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Ru-doped $La_{0.6}Sr_{0.4}MnO_3$ thin film as a coercivity tunable material studied by x-ray magnetic circular dichroism

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Introduction

$La_{1-x}Sr_xMnO_3$ (LSMO) is a typical half-metallic compound. Although LSMO is attracting attention for possible applications to magnetic tunnel junctions, there is a serious problem that the coercivity (H_C) is too small. Yamada *et al.*[1] reported that one can enhance the coercivity by substituting Ru for Mn, and attributed this effect to antiferromagnetic coupling between Mn and Ru and charge transfer from Mn^{4+} to Ru^{4+} ($Mn^{4+}+Ru^{4+}\rightarrow Mn^{3+}+Ru^{5+}$).

In order to obtain information about the electric and magnetic states of each element in this system and to elucidate the mechanism of the coersivity enhancement, we performed x-ray magnetic circular dichroism (XMCD) measurements.

Experimental

We fabricated the thin films by plused laser deposition (PLD) method. The thickness of these samples was 50nm. The substitution ratio y of Ru was 0.05. XMCD measurements were performed at BL23SU of SPring-8. The measurement was performed in the total electron yield (TEY) mode with T=30K and H=1T (out of plane). We used 1Hz helicity-switching mode. [2]

Results and Discussion

The XMCD spectra of Mn L-edge and Ru M-edge are shown in Fig. 1 and Fig. 2, respectively. One can conclude that the spin direction of Mn is opposite to that of Ru consistent with Yamada *et al.* [1] . By applying the XMCD sum rules, we found that the orbital moment of Ru is finite and is parallel to the spin moment. This suggests that Ru 4*d* orbitals are occupied by more than 5 electrons and that the valence of Ru is 3+.

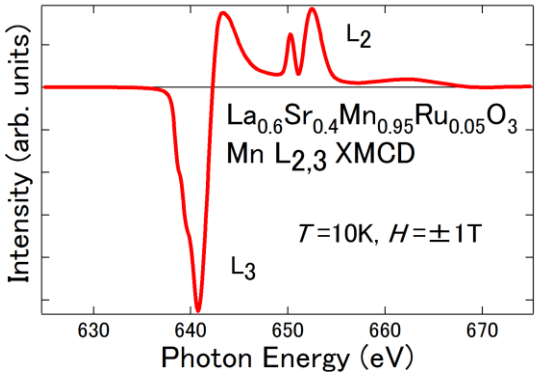

Fig. 1 XMCD spectrum at the Mn L-edge

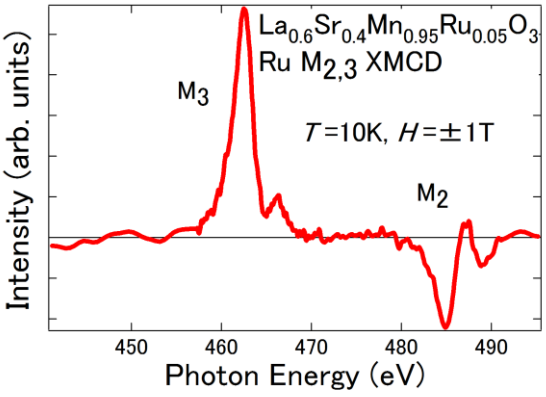

Fig. 2 XMCD spectrum at the Ru M-edge

Reference
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[2] Y. Saitoh *et al*., J. Synchrotron Radiation. **19**, 3, 388 (2012).

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