Abstract Submitted
for the MAR12 Meeting of
The American Physical Society

Engineered polarization rotation in $PbTiO_3/CaTiO_3$ superlattices JOHN SINSHEIMER, SARA J. CALLORI, YOUCEF BENKARA, BENJAMIN BEIN, JON DALEY, Dept of Physics and Astronomy, Stony Brook University, DONG SU, Center for Functional Nanomaterials, Brookhaven National Laboratory, MATTHEW DAWBER, Dept of Physics and Astronomy, Stony Brook University — Large piezoelectric responses, such as those seen in $PbZr_xTi_{1-x}O_3$ in the vicinity of the compositional morphotropic phase boundary, can occur when the direction of the polarization in a ferroelectric material can rotate. Here we show experimentally that a similar enhancement of the piezoelectric response can be achieved in artificially layered epitaxial superlattices composed of alternating layers of $PbTiO_3$ and $CaTiO_3$ deposited on $SrTiO_3$ substrates by RF magnetron sputtering. The exceptional quality of our samples is demonstrated by x-ray diffraction and transmission electron microscopy. The structural and functional properties of the materials have been measured as a function of relative layer thickness. Electrically measured ferroelectric polarization and dielectric constants corroborate the enhancement of d_{33} we have measured experimentally using piezoforce microscopy. The structural changes, which allow polarization rotation, have been directly measured using grazing incidence in-plane x-ray diffraction (at NSLS X21 and X22C). Finally, the as-grown domain structure has been imaged with piezoforce microscopy, further confirming polarization rotation and explaining the unusual switching dynamics observed in our electrical characterization.

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Date submitted: 10 Nov 2011 Electronic form version 1.4