The Effect of Substrate Clamping on the Paraelectric to Antiferroelectric Phase Transition in Nd-doped $BiFeO_3$ Thin Films

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Thin films were deposited on $Pt/Fi/SiO_2/Si$ substrates using pulsed laser deposition from a target with a composition ($Bi_{0.825}Nd_{0.175}Fe_{0.97}Ti_{0.03}O_3$) with 5 mol% excess Bi_2O_3 within the antiferroelectric (AFE) region of the $NdFeO_3$-$BiFeO_3$ phase diagram. However, Raman spectroscopy and transmission electron microscopy (TEM) revealed that films consisted of a mosaic microstructure in which (AFE), ferroelectric (FE) and paraelectric (PE) phases coexisted. Variation in the spatial distribution of Nd is typically greater in bulk ceramics than in thin films and therefore, the absence of single phase AFE cannot be attributed to local changes in composition. Instead, it is proposed that clamping due to mismatch in thermal expansion coefficient with the substrate suppresses the large volume change associated with the PE-FE and PE-AFE transition in bulk and its absence in the thin film prevents an avalanche-like transition throughout grains, which in bulk sustains single phase AFE, irrespective of local deviations in the Nd concentration.