Experimental Report 25-02-813

The exotic polymorph ε-Fe_2O_3 exhibits a polar ferrimagnetic structure with T_c around 500 K. It presents a huge coercivity at RT and is isomorphous to the reference multiferroic $GaFeO_3$, which exhibits gigantic optical magnetoelectric effects albeit with a lower T_c around 210 K. The recent stabilization of ε-Fe_2O_3 thin films epitaxially grown on $SrTiO_3$ (111) by PLD technique offers the unique opportunity to study the structural properties of this system at a nearly "single crystal" level. Structural changes coupled to high and low temperature magnetic transitions were previously detected in -ε-Fe_2O_3 phase stabilized in form of nanoparticles.

The experiment allowed characterising the structure of the films revealing the existence of 12 different in-plane domains: six along the SrTiO3 diagonals and the remaining six at 30 degrees with respect to the former. We could confirm that the room temperature structure of ε-Fe_2O_3 is described in the *Pna2₁* spacegroup as for nanoparticles and the bulk isostructural oxides $GFeO_3$ and $AlFeO_3$.The ε-Fe_2O_3 films were grown on STO(111) after depositing a seed layer of the isomorphous structure $AlFeO_3$. Films of $AlFeO_3$ on STO(111) with no ε-Fe_2O_3 were also studied. From the study of these films, a second outcome of the experiment was the discovery of satellites in the 00L reflections of the $AlFeO_3$ films which appear when this material becomes ferrimagnetic below its Curie Temperature at 250 K (see Figs. 1 and 2). This result indicates that the structure is affected by the onset of magnetic order in these polar ferrimagnets

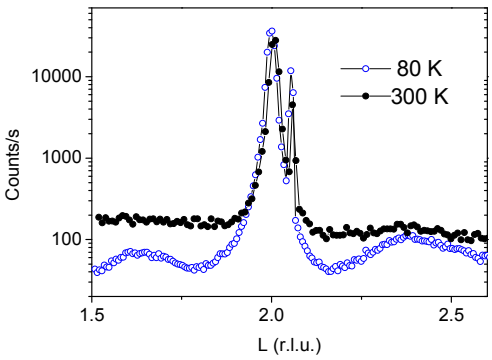

Fig. 1: θ-2θ pattern around the (002) Bragg peak of a 62 nm thick $AlFeO_3$ film, above (300 K) and below (80 K) the paramagnetic to ferrimagnetic transition.

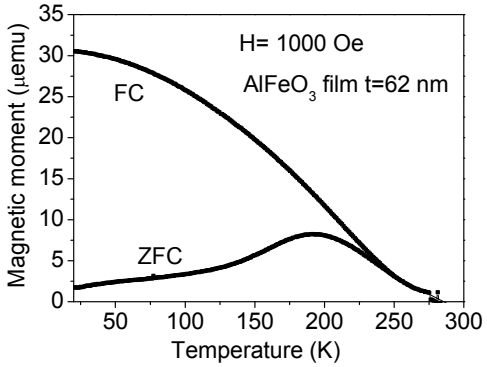

Fig. 2: ZFC-FC magnetisation of $AlFeO_3$ film with in-plane applied field.

This finding indicates what kind of structural changes can be expected to find in ε-Fe_2O_3 opens the door to a detailed understanding of the coupling relationships between the spin and lattice degrees of freedom in magnetoelectric oxides.