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In-situ angle-resolved photoemission study on $La_{1-x}Sr_xMnO_3$ thin films grown by laser MBE

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Introduction

Hole-doped perovskite manganese oxides $La_{1-x}Sr_xMnO_3$ (LSMO) have attracted much attention because of their interesting magnetic and electronic properties such as colossal magnetoresistance and metal-insulator transition.[1] In order to clarify the origin of their physical properties, it is necessary to investigate the band structures near the Fermi level (E_F) of manganites and their changes induced by hole-doping. In this study, we have performed *in-situ* angle-resolved photoemission (*in-situ* ARPES) study on well-ordered surfaces of LSMO (x = 0.1, 0.2, 0.3, and 0.4) thin films grown epitaxially on $SrTiO_3$(001) substrates by laser molecular beam epitaxy (laser MBE).

Experimental

The LSMO thin films were fabricated in a laser MBE chamber connected to a synchrotron radiation photoemission system at BL-1C of the Photon Factrory.[2] LSMO thin films were deposited on the TiO_2-terminated $SrTiO_3$ (001) substrates at 1050 ^{O}C at the oxygen pressure of 1 x 10^{-4} Torr.[3] After cooling down below 100 ^{O}C, the films were transferred into the photoemission chamber under the vacuum of 10^{-10} Torr. The PES spectra were taken with total energy resolution of about 150 meV at the photon energy of 88 eV.

Results and Discussion

Figure 1 shows the band structure of LSMO x = 0.4 along the Γ–X direction determined by the *in-situ* ARPES spectra (hν = 88 eV). We clearly found an electron pocket centered at the Γ point near E_F. In comparison with the Mn 2*p*-3*d* resonant PES results, the observed electron pocket originates from a Mn $3de_g$ orbital. On the other hand, the dispersionless band located at the binding energy of about 2.0 eV is assigned to Mn $3dt_{2g}$ states, while several highly dispersive bands in the region of 2.3 – 6.0 eV is derived from O 2*p* dominant states. The observed electron pocket in LSMO x = 0.4 gradually disappears with decreasing hole concentration. This behavior may reflect the phase transition from ferromagnetic metal to antiferromagnetic insulator (Mott insulator).

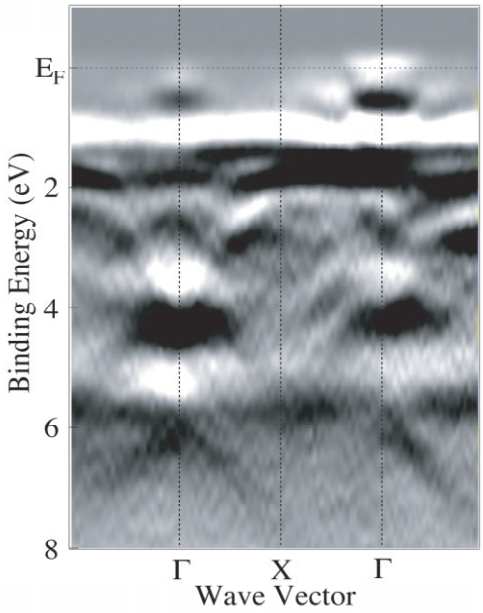

Figure 1: The band structure of LSMO x = 0.4 along the Γ–X direction determined by *in-situ* ARPES spectra (hν = 88 eV). Dark parts correspond to the energy bands.

References

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