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In-situ synchrotron-radiation photoemission characterization of $SrTiO_3/La_{0.6}Sr_{0.4}MnO_3$ heterointerfaces

H. Kumigashira[1*], R. Hashimoto[1], A. Chikamatsu[1], M. Oshima[1], T. Ohnishi[2], M. Lippmaa[2], H. Wadati[3], A. Fujimori[3], K. Ono[4], M. Kawasaki[5], and H. Koinuma[6]

[1]Department of Applied Chemistry, The Univ. of Tokyo, Tokyo 113-8656, Japan
[2]Department of Physics and Department of Complexity Science and Engineering, The Univ. of Tokyo, Kashiwa 277-8561, Japan
[3]Institute for Solid State Physics, The Univ. of Tokyo, Kashiwa 277-8581, Japan
[4]Institute of Materials Structure Science, KEK, Tsukuba 305-0801, Japan
[5]Institute for Materials Research, Tohoku Univ., Sendai 980-8577, Japan
[6]Materials and Structures Laboratory, Tokyo Institute of Technology, Yokohama 226-8503, Japan

Introduction

The half metallic nature of optimally hole-doped manganese oxides makes the manganites intriguing for potential applications in magnetroelectronic devices in the form of heterostructures, such as tunneling magnetoresistance (TMR) devices. However, the performance of TMR devices is far below what is expected from the high spin polarization, suggesting the "dead layer" formation at heterointerfaces [1,2]. In order to investigate an interfacial electronic structure, we have performed the Mn 2*p*-3*d* resonant photoemission (RPES), core-level photoemission, and x-ray absorption spectroscopic (XAS) study on $SrTiO_3$(STO)/ $La_{0.6}Sr_{0.4}MnO_3$(LSMO) multilayers.

Experimental

The LSMO/STO multilayers were fabricated in a laser MBE chamber connected to a synchrotron radiation photoemission system at BL-2C of the Photon Factrory [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 at the photon energy of 640 eV.

Results and Discussion

Figure 1 shows the Mn 2*p*-3*d* RPE S spectra of STO/LSMO multilayers. The elemental selectivity of these techniques enables us to extract the 3*d* partial density of states of LSMO layer in the vicinity of the interface with the STO overlayers. We have found that the spectral intensity of Mn 3*d* $e_g\uparrow$ states near the Fermi level is drastically reduced when the LSMO film is capped with the STO overlayer, indicating the occurrence of hole doping into Mn sites in LSMO layers close to STO layers. By contrast, Ti 2*p* core level spectra are indicative of typical Ti^{4+} states with octahedral crystal symmetry (not shown). The preservation of Ti^{4+} states in the STO capping layer may be due to the high chemical stability of TiO_2 plane in the STO. These results suggest that the hole doped into the LSMO layer close to the heterointeface originates from the chemical carrier-concentration modulation at the valence-mismatched interface composed of the stacking sequence –TiO_2–SrO–MnO_2–$La_{0.6}Sr_{0.4}$–, which is proper to multilayers based on perovskite oxides [2].

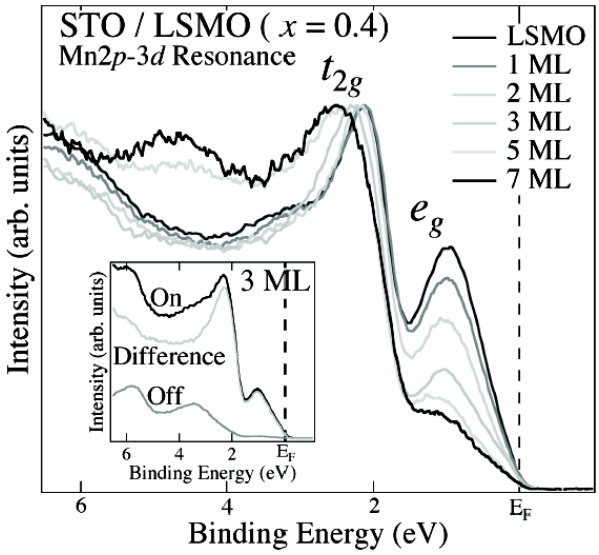

Fig.1: Mn 2*p*-3*d* RPES spectra of STO/LSMO multilyaers.

References

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* kumigashira@sr.t.u-tokyo.ac.jp