Upshift of Phase Transition Temperature in Nanostructured $PbTiO_3$ Thick Film for High Temperature Applications

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Abstract: Thick polycrystalline pure $PbTiO_3$ films with nano size grains were synthesized for the first time by aerosol deposition. Annealed 7 mu m thick films exhibit well-saturated ferroelectric hysteresis loops with a remanent polarization and coercive field of 35 mu C/cm(2) and 94 kV/cm, respectively. A large-signal effective d(33,eff) value of >60 pm/V is achieved at room temperature. The measured ferroelectric transition temperature (T-c) of the films similar to 550 degrees C is >50 degrees C higher than the reported values (similar to 490 degrees C) for $PbTiO_3$ ceramics. First-principles calculations combined with electron energy loss spectroscopy (EELS) and structural analysis indicate that the film is composed of nano size grains with slightly decreased tetragonality. There is no severe off-stoichiometry, but a high compressive in-plane residual stress was observed in the film along with a high transition temperature and piezoelectric response. The ferroelectric characteristics were sustained until 200 degrees C, providing significant advancement toward realizing high temperature piezoelectric materials.