Sub-nanometer interfacial study of the magnetoelectric $CoFe_2O_4/BaTiO_3$ system

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Thin ferrite films on piezoelectric substrates are of interest for applications as nanoscale components in next-generation memory devices and field sensors. If the two films in such a composite have large electro- and magnetostrictive properties, then the field coupling can be dominated by elastic interaction at the interface. Here, we use transmission electron microscopy (TEM) to study the interfacial characteristics of a system comprising a magnetostrictive film of $CoFe_2O_4$ (CFO) deposited on a piezoelectric $BaTiO_3$ (BTO) single crystal using pulsed laser deposition.

The expected lattice mismatch between $1xCoFe_2O_4$ and $2xBaTiO_3$ at room temperature is ~5%. X-ray diffraction indicates that (100) CFO grows epitaxially on BTO (100), as reported elsewhere [1]. Magnetic force microscopy measurements show cluster-like magnetic domains, which are thought to be associated with the formation of ordered regions with an average size of ~100 nm. Although similar observations have previously been reported for growth on $SrTiO_3$, the magnetic susceptibility and saturated magnetisation (M_S) of the CFO films are generally lower when they are grown on BTO [2, 3].

Here, we use several TEM techniques to understand the decrease in the magnetic properties of CFO films that have been grown on BTO using pulsed laser deposition. High-resolution TEM images of the interface reveal a region of low crystallinity that extends ~2 nm from the interface. This region results in the subsequent formation of a defective CFO film. We also use scanning TEM combined with electron energy-loss spectroscopy to determine the distribution of each element at the interface of the heterostructure.

References:

[1] See for example R.V. Chopdekar & Y. Suzuki, Applied Physics Letters **89** (2006) 182506
[2] A-K. Axelsson *et al*., Journal of Alloys and Compounds, in press
[3] A-K. Axelsson *et al*., Acta Materialia **59** (2011) 514