

In-situ angle-resolved photoemission study of $\text{La}_{1-x}\text{Sr}_x\text{FeO}_3$ epitaxial thin films

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Introduction

Angle-resolved photoemission spectroscopy (ARPES) has long played a central role in studying the electronic properties of strongly correlated electron materials with a layered perovskite structure. In contrast, there have been few studies on transition metal oxides with the three-dimensional perovskite structure because they do not have any cleavage plane. In this work, we have performed *in-situ* ARPES measurements of single-crystal thin films of $\text{La}_{1-x}\text{Sr}_x\text{FeO}_3$ (LSFO). By performing *in-situ* studies, no cleaning procedures were necessary and we succeeded in observing energy band dispersions in LSFO ($x = 0.4$).

Experimental

The LSFO thin films were fabricated in a laser MBE chamber connected to a synchrotron radiation photoemission system [1]. The experiment was done at BL-1C of Photon Factory. LSFO thin films were deposited on Nb-doped TiO_2 -terminated SrTiO_3 (001) substrates [2] at 950 °C at an oxygen pressure of 1×10^{-4} Torr. The fabricated LSFO thin films were 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 about 150 meV. Before taking the ARPES spectra, we checked the surface cleanliness of the samples by measuring LEED patterns. 1×1 spots were clearly observed, indicating that the surface of the fabricated LSFO thin film was clean enough.

Results and Discussion

Figure 1 shows the experimental band structure of LSFO ($x=0.4$) thin films obtained by ARPES measurements taken at $h\nu = 74$ eV. Here, the second derivatives of the energy distribution curves (EDC's) are plotted on the grey scale, and dark parts correspond to energy bands. The dispersions of the Fe $3d e_g$, Fe $3d t_{2g}$, and O $2p$ bands could be observed. The observed e_g band did not cross the Fermi level (E_F), consistent with the persistence of the gap as observed in angle-integrated photoemission spectra [3]. The band dispersions are characteristics of the G-type antiferromagnetic (AF) state realized in this system. In order to interpret the band

structure quantitatively, we have performed a tight-binding model calculation. Here, the effect of G-type AF is taken phenomenologically by making the energy difference ΔE between the spin-up and spin-down sites. The red dots in Fig. 1 show the result of this calculation, which reproduces the experimental band structure fairly well. However, the E_F position determined from the filling of electrons was not in agreement with the experimental E_F because of the insulating behaviour of this material. We consider that the insulating behaviour of this material is caused by localized holes observed by O $1s$ XAS [3], a polaronic effect, which is also observed in other transition-metal oxides like Fe_3O_4 [4], and/or local charge disproportionation [5].

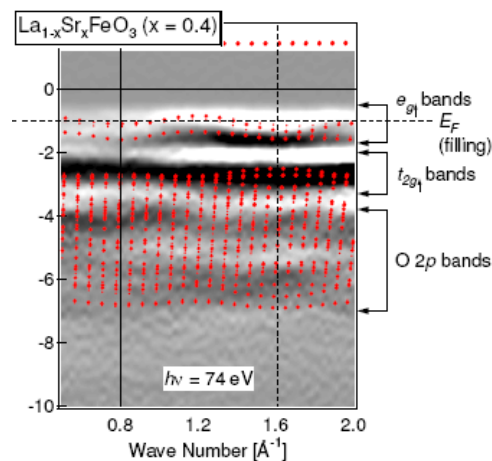


Fig. 1:

Experimental band structure of LSFO ($x = 0.4$) obtained by ARPES measurements taken at $h\nu = 74$ eV. Dark parts correspond to energy bands. Red dots show the band dispersion obtained by tight-binding calculation.

References

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