Substrate Clamping Effects on Irreversible Domain Wall Dynamics in Lead Zirconate Titanate Thin Films

Author(s): F. Griggio[1,2], S. Jesse[3], A. Kumar[3], O. Ovchinnikov[3], H. Kim[4,5], T.N. Jackson[4,5], D. Damjanovic[6], S.V. Kalinin[3], and S. Trolier-McKinstry[1,2]

Source: PHYSICAL REVIEW LETTERS **Volume**: 108 **Issue**: 15 **Article Number**: 157604
DOI: 10.1103/PhysRevLett.108.157604 **Published**: APR 13 2012

Abstract: The role of long-range strain interactions on domain wall dynamics is explored through macroscopic and local measurements of nonlinear behavior in mechanically clamped and released polycrystalline lead zirconate-titanate (PZT) films. Released films show a dramatic change in the global dielectric nonlinearity and its frequency dependence as a function of mechanical clamping. Furthermore, we observe a transition from strong clustering of the nonlinear response for the clamped case to almost uniform nonlinearity for the released film. This behavior is ascribed to increased mobility of domain walls. These results suggest the dominant role of collective strain interactions mediated by the local and global mechanical boundary conditions on the domain wall dynamics. The work presented in this Letter demonstrates that measurements on clamped films may considerably underestimate the piezoelectric coefficients and coupling constants of released structures used in microelectromechanical systems, energy harvesting systems, and microrobots.

Addresses:
1. Penn State Univ, Mat Res Inst, University Pk, PA 16802 USA
2. Penn State Univ, Mat Sci & Engn Dept, University Pk, PA 16802 USA
3. Oak Ridge Natl Lab, Ctr Nanophase Mat Sci, Oak Ridge, TN 37831 USA
4. Penn State Univ, Ctr Thin Film Devices, University Pk, PA 16802 USA
5. Penn State Univ, Dept Elect Engn, University Pk, PA 16802 USA
6. Ecole Polytech Fed Lausanne, Swiss Fed Inst Technol Lausanne, Ceram Lab, CH-1015 Lausanne, Switzerland