Chemical profiling and defect distribution of the magnetoelectric $CoFe_2O_4/BaTiO_3$ system using transmission electron microscopy techniques

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The performance of composite magnetoelectric (ME) devices depends primarily on the coupling between the magnetostrictive and piezoelectric attributes of the two component structures. Estimates of the order of the coupling requires understanding of the microscopic mechanism driving the ME behaviour. In thin film structures, it is the interface that determines the detectability of the ME response. Here, we investigate on the very local scale the interface characteristics of the model magneto-electric $CoFe_2O_4/BaTiO_3$ system using a range of different state-of-art transmission electron microscopy methodologies to determine the structure and chemistry at the interface. Negative spherical aberration corrected transmission electron micrographs reveal an uneven $BaTiO_3$ surface and a disordered $CoFe_2O_4$ region extending several nanometres from the interface. Electron energy loss spectra suggest major inter-diffusion across the interface. Fe is found in the surface of $BaTiO_3$ hampering its ferroelectric properties. From the opposite side of the interface, Ba and Ti also diffuse into the $CoFe_2O_4$ lowering the magnetic moment of the thin film.