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Temperature-dependent spectral weight transfer in $La_{0.8}Sr_{0.2}MnO_3$ thin films studied by *in situ* photoemission spectroscopy

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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 half-matallicity [1]. Especially, LSMO (x = 0.2) undergoes a transition at about 285 K from a ferromagnetic metal to a paramagnetic insulator [2]. In order to clarify the origin of the metal-insulator transition in LSMO (x = 0.2), it is necessary to investigate the temperature-dependent change in the electronic structure. In this study, we have performed *in situ* soft x-ray photoemission spectroscopy (SXPES) and angle-resolved photoemission spectroscopy (ARPES) on LSMO (x = 0.2) thin films with well-ordered surfaces.

Experiment

Experiments were carried out using a photoemission spectroscopy system combined with a laser MBE chamber, which was installed at BL-2C and BL-1C of the Photon Factory, KEK [3]. Approximately 40 nm thick LSMO (x = 0.2) films were grown epitaxially on TiO_2-terminated $SrTiO_3$ (001) substrates by laser MBE. After deposition, the films were moved into the photoemission chamber under a vacuum of 10^{-10} Torr. The SXPES and ARPES spectra were taken with total energy resolution of about 200 meV at the photon energy of 600 eV, while ARPES with the photon energy of about 60 meV at 94 eV. Low energy electron-diffraction patterns showed sharp 1 x 1 spots, together with some surface reconstruction-derived spots. The LSMO (x = 0.2) films were characterized by x-ray diffraction, electrical resistivity, and magnetization measurements [4].

Results and Discussion

Figure 1 shows the temperature dependence of the valence-band *in situ* SXPES spectra near E_F of LSMO (x = 0.2) taken at $h\nu$ = 600 eV. In Fig. 1, the spectra have been normalized to the area of whole valence band spectra. In the *in situ* SXPES measurement, we have clearly found that spectral weights derived from the Mn $3de_g$ states are transferred from the coherent part in the vicinity of E_F to the incoherent part located at the binding energy of about 1.3 eV with increasing temperature. In the *in situ* ARPES measurement, the electron pocket centered at the Γ point observed in the ferromagnetic phase gradually disappears with increasing temperature (insulating phases), reflecting the temperature-induced spectral weight transfer observed in SXPES. These results suggest that a gap formation due to the spectral weight transfer causes the metal-insulator transition in LSMO (x = 0.2) with increasing the temperature.

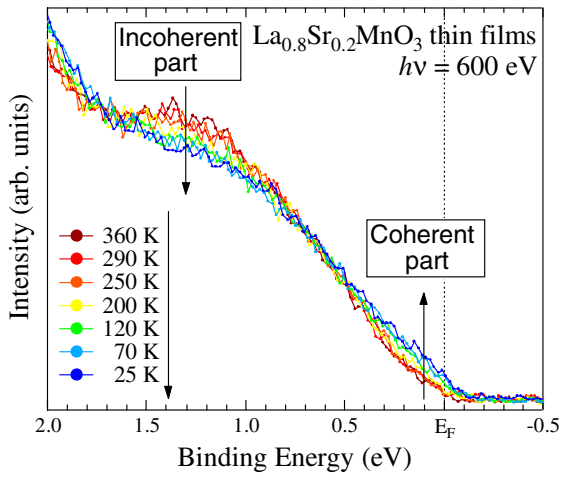

Figure 1: Temperature dependence of the *in situ* valence-band SXPES spectra near E_F of LSMO (x = 0.2) taken at $h\nu$ = 600 eV.

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