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High-Resolution Angle-Resolved Photoemission Study on $La_{0.6}Sr_{0.4}MnO_3$ Thin Films

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1 Introduction

$La_{1-x}Sr_xMnO_3$ is a typical compound of hole-doped perovskite manganese oxides which have attracted considerable attention for spintronics applications because of their unusual physical properties such as colossal magnetoresistance behavior and half-metallic nature of the ground state. In order to clarify the origin of such interesting properties, a lot of investigations for the electronic band structures of $La_{1-x}Sr_xMnO_3$ by angle-resolved photoemission spectroscopy (ARPES) have been reported [1, 2]. Nevertheless, the detailed electronic structure near the Fermi level (E_F) is still unclear because of strong k_z dependence, that is, the band dispersion along the perpendicular to the surface, derived from the three-dimensional perovskite structure of $La_{1-x}Sr_xMnO_3$. In this study, in order to clarify the momentum and the Fermi-surface dependence of quasiparticle excitation near E_F, we have performed high-resolution ARPES experiments of $La_{0.6}Sr_{0.4}MnO_3$ (LSMO) with variable excitation energies using synchrotron radiation.

2 Experiment

LSMO samples were grown on $SrTiO_3$ (001) substrate by pulsed laser deposition [1, 3] and immediately transferred through ultrahigh vacuum to the ARPES chamber without exposure to air [4]. The *in situ* ARPES measurements were carried out at KEK-PF BL-28. For mapping the Fermi surface on high-symmetry planes in the tetragonal Brillouin zone, photon energies of 88 eV for the ΓXM plane and 60 eV for the ZRA plane were selected as shown in Fig. 1. The total energy resolution was set to 30 meV at 20 K.

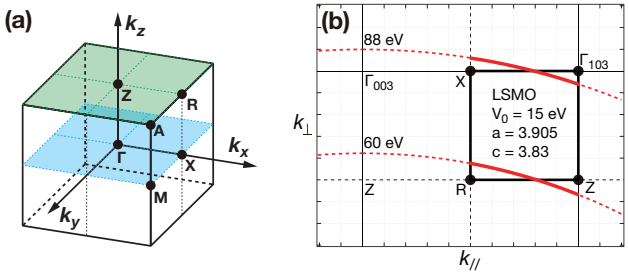

Fig. 1: (a) A schematic of Brillouin zone for a tetragonal structure of epitaxially strained LSMO films. (b) Measurement lines in the momentum space at the photon energy of 88 eV and 60 eV.

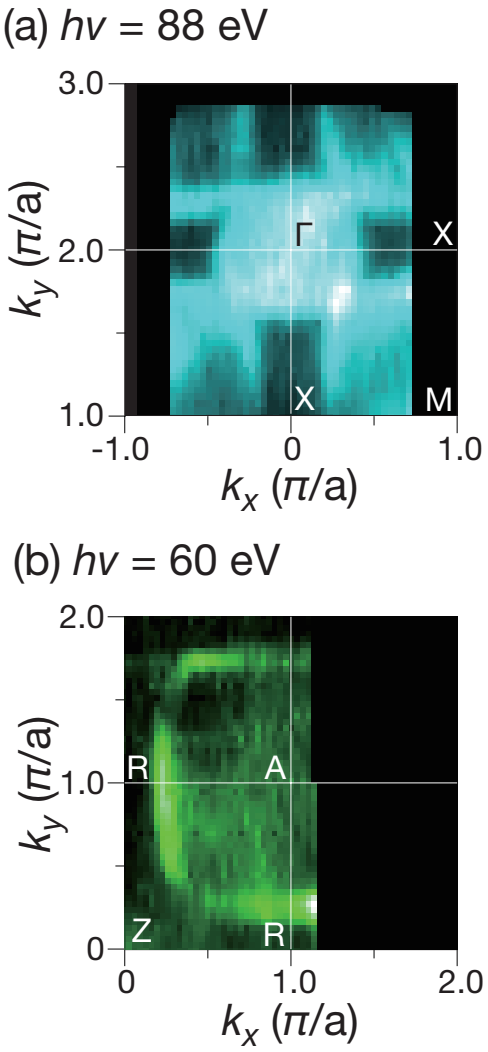

Fig. 2: (a) Fermi surface mapping at the photon energy of 88 eV corresponding to the ΓXM plane and (b) 60 eV corresponding to the ZRA plane.

3 Results and Discussion

Figure 2 (a) and (b) show the Fermi surface mapping results at the photon energy of 88 eV corresponding to the ΓXM plane and 60 eV corresponding to the ZRA plane, respectively. As predicted by band calculations [1, 5], a small electron pocket around the Γ point and a large hole pocket around the A point are separately observed. In the

each Fermi surface, clear band dispersion with Fermi cutoff is observed, reflecting a metallic ground state of LSMO. In addition, we have found that kink structures of quasiparticle band dispersions in both the electron and hole bands. The fine structures are similar to the kink structures that have been reported on bilayer manganite $La_{1.2}Sr_{1.8}Mn_2O_7$ crystals [6] and $(LaMnO_3)_4/(SrMnO_3)_2$ superlattices [7]. These kink structures indicate the strong electron-boson coupling in LSMO.

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References

[1] A. Chikamatsu, H. Wadati, H. Kumigashira, M. Oshima, A. Fujimori, N. Hamada, T. Ohnishi, M. Lippmaa, K. Ono, M. Kawasaki, and H. Koinuma, Phys. Rev. B **73**, 195105 (2006).

[2] M. Shi, M. C. Falub, P. R. Willmott, J. Krempasky, R. Herger, K. Hricovini, and L. Patthey, Phys. Rev. B **70**, 140407(R) (2004).

[3] K. Horiba, A. Chikamatsu, H. Kumigashira, M. Oshima, N. Nakagawa, M. Lippmaa, K. Ono, M. Kawasaki, and H. Koinuma, Phys. Rev. B **71**, 155420 (2005).

[4] K. Horiba H. Ohguchi, H. Kumigashira, M. Oshima, K. Ono, N. Nakagawa, M. Lippmaa, M. Kawasaki, and H. Koinuma, Rev. Sci. Instrum. **74**, 3406 (2003).

[5] E. A. Livesay, R. N. West, S. B. Dugdale, G. Santi, and T. Jarlborg, J. Phys.: Condens. Matter **11**, L279 (1999).

[6] N. Mannella, W. L. Yang, X. J. Zhou, H. Zheng, J. F. Mitchell, J. Zaanen, T. P. Devereaux, N. Nagaosa, Z. Hussain, and Z.-X. Shen, Nature **438**, 474 (2005).

[7] E. J. Monkman, C. Adamo, J. A. Mundy, D. E. Shai, J. W. Harter, D. Shen, B. Burganov, D. A. Muller, D. G. Schlom, and K. M. Shen, Nat. Mat. **11**, 855 (2012).

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