Soft X-ray magnetic circular dichroism of ferromagnetic perovskite Mn oxides

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Perovskite-type Mn oxides have been attracted much interest because of its showing a variety of anomalous properties such as insulator-metal transition, paramagnetic-ferromagnetic transition and charge ordering transition. Colossal magnetoresistance is also seen in the vicinity of insulator-metal transition accompanied by ferromagnetic transition. By changing the constitution, one can change the dimensionality, the bond length and the bond angle. These parameters changes the magnetic and transport properties drastically.

In this study, we focus on cubic perovskite-type Mn oxides which show paramagnetic to ferromagnetic transition accompanied by insulator to metal transition below room temperature. We chose $La_{0.84}Sr_{0.16}MnO_3$ (LSMO) and $Nd_{0.53}Sr_{0.47}MnO_3$ (NSMO) which have the transition temperature just below room temperature and do not undergo charge ordering to low temperatures. In order to obtain magnetic information of Mn $3d$, O $2p$ and rare-earth $4f$ orbitals, we have measured magnetic circular dichroism (MCD) of core level photoabsorption (XAS). We measured MCD in Mn $2p$, O $1s$ and rare-earth $3d$ XAS.

Soft x-ray with nearly perfect circular polarization are monochromatized by the varied line spacing grating monochromator and are led to the sample. Magnetic field of 1.4T parallel or antiparallel to the photon's k-vector is applied to the sample (Faraday geometry) by Nd-Fe-B permanent magnets. Total photoelectron yield was measured by the ammeter between the sample and the ground and was normalized by the photocurrent from the final mirror. As the photon energy is scanned, the direction of the magnetic field is flipped at each photon energy in order to cancel a possible drift or fluctuation of the photon current and other factors. Samples were cooled to about 20 K during the measurement. The surface of the samples were cleaned by scraping with diamond filers.

MCD in Mn $2p \rightarrow 3d$ XAS had prominent multiplet structures which were different between LSMO and NSMO. The sample dependence is considered to originate from the different Mn valnecy. MCD was also observed for O $1s \rightarrow 2p$ XAS and rare-earth $3d \rightarrow 4f$ XAS. By analyzing these results using cluster model taking into account the hybridization between the Mn $3d$ or rare earth $4f$ and surrounding O $2p$ electronic state, the electronic and magnetic states are expected to be revealed.