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Soft x-ray linear dichroism study of $La_{1-x}Sr_xMnO_3$ epitaxial thin films

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Introduction

$La_{1-x}Sr_xMnO_3$ has attracted much attention because of its remarkable physical properties [1]. It was reported that the magnetic and electronic phases can be controlled in thin films of $La_{1-x}Sr_xMnO_3$ grown on perovskite substrates with various lattice parameters [2]. The orbital states of such Mn oxides can be investigated by measuring linear dichroism (LD) in the Mn 2*p* x-ray absorption spectra [3]. In a previous study, we performed *in-situ* x-ray absorption spectroscopy (XAS) measurements of epitaxial thin films of $La_{0.6}Sr_{0.4}MnO_3$ grown on $LaAlO_3$ (001) (compressive strain) and $SrTiO_3$ (001) (tensile strain) substrates by laser molecular beam epitaxy (laser MBE). In the present work, we have constructed a new experimental setup for LD measurements which can eliminate experimental artifacts related to the difference in the optical path and to the probing area [4].

Experimental

The $La_{0.6}Sr_{0.4}MnO_3$ thin films were fabricated in a laser MBE chamber connected to a synchrotron radiation photoemission system at BL-2C of the Photon Factory [5]. $La_{0.6}Sr_{0.4}MnO_3$ thin films were deposited on $LaAlO_3$ (001) substrates at 500 °C and on $SrTiO_3$ (001) substrates at 1050 °C in the oxygen pressure of 1×10^{-4} Torr. The fabricated $La_{0.6}Sr_{0.4}MnO_3$ thin films were transferred into the photoemission chamber under vacuum of 10^{-10} Torr. The XAS spectra were taken at room temperature in the total-electron-yield mode.

Results and Discussion

For the measurements of LD in XAS, we can consider two experimental setups as shown in Fig. 1: (a) is the "conventional" setup feasible for a simple one-axis-rotation manipulator, whereas (b) is the "best" setup proposed in Ref. [4]. In (b), the experimental artifacts related to the saturation effect, which is serious when the x-ray penetration depth λ_x is comparable to the electron escape depth λ_e, can be eliminated.

Figure 2 (a) shows the polarization-dependent XAS and LD spectra of a $La_{0.6}Sr_{0.4}MnO_3$ epitaxial thin film grown on $SrTiO_3$ (001) substrates taken with the "conventional" setup (a) and "best" setup (b). These two essentially give the same LD spectra, indicating that the configuration problem was not serious at least in the present case. The saturation effect was negligible probably because λ_x is much longer than λ_e. From these results we found that the "conventional" setup is enough for obtaining the intrinsic LD spectra.

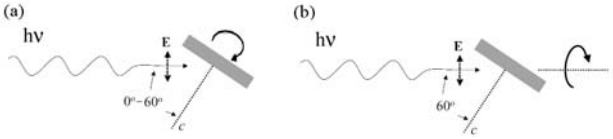

Fig. 1: Schematic illustration of experimental setups for LD measurements. (a) "Conventional" setup available for a simple one-axis-rotation manipulator. (b) "Best" setup proposed in Ref. [4]. In (b), the sample is rotated around the propagation direction of incident photons.

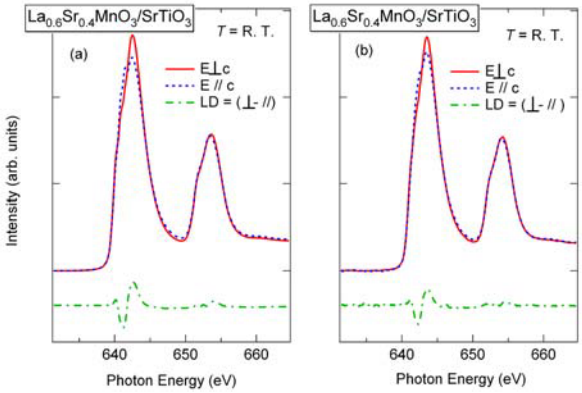

Fig. 2: Polarization-dependent XAS and LD spectra of $La_{0.6}Sr_{0.4}MnO_3$ epitaxial thin films grown on $SrTiO_3$ (001) substrates taken with the "conventional" setup (a) and "best" setup (b).

References

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