Annealing Behavior and Electrical Properties of Atomic Layer Deposited $PbTiO_3$

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The annealing behavior and electrical properties of lead titanate (PTO) and lead zirconate titanate (PZT) thin films deposited by atomic layer deposition (ALD) were investigated. ALD films were deposited on platinized silicon substrates. The composition of the PTO films ranged from Pb-deficient $Pb_{0.73}TiO_{3-x}$ to Pb-rich $Pb_{2.3}TiO_{3-x}$, including stoichiometric $PbTiO_3$. The PZT films were all Pb-deficient, with Pb/(Zr + Ti) ratios of 0.40-0.75. Stoichiometric $PbTiO_3$ films showed the perovskite structure, and a well-defined, dense microstructure after crystallization at 600 degrees C for 1 min in 2 slpm O_{-2} in a rapid thermal annealer (RTA). Pb excess $PbTiO_3$ films developed into perovskite $PbTiO_3$ after annealing but the surface microstructure showed a large grained microstructure with significant porosity. The dielectric constant was 140 at 10 kHz and a ferroelectric polarization - electric field curve was observed. A Pb-deficient $Pb_{0.66}Zr_{0.55}Ti_{0.45}O_{3-x}$ film showed a dense and fine-grained microstructure after annealing at 700 degrees C for 1 min in 2 slpm O-2 in a rapid thermal annealer (RTA). The dielectric constant was 100 at 10 kHz.