Sturdy of Electronic States in 3d Transition-Metal Oxides by X-Ray Resonance Magnetic Scattering

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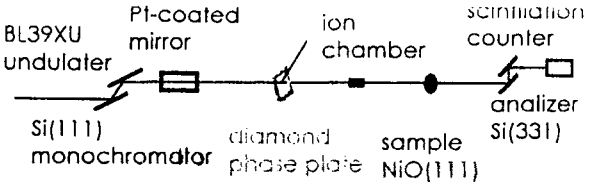
Transition-metal oxides NiO, CoO, and MnO are recognized recently as charge transfer type insulators. Magnetic features of vacant p-band of these materials have not been elucidated satisfactory. X-ray resonance magnetic scattering is a powerful method that provides spin resolved vacant states spectroscopic information. This is the first our application of this method to the antiferromagnetic NiO.

Experimental set-up is illustrated in the next figure.

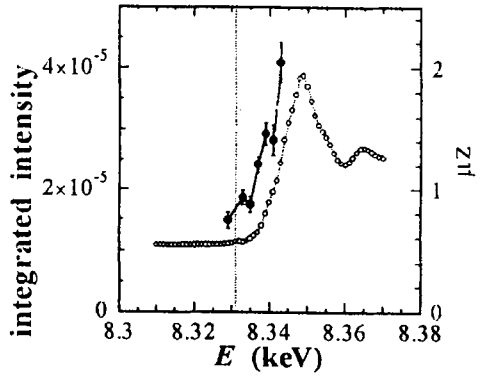


Undulater X-ray beam is monochromatized, then polarized by a diamond phase retarder to π or σ polarization. A total reflection mirror is used to suppress higher harmonics. A π or σ component of the scattered beam has been analyzed by Si (331) analyzer crystal.

A Sample is a slab-like (111) single T-domain crystal. Magnetic field has been applied at about 6 kOe parallel to the <110> and perpendicular to the scattering plane. Both parallel and perpendicular components of the magnetization can appear since the applied magnetic field is not so strong as to make single S-domain.

Rocking curves of a half integer order 5/2 5/2 5/2 reflection are measured on a $\pi-\pi$ polarization configuration at some energies near the K-absorption edge. Integrated intensity plots, corrected for the absorption, are shown in the next figure. An absorption spectrum is illustrated in the same figure to refer the energy.

We observe a strong intensity enhancement at the energy corresponding to the main edge of the absorption spectrum.



Hill et al., without magnetic field, have been performed similar measurements on an $\sigma-\sigma$ polarization configuration. They observed a sharp peak at the energy corresponding to the prepeak. They claimed this sharp peak is due to the quadrapole transition from 1s state to 3d state. However, they recognized no intensity enhancement at the main edge.

On a $\sigma-\sigma$ configuration, resonant and non-resonant intrinsic magnetic scattering due to the spin interaction and quadrapole X-ray resonance exchange scattering appear. On a $\pi-\pi$ configuration, dipole X-ray resonance exchange scattering appear besides the above three kinds of scattering.

The reason they can observe no intensity enhancement at the energy corresponding to the main edge is that the dipole resonant exchange scattering is prohibited and intrinsic magnetic scattering does not take place accidentally probably due to no parallel component appear in the X-ray spotting region. Our present conclusion is spin polarization in p-state is exist even in NiO.