Microstructure Evolution of In Situ Pulsed-Laser Crystallized $Pb(Zr_{0.52}Ti_{0.48})O_3$ Thin Films

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Integration of lead zirconate titanate (PZT) films with temperature-sensitive substrates (CMOS, polymers) would benefit from growth at substrate temperatures below 400°C. In this work, *in situ* pulsed-laser annealing [Rajashekhar et al. (2013) *Appl. Phys. Lett.*, 103 [3] 032908] was used to grow crystalline lead zirconate titanate ($PbZr_{0.52}Ti_{0.48}O_3$) thin films at a substrate temperature of ~370°C on $PbZr_{0.30}Ti_{0.70}O_3$-buffered platinized silicon substrates. Transmission electron microscopy analysis indicated that the films were well crystallized into columnar grains, but with pores segregated at the grain boundaries. Lateral densification of the grain columns was significantly improved by reducing the partial pressure of oxygen from 120 to 50 mTorr, presumably due to enhanced adatom mobility at the surface accompanying increased bombardment. It was found that varying the fractional annealing duration with respect to the deposition duration produced little effect on lateral grain growth. However, increasing the fractional annealing duration led to shift of 111 PZT X-ray diffraction peaks to higher 2θ values, suggesting residual in-plane tensile stresses in the films. Thermal simulations were used to understand the annealing process. Evolution of the film microstructure is described in terms of transient heating from the pulsed laser determining the nucleation events, while the energy of the arriving species dictates grain growth/coarsening.