Thin Films

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Abstract

The bulk photovoltaic effect (BPE) is a nonlinear light-matter interaction in which light is converted into electrical current. Unlike the junction based PV mechanism, which relies on an interface to induce band bending between two differently doped regions or materials, or the Dember effect involves uses non-uniform incident light intensity to generate asymmetrical populations of holes and electrons, the BPE occurs in materials which lack inversion symmetry or break time-reversal symmetry. The process in which light is converted into an electrical current by the BPE involves aspects of crystal structure, electronic structure, and carrier transport. The BPE is influenced by material synthesis not unlike the materials science and engineering paradigm of structure, properties, performance, and processing. This broad perspective is important to consider, as modern research in the BPE e.g., light detection under a broad range of wavelengths, exploring the mechanisms of the BPE, and improving the power conversion efficiency, reveals other influences that can alter the observed response. To distinguish and elucidate the contribution from the BPE, $BaTiO_3$ epitaxial thin films grown by pulsed laser deposition were used a model system.

The main goals of this thesis are (1) investigate the roles of biaxial strain and crystallographic orientation on the BPE response and (2) to probe the influence of electrode materials and their resistivity on BPE photocurrent in epitaxial thin films. These results deepen practical understanding of the BPE, which may help to improve the BPE response in future ferroelectric photovoltaic thin films.