In Situ Measurement of Increased Ferroelectric/ferroelastic Domain Wall Motion in Declamped Tetragonal Lead Zirconate Titanate Thin Films

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Ferroelectric/ferroelastic domain reorientation was measured in a 1.9 μm thick tetragonal{001} oriented $PbZr_{0.3}Ti_{0.70}O3$ thin film doped with 1% Mn under different mechanical boundary constraints. Domain reorientation was quantified through the intensity changes in the 002/200 Bragg reflections as a function of applied electric field. To alter the degree of clamping, films were undercut from the underlying substrate by 0%, ~25%, ~50%, or ~75% of the electrode area. As the amount of declamping from the substrate increased from 0% to ~75%, the degree of ferroelectric/ferroelastic domain reorientation in the films increased more than six fold at three times the coercive field. In a film that was ~ 75% released from the substrate, approximately 26% of 90° domains were reoriented under the maximum applied field; this value for domain reorientation compares favorably to bulk ceramics of similar compositions. An estimate for the upper limit of 90° domain reorientation in a fully released film under these conditions was determined to be 32%. It was also found that the different clamping conditions strongly influence the amount of reorientation upon removing the applied field, with higher remanence of preferred domain orientations observed in declamped films.