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Submitted Abstract

on November 01, 11:08 PM

for mrsspring2007

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CONTROL ID: 310351

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Abstract Details

PRESENTATION TYPE: Oral Presentation Preferred

SYMPOSIUM: I: Materials and Processes for Nonvolatile Memories

KEYWORDS: Performance / Functionality / ferroelectric, Composition & Microstructure / Bulk Techniques / x-ray diffraction (XRD), Composition & Microstructure / Material Type / thin film.

Abstract

TITLE: Nanosecond separation of domain nucleation and propagation in thin ferroelectric films

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ABSTRACT BODY: The switching speed and reliability of ferroelectrics depend on the details of the polarization switching process. This process involves nucleation and growth of polarization domains and occurs in thin films in times as short as fractions of nanoseconds. We have used time-resolved synchrotron x-ray microdiffraction to access local structural changes at short time scales. In this technique, polarization switching manifests itself as a time-dependent structural signature. We have visualized the polarization domain wall motion in a thin film Pb(Zr,Ti)O3 capacitor by mapping the structural changes as a function of time across the capacitor. Different regimes of polarization switching apply, depending on the magnitude of the electric field. At electric fields of 230 kV/cm, close to the coercive field, the switching dynamics were dominated by the velocity of polarization domain walls, about 40 m/s. At 300 kV/cm the dynamics were determined by the nucleation kinetics as a result of a ~100 fold increase in the nucleation density of reversed polarization domains. Using these results we can independently assess the contributions of domain wall motion and nucleation to polarization switching. We can thus separately compare the dependence of the domain wall velocity and the nucleation density on the electric field to theoretical predictions.

(No Table Selected)

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