2C/2005S2-002

Electronic structure at the $LaAlO_3/SrTiO_3$ heterointerface studied by *in situ* photoemission spectroscopy

Kouhei YOSHIMATSU[1] , Ryutaro YASUHARA[1]
Hiroshi KUMIGASHIRA[1,2] , Masaharu OSHIMA[1,2]
[1]Department of Applied Chemistry, The University of Tokyo, Tokyo 113-8656, Japan
[2]Core Research for Evolutional Science and Technology (CREST),
Japan Science and Technology Agency (JST), Tokyo 113-8656, Japan

Introduction

There has been a great deal of interest recently in the metallic states at the heterointerface between band insulators $LaAlO_3$ (LAO) and $SrTiO_3$ (STO)[1]. Despite intensive studies, the origin of the high-mobility and metallic states is still unclear. Two possible scenarios are proposed for describing the physics of these states; one is the "charge transfer" originated from the charge discontinuity at the heterointerface to prevent the potential divergence in LAO films [2]. The other is "oxygen vacancy" generated by the deposition of LAO films by a pulsed laser deposition method [3]. In this study, to investigate the origin of the high-mobility and metallic states at the LAO/STO heterointerface, we have performed *in situ* photoemission spectroscopy.

Experiment

LAO/STO multilayers were fabricated onto atomically flat TiO_2-terminated Nb:STO (001) substrates in a laser MBE chamber connected to a synchrotron radiation photoemission system at BL2C of the Photon Factory, KEK. The thickness of each layer was controlled on an atomic scale by monitoring the intensity of the specular spot in reflection high-energy electron diffraction (REHHD). The LAO layer thickness was varied from 0 to 6 ML, while the thicknesses of the "buffer" STO layers to avoid the influence of Nb:STO substrates were fixed at 20 ML.

Results and Discussion

Figure 1(a) shows the valence band spectra of LAO/STO mutilayers with topmost LAO layers of variable thickness. In contrast to the systematic changes in valence band spectra, there are no detectable changes near the Fermi level within the experimental error. Suggesting that the "charge transfer" doesn't occur at the LAO / STO heterointerface. Figure 1(b) shows that Ti 2*p* core level shifts significantly toward higher binding energy with increasing LAO overlayer thickness. These results suggest that the accumulation of carriers which may be generated by oxygen vacancies in the STO layers at the heterointerface plays an important role for metallic states in the LAO / STO heherointerface.

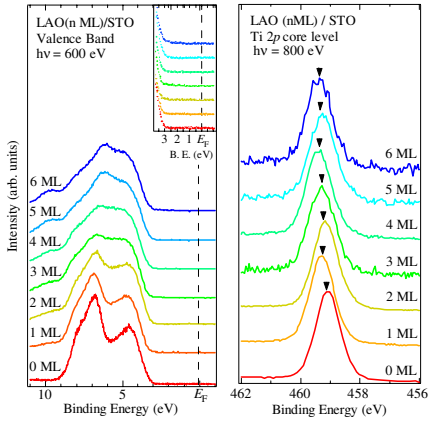

Fig. 1: (a) The valence band spectra and (b) Ti 2*p* core level spectra. The inset shows the expansion near E_F.

References

[1]A. Ohtomo *et al.,* Nature **427**, 423 (2004).
[2] N. Nakagawa *et al.,* Nature Materials **5,** 204 (2006).
[3] W. Simons *et al*., cond-mat/0612223 (2007).

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