Sputter deposition of PZT piezoelectric films on thin glass substrates for adjustable x-ray optics

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Piezoelectric $PbZr_{0.52}Ti_{0.48}O_3$ (PZT) thin films deposited on thin glass substrates have been proposed for adjustable optics in future x-ray telescopes. The light weight of these x-ray optics enables large collecting areas, while the capability to correct mirror figure errors with the PZT thin film will allow much higher imaging resolution than possible with conventional lightweight optics.However, the low strain temperature and flexible nature of the thin glass complicate the use of chemical-solution deposition due to warping of the substrate at typical crystallization temperatures for the PZT. RF magnetron sputtering enabled preparation of PZT films with thicknesses up to 3 μm on Schott D263 glass substrates with much less deformation. X-ray diffraction analysis indicated that the films crystallized with the perovskite phase and showed no indication of secondary phases. Films with 1 cm^2 electrodes exhibited relative permittivity values near 1100 and loss tangents below 0.05. In addition, the remanent polarization was 26 $\mu C/cm^2$ with coercive fields of 33 kV/cm. The transverse piezoelectric coefficient was as high as −6.1 _ 0.6 C/m^2. To assess influence functions for the x-ray optics application, the piezoelectrically induced deflection of individual cells was measured and compared with finite-element-analysis calculations. The good agreement between the results suggests that actuation of PZT thin films can control mirror figure errors to a precision of about 5 nm, allowing sub-arcsecond imaging.
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