Quantitative electron microscopy analysis of the polar discontinuity at oxide interfaces

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Interfaces in heteroepitaxial perovskite oxides have received considerable attention because of the surprising properties that can be obtained. One of the most striking examples is the conductive interface between the insulators $LaAlO_3$ and $SrTiO_3$ reported by Ohtomo [1]. This emergent property was thought to be related to the polar discontinuity obtained at the interface between polar $LaAlO_3$ and nonpolar $SrTiO_3$[2]. Such polar discontinuities can result in a reconstruction of either structural or electronic nature of the material resulting in the observed transport properties. In many cases, these reconstructions are unwanted and deteriorate the device properties [3]. Interface engineering the interface composition to compensate for the charges takes away the driving force for this reconstruction and holds great promise to optimize oxide devices [4]. Here we report on a transmission electron microscopy to study this effect. Two samples of a thin film of $La_{0.67}Sr_{0.33}MnO_3$ on $SrTiO_3$ were prepared one with and one without interface engineering. In this case, the interface engineering consisted of changing the composition of the last La/Sr layer to $La_{0.33}Sr_{0.67}MnO_3$. Both samples are epitaxial with no observed defects. An atomically resolved STEM-EELS study reveals subtle differences in the La profile at the interface between both samples together with a full determination of the interface stacking sequence. The observed profiles confirm the successful inclusion of the interface engineered layer leading to a much reduced La diffusion into the $SrTiO_3$ substrate. This local observation is in good agreement with the improved interface magnetization and electrical transport measurements on these devices.

References

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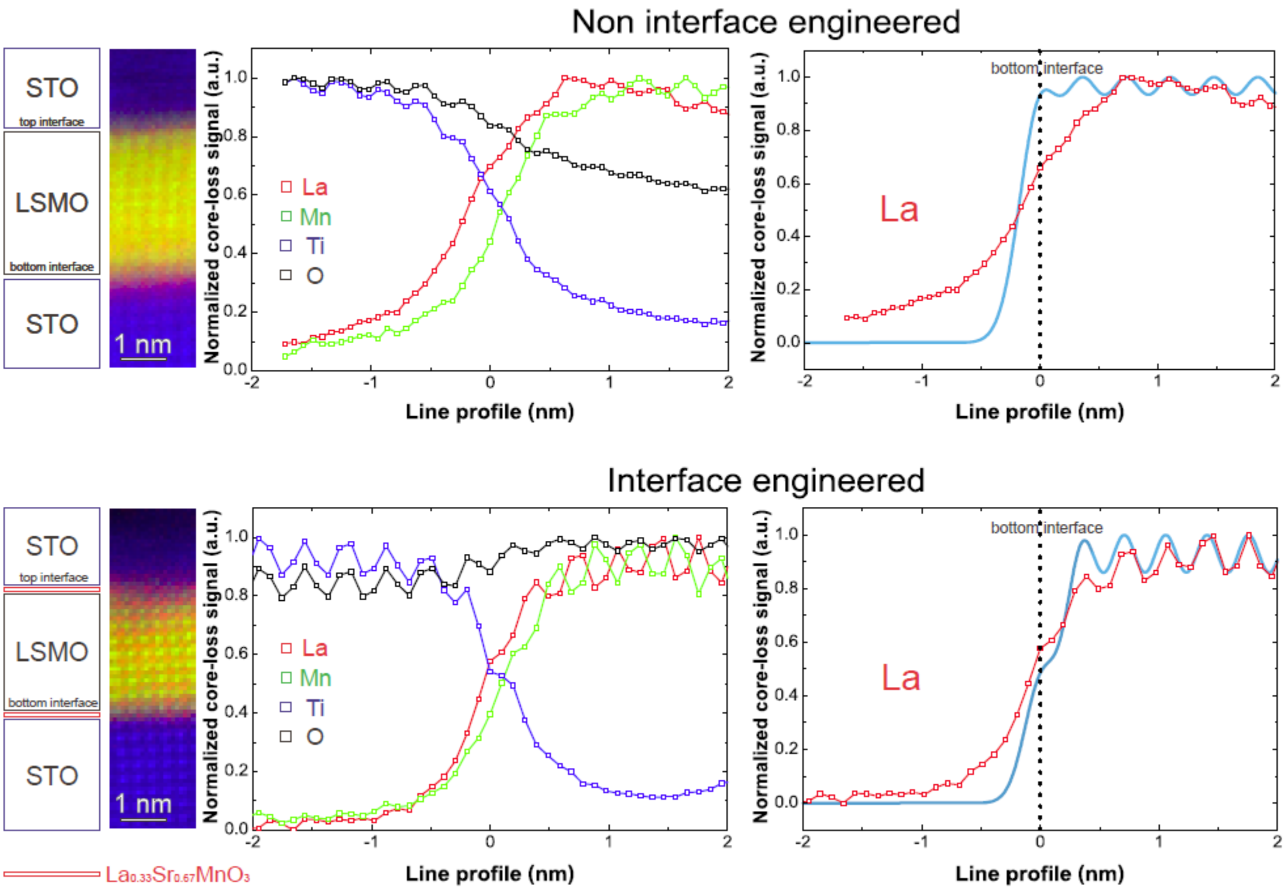

Figure 1. *EELS analysis of the LSMO/STO heterostructures. Left: Quantitative elemental RGB map with La (red), Mn (green) and Ti (blue). Middle: Normalized core loss signal for La M45 (red), Mn L23 (green, Ti L23 (blue) and O K (black) edges. Right: Comparison with a weighted Gaussian model (light blue).*