論文の内容の要旨

論文題目：Magnetic and electronic states of spinel ferrites studied by x-ray magnetic circular dichroism

（X 線磁気円二色性によるスピネルフェライトの磁性と電子状態の研究）

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Transition-metal oxides are one of the most representative class of materials of strongly correlated electron systems. They show novel phenomena originating from the interplay between charge, spin, lattice, and orbital degrees of freedom. Among them, spinel ferrites $M\mathrm{Fe_2O_4}$ have attracting strong attention from both the scientific and technological point of view. In this thesis, we presented new insights into the electronic and magnetic states in spinel ferrites.

From the viewpoint of technological applications, the spin-filter structure using spinel ferrites are intensively studied as a promising spin injector to Si. However, the degradation of ferrimagnetic order at the interface between the spinel ferrites and other materials have prevented practical applications. In order to clarify the microscopic origin of the degradation of ferrimagnetic order, we have investigated magnetic and electronic states of epitaxial $CoFe_2O_4$(111) and $NiFe_2O_4$(111) thin films using x-ray absorption spectroscopy (XAS) and x-ray magnetic circular dichroism (XMCD).

In Chapter 3, we investigated the magnetocrystalline anisotropy (MCA) of $CoFe_2O_4$ thin films. From the magnetic-field-angle dependence of XMCD spectra, it was found that the MCA of $CoFe_2O_4$ is significantly reduced near the interface. This behavior was qualitatively explained by the change of cation distribution near the interface. We also pointed out that the small epitaxial strain induce a uniaxial MCA.

In Chapter 4, the as-grown and annealed $CoFe_2O_4(111)$ and $NiFe_2O_4(111)$ thin films were studied by XAS and XMCD. By analyzing the spectral line shapes, the valences and site occupancies of Fe ions were obtained. We observed that the Fe ions are redistributed by annealing, and the degraded ferrimagnetic order near the interface is successfully recovered. It was found that the microscopic origin of the degradation of ferrimagnetic order is vacant T_d sites which exist near the interface.

From a fundamental scientific viewpoint, the Verwey transition of Fe_3O_4 has also been studied. Accurate XMCD experiments have been performed using a newly developed 'vector-magnet' apparatus and a fast polarization-switching undulator beamline. We found that the orbital magnetic moment decreases upon cooling across the Verwey transition temperature T_V. We also found that there was almost no anisotropy of the orbital magnetic moment above and below T_V within experimental error below 0.01 μ_B/atom. The observed temperature dependence and the upper bound for the angle dependence of the orbital magnetic moments would put constraints on theoretical models for the studies of the Verwey transition.