2C/2005G101,2005S2-002

Photoemission study of $SrVO_3$ thin films

Masaru TAKIZAWA*[1], Riichiro TAKAISHI[2], Daisuke TOYOTA[2], Koji MAEKAWA[1], Hiroshi KUMIGASHIRA[2], Atsushi FUJIMORI[1], Masaharu OSHIMA[2], Mikk LIPPMAA[3], Masashi KAWASAKI[4], and Hideomi KOINUMA[5]

[1] Department of Physics and Department of Complexity Science and Engineering, University of Tokyo, Kashiwa 277-8561, Japan
[2]Department of Applied Chemistry, University of Tokyo, Tokyo 113-8656, Japan
[3]Institute for Solid State Physics, University of Tokyo, Kashiwa 277-8581, Japan
[4]Institute for Materials Research, Tohoku University, Sendai 980-8577, Japan
[5]NIMS, Tsukuba 305-0047, Japan

Introduction

Metal-insulator transition has been extensively studied because of its fundamental importance as well as its close relationship to interesting phenomena such as high-temperature superconductivity in cuprates and colossal magnetoresistance in manganites [1]. $Ca_{1-x}Sr_xVO_3$ (CSVO) is a typical bandwidth control system but remains metallic for the entire x range. With Ca doping, ultra-violet photoemission spectra of CSVO have shown the spectral weight transfer from the coherent part to the incoherent part [2], while using high photon energies there were no spectral weight transfer [3]. In bulk CSVO, therefore, it is now well known that the surface electronic states are very different from the bulk ones. Many studies were devoted to investigate the real "bulk" electronic states [4-6], but the problem remains highly controversial and further studies are strongly required. In the present work we have fabricated a $SrVO_3$ (SVO) thin film and studied its electronic structure in detail by photoemission spectroscopy (PES).

Experiment

A SVO thin film was fabricated in a laser MBE chamber connected to a synchrotron radiation PES system at BL-2C of Photon Factory [7]. The films were deposited on Nb-doped TiO_2-terminated $SrTiO_3$ (001) substrates [8] at 900 °C at an ultra high vacuum of ~10^{-9} Torr. The fabricated SVO thin film was transferred into the photoemission chamber under an ultrahigh vacuum of 10^{-10} Torr. The PES spectra were taken at room temperature with the total energy resolution of 200 ~ 500 meV depending on photon energies.

Results and Discussion

Figure1 (a) shows a valence-band spectrum taken at $h\nu$ = 600 eV. The band between -10 eV to -3 eV is mainly composed of O 2*p* states and that between -3 eV to E_F is mainly of V 3*d* states. In the V 3*d* band, there were two features: the coherent part (the quasiparticle band near EF) and the incoherent part (the remnant of the lower Hubbard band). The intensity ratio of the coherent part to the incoherent part was similar to that of the "bulk" spectra in Refs. [3] and [5]. We further investigated the photon-energy and emission-angle dependence (Fig. 1 (b) (c)). In the V 3*d* band, there were no significant dependencies both on the photon energy and the emission angle, indicating that the surface state little affects the V 3*d* band in the SVO thin film.

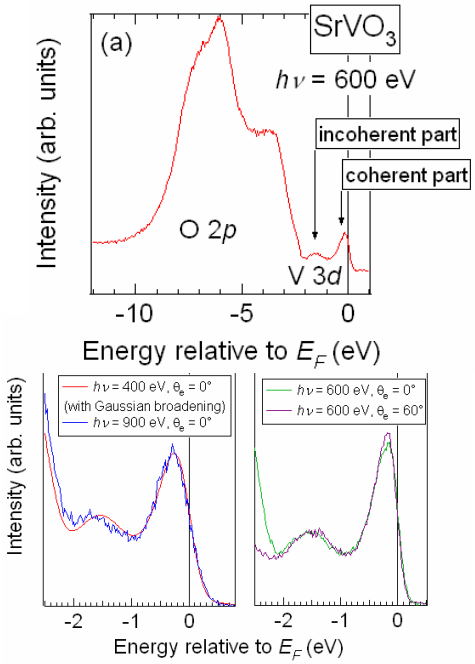

Figure1: Valence-band spectra of $SrVO_3$ thin film. (a): Wide range spectrum taken at $h\nu$ = 600 eV. (b): Photon energy dependence. (c): Emission angle dependence.

References

[1] M. Imada, A. Fujimori, and Y. Tokura, Rev. Mod. Phys. **70** 1039 (1998), and references therein.
[2] I. H. Inoue et al., Phys. Rev. Lett. **74**, 2539 (1995).
[3] A. Sekiyama et al., Phys. Rev. Lett. **93**, 156402 (2004).
[4] R. Eguchi et al., Phys. Rev. Lett. **96**, 076402 (2006).
[5] K. Maiti et al., Phys. Rev. B **73**, 052508 (2006).
[6] T. Yoshida et al., Phys. Rev. Lett. **95**, 146404 (2006).
[7] K. Horiba et al., Rev. Sci. Instr. **74**, 3406 (2003).
[8] M. Kawasaki et al., Science **266**, 1540 (1994).
*takizawa@wyvern.phys.s.u-tokyo.ac.jp