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Stress Effects on Ferroelectric Thin Film Patterning, Properties and Performance

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Recent developments in soft lithographic patterning and micro-contact printing techniques enable the integration of ferroelectric thin films on a chip, rather than added as a discrete component in the system. As integrated device applications push the characteristic length scale of these materials smaller and smaller, surface and interface effects dominate response, producing significant scientific challenges in the characterization of mechanical properties, performance and reliability. In this paper, we investigate the complex roles of microstructure, interface effects and residual stresses on ferroelectric thin film performance. PZT films ranging in thickness from 200 nm to 1.0 micron are deposited by the sol-gel method onto a platinized Si substrate. The average residual stress, which is highly dependent on film thickness, is calculated from laser reflectance measurements of wafer curvature during processing. Field-induced strains are measured interferometrically for films with well-characterized residual stress-states. Results indicate significant increases in film performance with a decrease in residual stress. Residual stress development also plays a significant role in the patterning and lift-off process. Preliminary investigations of interfacial adhesion and crack initiation of the sol-gel film on a functionalized Si substrate provide some insight into the stress driven mechanisms for mediated patterning.

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