Antiferroelectric like state in $BiFeO_3/LaFeO_3$ superlattices

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Bismuth ferrite ($BiFeO_3$ or BFO) is the most studied multiferroic due to its robust ferroelectric state (TC = 1100K) coexisting at room temperature with an antiferromagnetic order (TN=640K). Such coexistence and the possible cross coupling between both ferroic orders pave the way to so-called MagnetoElectric RAM combining advantages of the ferroelectric and the antiferromagnetic state. BFO also shows an anomalous photovoltaic response and an important piezoelectric response when doped with rare earth ($(Bi,RE)FeO_3$ solid solution). Similarly to the relaxor-ferroelectric systems ($PbMg_{1/3}Nb_{2/3}O_3$-$PbTiO_3$) a morphotropic phase boundary has been observed in La doped BFO $(Bi,La)FeO_3$ solid solution with peculiar nanoscale mixture (incommensurate and antiferroelectric ordering). Emergence of such MPB is believed to arise from the competition between antiferrodistortive and ferroelectric instabilities. Our approach to investigate the structural interaction between BFO and LFO is based on superlattices. These epitaxial multilayers were grown by pulsed laser deposition and characterized by Raman spectroscopy, electronic and X-Ray diffraction. Structural characterizations and Raman spectroscopy indicate an anti-polar structure in the BFO layers of the SLs that is strongly dependent on the BFO thickness and temperature[1]. This antiferroelectric like structure, very similar to the $PbZrO_3$ system, cannot be explained solely by the nature of the induced strain (compressive vs tensile) but by the symmetry mismatch at the interfaces of the SLs. Compatibility of the octahedral tilt system seems to be the main driving force for this induced anti-polar state.

[1]. B. Carcan, H. Bouyanfif, M. El Marssi, F. Le Marrec, L. Dupont, C.Davoisne, J. Wolfman, D. C. Arnold, Phase diagram of $BiFeO_3/LaFeO_3$ superlattices: antiferroelectric-like state stability arising from strain effects and symmetry mismatch at heterointerfaces, Advanced Materials Interfaces 4 (11), 1601036 (2017)