Ferroelectricity in CaTiO\textsubscript{3} Single Crystal Surfaces and Thin Films and Probed by Nonlinear Optics and Raman Spectroscopy

EFTIHIA VLAHOS, TOM LUMMEN, RYAN HAISSLMAIER, SAVA DENEV, CHARLES BROOKS, The Pennsylvania State University, MICHAEL BIEGALSKI, Oak Ridge National Lab, DARRELL SCHLOM, Cornell University, CARL-JOHAN EKLUND, KARIN RABE, Rutgers University, CRAIG FENNIE, Cornell University, VENKATRAMAN GOPALAN, The Pennsylvania State University — Bulk CaTiO\textsubscript{3} has a centrosymmetric point group and is not polar or ferroelectric. However, we present surprising results that show highly regular polar domains in single crystals of CaTiO\textsubscript{3}. Confocal Second Harmonic Generation (SHG) and Raman imaging studies were carried out on perovskite CaTiO\textsubscript{3} crystal surfaces. They reveal large, crystallographic polar domains at room temperature, with in-plane polarization components delineated by twin walls. SHG analysis indicates that the highest symmetry of the polar surface is $m$ (space group $P\bar{c}$) with polarization in the $m$ plane. In addition, we present results of the polar domain structure imaged before and after the application of an external electric field. Finally, we present the SHG studies of CaTiO\textsubscript{3} thin films grown using reactive Molecular Beam Epitaxy (MBE); these films are predicted by theory to be ferroelectric and are shown experimentally, both with SHG and in-plane dielectric measurements, to be ferroelectric for temperatures less than \textasciitilde150 K with group symmetry $mm\bar{2}$. 

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