In situ X-ray Diffraction of Lead Zirconate Titanate PiezoMEMS Cantilever During Actuation

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Synchrotron X-ray diffraction (XRD) was used to probe the electric-field-induced response of a 500 nm lead zirconate titanate (52/48,Zr/Ti) (PZT) based piezoelectric microelectromechanical system (piezoMEMS) device. 90 degrees ferroelectric/ferroelastic domain reorientation was observed in a cantilever comprised of a 500 nm thick PZT film on a 3 mu m thick elastic layer composite of SiO_2 and Si_3N_4. Diffraction data from sectors both parallel- and perpendicular-to-field showed the presence of ferroelastic texture, which is typically seen in in situ electric field diffraction studies of bulk tetragonal perovskite ferroelectrics. The fraction of domains reoriented into the field direction was quantified through the intensity changes of the 002 and 200 diffraction profiles. The maximum induced volume fraction calculated from the results was 20%, which is comparable to values seen in previous bulk and thin film ferroelectric diffraction studies. The novelty of the present work is that a fully released ferroelectric thin film device of micron scale dimensions (down to 60,000 mu m(3)) was interrogated in situ with an applied electric field using synchrotron XRD. Furthermore, the experiment demonstrates that 90 degrees ferroelectric/ferroelastic domain reorientation can be characterized in samples of such small dimensions.