Measuring Interfacial Disruption at a Complex Interface

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Introduction: The distribution of each element of a complex buried magnetic interface can be determined by a combination of x-ray magnetic circular dichrosim (XMCD) and x-ray resonant magnetic scattering (XRMS) to help identify new mechanisms of interface disruption. The deposition of $YBa_2Cu_3O_{7-\delta}$ on $La_{0.7}Sr_{0.3}MnO_3$ results in the diffusion of La away from the interfacial region, strongly modifying the interfacial electronic and magnetic properties.

Methods and Materials: Recently, we have developed a method to elementally map the magnetic and chemical quality of an interface. (1) By combining X-ray magnetic circular dichroism (XMCD) and X-ray resonant magnetic scattering (XRMS) we can dissect the chemistry and magnetism of a buried interface. As an illustrative example, we have examined the evolution of the surface of $La_{0.7}Sr_{0.3}MnO_3$ (LSMO) as it is covered by various overlayers.

Results: **Figure 1** displays the evolution of the specular and diffuse XRMS intensities at the La M_5 edge for different overlayer coverages. The pristine LSMO surface is represented by the 12 Å STO capped LSMO. The data is presented in two ways to separately highlight the perpendicular and in-plane distribution of La at the interface. By normalizing the scans to the maximum diffuse scattering, a direct visual comparison of the shape of the diffuse peaks can be performed to determine the variation in the La distribution in the plane of the interface with varying YBCO coverage. The spectra all have the same shape, indicating that the La distribution taken laterally in the interface does not change significantly with YBCO coverage.

In the inset to **Figure 1**, the same data is normalized instead to the maximum specular intensity to visually compare the relative diffuse scattering intensities. From the inset, it is clear that the overall diffuse scattering intensity increases with the YBCO overlayer thickness, indicating an increasing distribution of the La perpendicular to the interface. Both these observations are consistent with localized outdiffusion of La from the interfacial region of the LSMO.

To verify the thickness dependence of the La outdiffusion, the diffuse and specular XRMS spectra acquired at the Mn L_3 edge (not show). The Mn data displays no thickness dependent Mn diffusion. There is some initial interfacial disruption of the Mn distribution upon YBCO deposition, but there is no additional Mn redistribution with subsequent YBCO deposition.

Conclusions: By combining XMCD and XRMS, we have characterized a complex interface and demonstrated, for the first time, that cation outdiffusion can significantly disrupt interface quality. The ability to elementally characterize complex buried interfaces will assist in understanding these new interfacial relaxation mechanisms and suggests that it is possible to exploit these mechanisms to tailor interface structures and tune device performance.

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References: (1) S. Stadler, Y. U. Idzerda, Z. Chen, *et al.*, Appl. Phys. Lett. **75**, 3384 (1999).

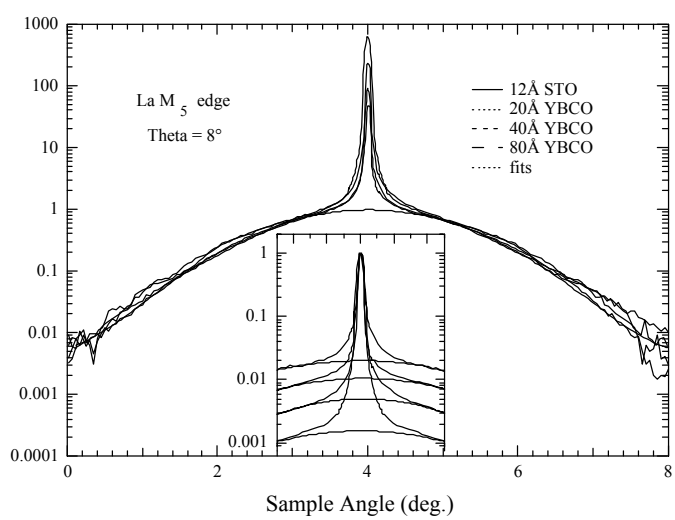

Figure 1. The specular and diffuse XRMS spectra acquired at the La M_5-edge energy for various coverages of YBCO on LSMO, normalized to the diffuse peak. INSET: Same spectra, normalized to the specular peak.