Strain effects in mutiferroic heterostructures

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In multiferroic heterostructures magneto electric coupling between a ferroelectric and a ferromagnetic material has been extensively studied during the last decade and various interaction mechanisms have been identified as promising routes towards exclusively electric-field controlled magnetism. In this work, we report the magnetic anisotropy in strain-coupled systems. We have systematically growth ferromagnetic (FM) $La_{2/3}Sr_{1/3}MnO_3$ (t_{LSMO}=100 nm) / ferroelectric (FE) $BaTiO_3$ (t_{BTO}=100 nm), (LSMO/BTO), bilayers on (001) oriented $SrTiO_3$ (STO), $(LaAlO_3)_{0.3}(Sr_2TaAlO_6)_{0.7}$ (LSAT), and $LaAlO_3$ (LAO) substrates as a possible route to design heterostructures with artificial magnetoelectric coupling. We have analyzed samples via X-ray reciprocal space map revealing that LSMO grew epitaxially strained whereas the BTO film grew relaxing its single-crystal structure through dislocations formed in the LSMO-BTO interface. Samples also exhibited ferromagnetic order with magnetization between 280-320 emu/cm^3 at 300 K, making possible multiferroic behaviour at room temperature. We realized magnetization hysteresis loops at 300 K, with the magnetic field (H_{app} = 5 kOe) applied along different in-plane crystallographic directions for magnetic anisotropy analysis. Results show that bilayer grown on STO substrate exhibits a change in the magnetic anisotropy from biaxial magnetic ordering (observed in the LSMO/STO single-layer) to uniaxial magnetic ordering, probably due to strain induced by the BTO layer on the top of LSMO layer. This effect is not observed in the bilayers grown on LSAT and LAO substrates. This result revealed that the superficial strain effect only induced a uniaxial anisotropy when the LSMO films is grown under tensile strain.

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