Effect of Mechanical Constraint on Domain Reorientation in Predominantly {111}-Textured Lead Zirconate Titanate Films

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Ferroelectric/ferroelastic domain reorientation was measured in 2.0 μm thick tetragonal {111}-textured $PbZr_{0.30}Ti_{0.70}O_3$ thin films using synchrotron X-ray diffraction (XRD). Lattice strain from the peak shift in the 111 Bragg reflection and domain reorientation were quantified as a function of applied electric field amplitude. Domain reorientation was quantified through the intensity exchange between the 112 and 211 Bragg reflections. Results from three different film types are reported: dense films that are clamped to the substrate (as-processed), dense films that are partially released from the substrate, and films with 3% volume porosity. The highest amount of domain reorientation is observed in grains that are misoriented with respect to the {111} preferred (domain engineered) orientation. Relative to the clamped films, films that were released from the substrate or had porosity exhibited neither significant enhancement in domain reorientation nor in 111 lattice strain. In contrast, similar experiments on {100}-textured and randomly oriented films showed significant enhancement in domain reorientation in released and porous films. Therefore, {111}-textured films are less susceptible to changes in properties due to mechanical constraints because there is overall less domain reorientation in {111} films than in {100} films.
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