

***In-situ* angle-resolved photoemission study on $\text{La}_{1-x}\text{Sr}_x\text{MnO}_3$ thin films**

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Introduction

Hole-doped perovskite manganese oxides $\text{La}_{1-x}\text{Sr}_x\text{MnO}_3$ (LSMO) have attracted much attention because of their interesting magnetic and electronic properties such as colossal magnetoresistance, half-metallicity, and metal-insulator transition.¹ In order to clarify the origin of their physical properties, it is necessary to obtain the information on the band structures of these oxides and their changes as a function of hole concentration (x). 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 Factory.² LSMO thin films were deposited on the TiO_2 -terminated SrTiO_3 (001) substrates at 1050 °C at the oxygen pressure of 1×10^{-4} Torr. After cooling down below 100 °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 (a) $x = 0.1$, (b) $x = 0.2$, (c) $x = 0.3$, (d) $x = 0.4$ along the Γ -X direction determined by the *in-situ* ARPES spectra ($h\nu = 88$ eV). As seen in Fig. 1(d), the band structures of LSMO $x = 0.4$ consist of several highly dispersive O $2p$ derived bands at the binding energies of 2.3 – 6 eV, almost dispersionless Mn $3d$ bands at 2.0 eV, and an Mn $3d_{e_g}$ derived electron pocket centered at the Γ point. We find that the energy positions of these bands monotonically shift toward higher binding energy with decreasing hole concentration in a rigid-band manner, whereas the electron pocket which is clearly observed in ferromagnetic metal LSMO $x = 0.4$ films gradually smears out with decreasing x , and almost disappears at ferromagnetic insulator LSMO $x = 0.1$ (Fig. 1(a)). These results suggest that the pseudogap or gap formation due to the spectral weight transfer from the near- E_F region dominates the changes in electronic structure near E_F of LSMO thin films with x .

References

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- [2] K. Horiba *et al.*, Rev. Sci. Instrum, **74**, 3406 (2003).

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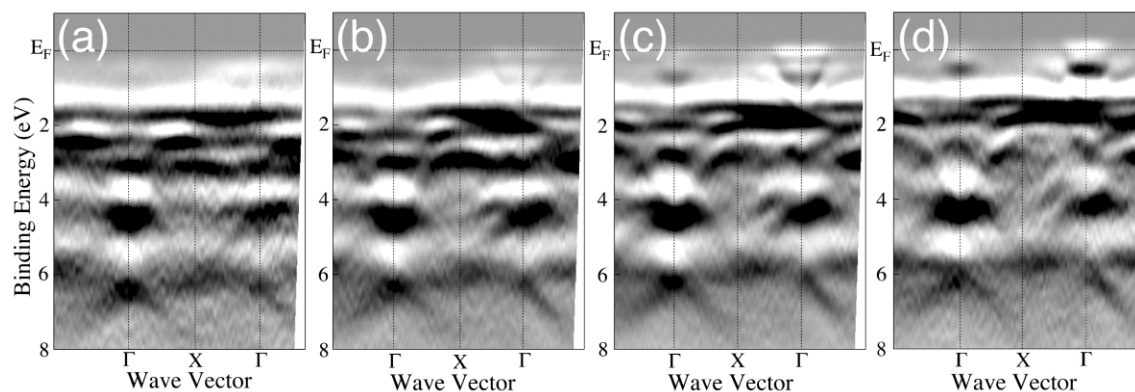


Figure 1: The band structure of LSMO (a) $x = 0.1$, (b) $x = 0.2$, (c) $x = 0.3$, (d) $x = 0.4$ along the Γ -X direction determined by *in-situ* ARPES measurements ($h\nu = 88$ eV). Dark parts correspond to the energy bands.