

MAR13-2012-020100

Abstract for an Invited Paper
for the MAR13 Meeting of
the American Physical Society

Engineering new properties in PbTiO₃ based superlattices: compositionally broken inversion symmetry and polarization rotation¹

MATTHEW DAWBER, Stony Brook University

In this talk I will present results on two superlattice systems which contain ultra fine layers of PbTiO₃ and another perovskite material. In recent years, much work has been done on the PbTiO₃/SrTiO₃ system, with a focus on improper ferroelectricity and the arrangement of ferroelectric domains. Here, we consider two different partner materials for PbTiO₃, each of which introduces markedly different behavior in the resulting superlattice. PbTiO₃/SrRuO₃ superlattices with ultra-thin SrRuO₃ layers were studied both experimentally and using density functional theory. Due to the superlattice geometry, the samples show a large anisotropy in their electrical resistivity, which can be controlled by changing the thickness of the PbTiO₃ layers. Therefore, along the ferroelectric direction, SrRuO₃ layers can act as dielectric, rather than metallic, elements. We show that, by reducing the thickness of the PbTiO₃ layers, an increasingly important effect of polarization asymmetry due to compositional inversion symmetry breaking occurs. The compositional inversion symmetry breaking is seen in this bi-color superlattice due to the combined variation of A and B site ions within the superlattice. We have also achieved an experimental enhancement of the piezoelectric response and dielectric tunability in artificially layered epitaxial PbTiO₃/CaTiO₃ superlattices through an engineered rotation of the polarization direction. As the relative layer thicknesses within the superlattice were changed from sample to sample we found evidence for polarization rotation in multiple x-ray diffraction measurements. Associated changes in functional properties were seen in electrical measurements and piezoforce microscopy. These results demonstrate a new approach to inducing polarization rotation under ambient conditions in an artificially layered thin film.

¹Work supported by NSF DMR1055413