Stabilization of Fe_2O_3-rich Perovskite Nanophase in Epitaxial Rare-earth Doped $BiFeO_3$ Films

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Researchers have demonstrated that $BiFeO_3$ exhibits ferroelectric hysteresis but none have shown a strong ferromagnetic response in either bulk or thin film without significant structural or compositional modification. When remanent magnetisations are observed in $BiFeO_3$ based thin films, iron oxide second phases are often detected. Using aberration-corrected scanning transmission electron microscopy, atomic resolution electron energy loss spectrum-mapping and quantitative energy dispersive X-ray spectroscopy analysis, we reveal the existence of a new Fe_2O_3-rich perovskite nanophase, with an approximate formula $(Fe_{0.6}Bi_{0.25}Nd_{0.15})^{3+}$ $Fe^{3+}O_3$, formed within epitaxial Ti and Nd doped $BiFeO_3$ perovskite films grown by pulsed laser deposition. The incorporation of Nd and Bi ions on the A-site and coherent growth with the matrix stabilize the Fe_2O_3-rich perovskite phase and preliminary density functional theory calculations suggest that it should have a ferrimagnetic response. Perovskite-structured Fe_2O_3 has been reported previously but never conclusively proven when fabricated at high-pressure high-temperature. This work suggests the incorporation of large A-site species may help stabilize perovskite-structured Fe_2O_3. This finding is therefore significant not only to the thin film but also to the high-pressure community.