Influence of a Single Grain Boundary on Domain Wall Motion in Ferroelectrics

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Abstract: Epitaxial tetragonal 425 and 611 nm thick Pb(Zr0.45Ti0.55)O-3 (PZT) films are deposited by pulsed laser deposition on SrRuO3-coated (100) SrTiO3 24 degrees tilt angle bicrystal substrates to create a single PZT grain boundary with a well-defined orientation. On either side of the bicrystal boundary, the films show square hysteresis loops and have dielectric permittivities of 456 and 576, with loss tangents of 0.010 and 0.015, respectively. Using piezoresponse force microscopy (PFM), a decrease in the nonlinear piezoelectric response is observed in the vicinity (720-820 nm) of the grain boundary. This region represents the width over which the extrinsic contributions to the piezoelectric response (e.g., those associated with the domain density/configuration and/or the domain wall mobility) are influenced by the presence of the grain boundary. Transmission electron microscope (TEM) images collected near and far from the grain boundary indicate a strong preference for (101)/((1) over bar 01) type domain walls at the grain boundary, whereas (011)/(0 (1) over bar1) and (101)/((1) over bar 01) are observed away from this region. It is proposed that the elastic strain field at the grain boundary interacts with the ferro-electric/elastic domain structure, stabilizing (101)/((1) over bar 01) rather than (011)/(0 (1) over bar1) type domain walls, which inhibits domain wall motion under applied field and decreases non-linearity.