Release and Transfer of Thin-Film $Pb(Zr_{0.52}Ti_{0.48})O_3$ onto Thin Polyimide Substrate

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While thin-film piezoelectric devices would benefit from being accommodated by flexible polymeric substrates due to their low elastic stiffness (hence reduced substrate-clamping), there exists a conflict between the high crystallization temperature of the piezoelectrics and low decomposition temperature of the polymer. Thus, deposition of high strain piezoelectric films directly on polymers is challenging. In this work, a process has been developed to transfer high-density, ~1 µm thick $Pb(Zr_{0.52}Ti_{0.48})O_3$ (PZT) films from a thermally robust substrate, $Pt/ZnO/SiO_2/Si$, onto a solution cast polyimide layer by etching away the sacrificial ZnO layer in weak acid. Released PZT films on polyimide showed increased remanent polarization (26 $\mu C/cm^2$) relative to clamped films on silicon (17.5 $\mu C/cm^2$). Furthermore, on poling to 3 times the coercive field at 125^{o}C for 15 minutes led to more ferroelastic/ferroelectric realignment in the films on polyimide as the dielectric permittivity was reduced by 17% compared to a ~3% reduction for the same films on Si. In addition, Rayleigh analysis confirmed the correlation between diminished substrate constraint and increased domain wall mobility on the polymeric substrates. These films are not only attractive candidates for flexible sensors, actuators, and energy harvesters, but also can provide useful information on the material fundamentals of released perovskite thin films.