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In-situ Mn 2*p*-3*d* resonant photoemission study on $La_{0.6}Sr_{0.4}MnO_3$ epitaxial thin films grown by laser MBE

Kouji HORIBA[1], Hiroyuki OHGUCHI[1], Daisuke KOBAYASHI[1], Hiroshi KUMIGASHIRA[1*], Masaharu OSHIMA[1], Naoyuki NAKAGAWA[2], Mikk LIPPMAA[2], Kanta ONO[3], Masashi KAWASAKI[4], and Hideomi KOINUMA[5]

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

Introduction

Hole-doped perovskite manganese oxides have attracted considerable attention because of their interesting magnetic and electronic properties.[1] Photoemission spectroscopy (PES) has long played a central role in the measurement of the electronic properties of manganese oxides.[2-6] However, recently questions arose as to reliability of PES spectra on addressing the bulk electronic structure of manganese oxides[7]; the PES spectra of manganese oxides, especially the density of states (DOS) at the Fermi level (E_F), strongly depend on the surface preparation procedure as well as the experimental conditions.[2-6] Since PES is a quite surface sensitive technique owing to short photoelectron mean free paths, this may originate from different surface electronic structure induced by different surface preparations as well as different surface sensitivity in different experimental conditions.[8,9] Thus, in order to understand the bulk electronic structure, it is indispensable to perform the PES measurements on well-defined surfaces of manganese oxides. In this study, we report an *in-situ* resonant PES study on well-ordered surfaces of $La_{0.6}Sr_{0.4}MnO_3$ (LSMO) thin films grown by laser molecular beam epitaxy (laser MBE).

Experimental

The LSMO thin films were fabricated in a laser MBE chamber connected to a synchrotron radiation photo-emission system at BL-2C of the Photon Factory.[10] LSMO thin films were deposited on the TiO_2-terminated $SrTiO_3$ (001) substrates at 950 °C at an oxygen pressure of 1 x 10^{-4} Torr.[11] After cooling down below 100 °C, the films were transferred into the photoemission chamber under vacuum of 10^{-10} Torr. The PES spectra were taken with total energy resolution at the photon energy of 600 eV was about 150 meV.

Results and Discussion

Figure 1 shows the high-resolution resonant PES spectra in the near-E_F region at low temperature. In Fig. 1, we find that the spectrum exhibits clear evidence of a Fermi cutoff, which is consistent with the metallic ground states of LSMO thin films. The existence of a Fermi edge is more clearly seen by comparison with the spectrum of gold. This result is a sharp contrast with so far reported PES results[2-6] where the spectral intensity near E_F is considerably suppressed. The suppression may originate from surface disorder induced by conventional surface preparation procedures (scraping or fracturing) in the previous PES measurements[2-6], since the metallic state of LSMO results from the coherence of doped states which may be deeply disturbed by the disorder. These results strongly suggest the importance of *in-situ* PES measurement on a well-ordered surface of transition metal oxides for revealing their intrinsic electronic structure.

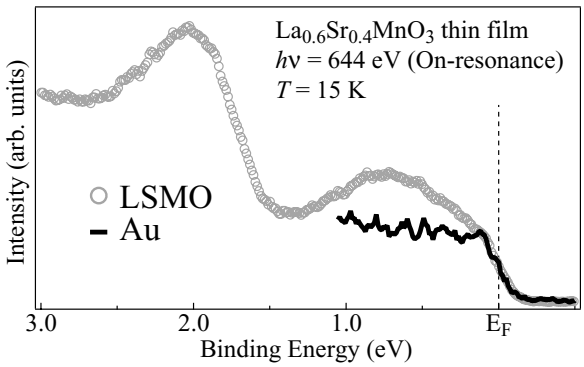

Fig. 1: Resonant PES spectra of LSMO thin films.

References

[1] M. Imada, A. Fujimori, and Y. Tokura, Rev. Mod. Phys. **70** (1998) 1039, and references there in.
[2] A. Chainani *et al.*, Phys. Rev. B **47** (1993) 15397.
[3] T. Saitoh *et al.*, Phys. Rev. B **51** (1995) 13942.
[4] D. D. Sarma *et al.*, Phys. Rev. B **53** (1996) 6873.
[5] T. Saitoh *et al.*, Phys. Rev. B **56** (1997) 8836.
[6] J. –H. Park *et al.*, Nature (London) **392** (1998) 794.
[7] R. Joynt *et al.*, Science **284** (1999) 777.
[8] A. Sekiyama *et al.*, Nature (London) **403** (2000) 396.
[9] K. Maiti *et al.*, Phys. Rev. Lett. **80** (1998) 2885.
[10] K. Horiba *et al.*, Rev. Mod. Instr, in press.
[11] M. Kawasaki *et al.*, Science **266** (1994) 1540.

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