Abstract Submitted
for the MAR10 Meeting of
The American Physical Society

Photo-induced poly-domain to mono-domain switching in ultra-thin $PbTiO_3$ films A. VAILIONIS, R. MEYER, P.C. MCINTYRE, Stanford University — Ferroelectric (FE) domain structures play a crucial role in polarization switching dynamics, ferroelectric random access memory (FRAM) data retention and polarization fatigue and it is therefore of practical importance to gain a more fundamental understanding of the origin of the transition between poly-domain and mono-domain states. Methods that promote the mono-domain state in the FE films are also of interest for model studies of ferroelectricity and its dimensional scaling. We investigate a novel poly-domain to mono-domain (P-M) switching mechanism in thin ferroelectric $PbTiO_3$ (PTO) films induced by ultraviolet (UV) light illumination. The switching occurs within minutes if a sample is irradiated with light of wavelength < 390 nm which corresponds to a photon energy that is roughly equivalent to the band gap of $PbTiO_3$ (3.2 eV). Based on a developed electrostatic model, we show that the observed phenomenon is related to photo generation of free carriers at the $PbTiO_3/SrTiO_3$ interface which effectively screens the PTO polarization charge at the interface and therefore promotes the transition of the ferroelectric film from a poly-domain to a mono-domain state. The model successfully describes not only the observed illumination effects on PTO stripe domain patterns but also a longer-term poly-domain to mono-domain (P-M) transition that occurs without intentional illumination.

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Date submitted: 02 Dec 2009 Electronic form version 1.4