

Temperature-dependent study of charge disproportionation in $\text{La}_{1-x}\text{Sr}_x\text{FeO}_3$

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Introduction

Carrier doping into a Mott insulator causes various intriguing properties. Recently, charge ordering (CO) and its associated metal-insulator transition (MIT) have attracted great interest in relation to charge stripes in high- T_c cuprates [1] and giant magnetoresistance in manganites. $\text{La}_{1-x}\text{Sr}_x\text{FeO}_3$ (LSFO) with $x \sim 0.67$ exhibits charge disproportionation (CD), a unique type of CO, below 190 K [2]. Matsuno *et al.* [3] studied detailed temperature dependent changes near the Fermi level (E_F) in the photoemission spectra of LSFO with $x = 0.67$. The intensity at E_F was found to change dramatically across the transition temperature. In their measurements, however, the O $2p$ contribution overwhelmed the Fe $3d$ contribution due to the low photon energies $h\nu = 21.2 - 100$ eV [4] and information directly related to Fe $3d$ states has been lacking. In this work, we address the question of how the electronic structure of LSFO changes as the charge disproportionation occurs by measuring soft x-ray photoemission and absorption spectra of epitaxially-grown high-quality thin films prepared *in situ*.

Experimental

The LSFO thin films were fabricated in a laser MBE chamber connected to a synchrotron radiation photoemission system at BL-2C of Photon Factory [5]. LSFO thin films were deposited on Nb-doped TiO_2 -terminated SrTiO_3 (001) substrates [6] 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 250 meV at the photon energy of 710 eV (Fe $2p \rightarrow 3d$ resonance). After the measurements, we confirmed that for $x = 0.67$, there is a jump of resistivity at 190 K (T_{CD}).

Results and Discussion

Figure 1 shows the temperature dependence of the valence-band photoemission spectra of LSFO ($x = 0.67$) taken at $h\nu = 710$ eV (Fe $2p \rightarrow 3d$ resonance). The spectra change gradually with temperature. The spectra clearly indicate the transfer of spectral weight from lower

to higher binding energies with decreasing temperature within 2 eV of E_F , i.e., within the e_g band. The energy range at which spectral weight transfer occurs is about 2 eV, which is large compared with the transition temperature $T_{CD} = 190$ K (~ 22 meV). Spectral weight transfer over such a wide energy range was also reported in other transition-metal oxides such as $\text{La}_{1-x}\text{Sr}_x\text{MnO}_3$ [7]. We also observed the temperature dependence of the photoemission spectra taken at 600 eV and the O $1s$ x-ray absorption spectra. Similar temperature dependence was observed in the $x = 0.4$ sample, suggesting a local charge disproportionation even at $x = 0.4$. This is consistent with the previous report [3].

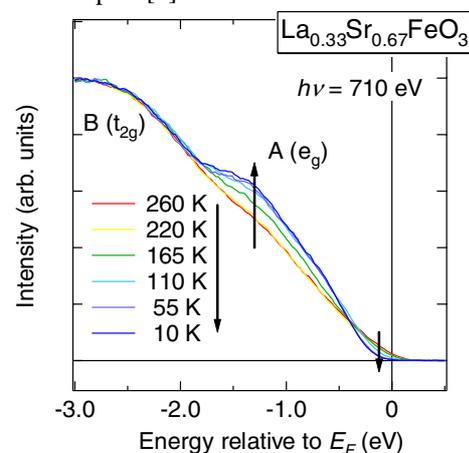


Fig. 1: Temperature dependence of the valence-band photoemission spectra of LSFO ($x = 0.67$) taken at $h\nu = 710$ eV (Fe $2p \rightarrow 3d$ resonance).

References

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