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Robust Ti^{4+} states in $SrTiO_3$ layers of $La_{0.6}Sr_{0.4}MnO_3/SrTiO_3/La_{0.6}Sr_{0.4}MnO_3$ junctions

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Introduction

Spin tunnel junction based on half-metalic materials has a great potential for future magnetroelectronic applications, such as tunneling magnetoresistance (TMR) devices [1]. Hole doped manganese oxide $La_{0.6}Sr_{0.4}MnO_3$ (LSMO) is one of the most promising materials for TMR devices owing to their half metallic nature. However, the performance of TMR devices based on the LSMO/$SrTiO_3$(STO)/LSMO tunneling junction, in which STO is used as a tunnel barrier, is far below what is expected from the high spin polarization, suggesting the "dead layer" formation at heterointerfaces between LSMO and STO [2]. In order to investigate an interfacial electronic structure, we have performed Ti 2*p* core-level photoemission and x-ray absorption spectroscopic (XAS) studies on the insulating barrier STO sandwiched by LSMO layers.

Experimental

The LSMO/STO/LSMO junctions were fabricated in a laser MBE chamber connected to a synchrotron radiation photoemission system at BL-2C of the Photon Factory [3]. A Nd:YAG laser was used for ablation in its frequency-tripled mode (λ= 355 nm) at a repetition rate of 1 Hz. During deposition, the substrate temperature was kept at 1050 °C and the oxygen pressure was 1 x 10^{-4} Torr. After cooling down below 100 ºC, the multilayers were transferred into the photoemission chamber under the vacuum of 10^{-10} Torr. The PES spectra were taken with total energy resolution of about 150 meV. The XAS spectra were obtained by measuring the sample drain current.

Results and Discussion

Figure 1 shows the Ti 2*p* core level spectra of the LSMO/STO/LSMO junction. The elemental selectivity of the techniques enables us to extract the electronic structure (valency) of the STO layer. We have found that Ti 2*p* core-level spectra clearly show Ti^{4+} states and do not exhibit any indication of Ti^{3+} states in TiO_2 layers irrespective of a different kind of adjacent atomic layer with different chemical carrier concentration. This result indicates that the Ti ions in the TiO_2 atomic layers preserve their tetravalent states even in the vicinity of the valence-mismatched interface between LSMO and STO, reflecting chemical stability of the Ti^{4+} states.

References

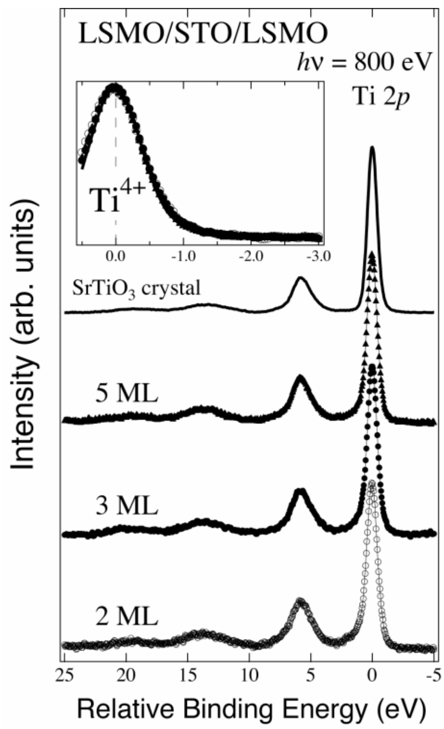

Fig1: Ti 2*p* core-level spectra of STO layers with different layer thicknesses for LSMO/STO/LSMO junctions.

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