Characterization and Electronic Structure of $LaAlO_3/LaVO_3$ Interfaces by Hard X-ray Photoelectron Spectroscopy

Hiroki Wadati[1], Yasushi Hotta[2], Masaru Takizawa[1], Atsushi Fujimori[1], Yasutaka Takata[3], Koji Horiba[3], Masaharu Matsunami[3], Shik Shin[3], Makina Yabashi[3, 4], Kenji Tamasaku[3], Yoshinori Nishino[3], Daigo Miwa[3], Tetsuya Ishikawa[3, 4], Tomofumi Susaki[2], Harold Y. Hwang[2]

[1]Department of Physics and Department of Complexity Science and Engineering, University of Tokyo, 5-1-5 Kashiwanoha, Kashiwa, Chiba 277-8561, Japan
[2]Department of Advanced Materials Science, University of Tokyo, 5-1-5 Kashiwanoha, Kashiwa, Chiba 277-8561, Japan
[3]RIKEN/SPring-8, 1-1-1 Kouto, Mikazuki-cho, Sayo-gun, Hyogo 679-5148, Japan
[4]JASRI/SPring-8, 1-1-1 Kouto, Mikazuki-cho, Sayo-gun, Hyogo 679-5198, Japan

Due to the recent development in oxide thin film fabrication, atomically controlled heterostructures of transition-metal oxides have become available. Novel electronic structures such as the metallic state between Mott and band insulators [1] are expected to appear at the interfaces of such structures. In this work, we have performed a photoemission study of interfaces between a band insulator $LaAlO_3$ (LAO) and a Mott insulator $LaVO_3$ (LVO) using hard x rays (~ 8 keV) at BL-29XU of SPring-8. We have studied LAO (3ML)/LVO (50ML), LAO (3ML)/LVO (3ML)/LAO (30ML), and thick LVO (50ML) grown on $SrTiO_3$ (STO) substrates.

A Mott-Hubbard gap of LVO remained open at the interface between LAO and LVO as shown in Fig.1, indicating that this interface was insulating unlike the $LaTiO_3$/STO interfaces [1]. The value of the gap of LAO(3ML)/LVO(50ML) was almost the same (~ 100 meV) as that of thick LVO(50ML), while that of LAO(3ML)/LVO(3ML) was much larger (~ 400 meV) due to the energy shift of V 3*d* band. We found from V 1*s* and 2*p* core-level photoemission spectra that the valence of V in LVO were partially converted from V^{3+} to V^{4+} and V^{5+} at the interface.

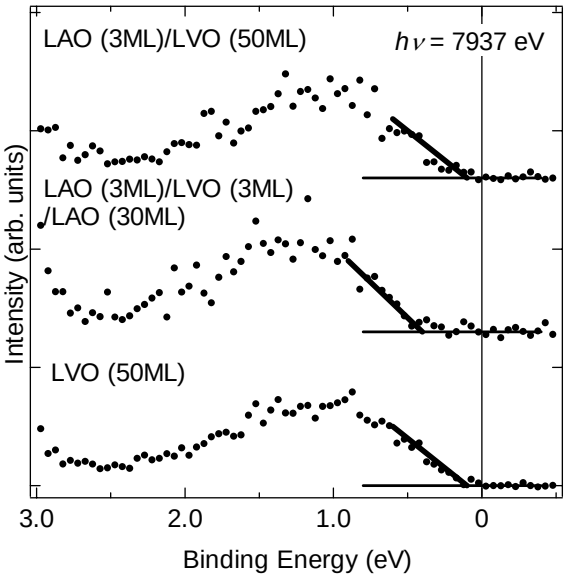

Fig. 1: V 3*d* band photoemission spectra of $LaAlO_3/LaVO_3$ heterostructures and a $LaVO_3$ thin film.

[1] A. Ohtomo *et al*., Nature **419**, 378 (2002).