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In-situ Soft X-Ray Photoemission Study of $La_{1-x}Sr_xTiO_3$ Thin Films

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Introduction

The perovskitelike $LaTiO_3$ (LTO) and its "hole-doped" analog $La_{1-x}Sr_xTiO_3$ (LSTO) are among the most appropriate system for experimental investigations of the filling control metal insulator transition (FC-MIT) [1]. The end member LTO is known as a typical Mott-Hubbard insulator with Ti^{3+} $3d^1$ configuration, and the Sr content x represents a nominal "hole" concentration per Ti site. The other end member $SrTiO_3$ is known as a typical band insulator with Ti^{3+} $3d^0$ configuration, and the La content 1-x represents a nominal "electron" concentration per Ti site, or equivalently the 3*d* band filling n. In the x region from 0.05 to 0.9, LSTO exhibits Fermi liquid like behavior, in which electrons behave beyond the conventional band theory using mean field approximation. Especially around hole doping x=0.05, LSTO show Fermi liquid like metal - Mott insulator transition (MIT) [2].

In this work, we have measured *in-situ* soft x-ray photoemission spectroscopy (SX-PES) of epitaxially grown LSTO thin films(x=0.9, 0.8, 0.7) with clear step-and-terrace structure and well-ordered surface as a function of hole doping x.

Experiment

LSTO thin films were fabricated eptiaxially on TiO_2-terminated $SrTiO_3$ (100) substrates at 950-1000 °C and in an oxygen pressure 1-5 × 10^{-6} Torr by laser Molecular Beam Epitaxy (MBE) method. The LSTO thin films were transferred to a synchrotron radiation photoemission chamber at BL-2C of Photon Factory under ultrahigh vacuum of about 10^{-10} Torr connected directly with a laser MBE chamber [3]. The thickness of the LSTO thin films is 100 monolayer (approximate 39.05 nm) and was examined by Reflection High Energy Electron Diffraction oscillation data. Crystallographic properties examination by Atomic Force Microscope shows a step-and-terrace structure and well-ordered surface. The *in-situ* SX-PES spectra were taken at room temperature with total energy resolution of 171 meV near Fermi level at the photon energy of 464.8 eV.

Results and Discussion

The Ti 2*p*-3*d* resonance *in-situ* SX-PES spectra taken at 464.8 eV are shown in Figure 1. In the Ti 3*d* band, there are two features: the coherent part (the quasi particle band crossing the Fermi level) and the incoherent part (the remnant of the lower Hubbard band). The intensity ratio of the coherent part to the incoherent part is different greatly from that of the bulk spectra reported in Ref. [4,5]. This fact indicates that the contribution of surface state to incoherent part is very small in the Ti 3*d* states for LSTO thin films.

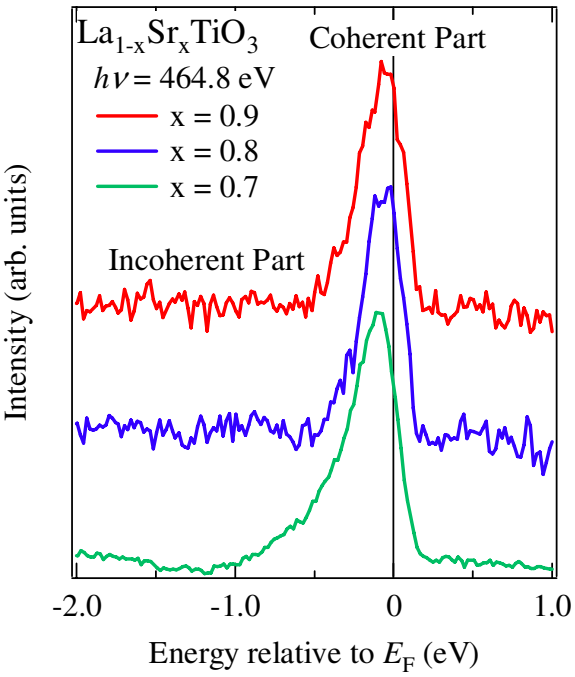

Figure 1: The hole concentration x dependence of Ti 2*p*-3*d* resonance *in-situ* SX-PES spectra of LSTO thin films in near the Fermi level taken at 464.8 eV.

References

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