Abstract No. Luss0262

Characterization for Strontium Titinate/Fe_3O_4 and TiN/Fe_3O_4 Interfaces

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Beamline(s): U4B

Introduction: Fe_3O_4 is theoretically a half metallic ferromagnet. It thus has interesting applications in spin devices. However, in order to be useful it must be successfully interfaced with various materials. We studied the effects of two overlayer materials on the Fe_3O_4 interface.

Methods and Materials: The interface formation between different thicknesses of strontium titanate ($SrTiO_3$) or titanium nitride (TiN) with a 2000 Å Fe_3O_4 film was studied using x-ray absorption spectroscopy (XAS) and x-ray magnetic circular dichroism (XMCD).

Results: Our results show that the deposition of 10-50 Å of TiN results in an immediate and substantial removal of oxygen from the near interface region, resulting in the formation of FeO interlayers. This is confirmed first by a chemical shift of the L_3 line of iron from its position in Fe_3O_4 to its position in FeO (lower binding energy). Secondly, the XMCD signal concurrently decreases, confirming the disappearance of the ferromagnetic state of the iron oxide (Fe_3O_4). Additionally, from the relative intensity of the XMCD signal we can evaluate the proportion of Fe_3O_4 that transformed to FeO near the interface.

For the deposition of $SrTiO_3$ on Fe_3O_4 our measurements show only a small deviation from the Fe_3O_4 characteristic XAS signature, suggesting the limited formation of perhaps only one monolayer of another Fe oxide at the interface. However, the XMCD signal that is persistent except for two overlayer thicknesses (22 and 24 Å) confirms the preservation of Fe_3O_4 in its ferromagnetic state. For these two cases, the lack of a chemical shift confirms the loss if XMCD is not due to the formation of FeO, but another structural effect.