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X-ray holography by detection of optical luminescence using ZnO epitaxial thin film

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Site selectivity of X-ray absorption fine structure (XAFS) was realized by detection of X-ray excited optical luminescence (XEOL). The idea of this XEOL XAFS was utilized for atom-resolved X-ray holography. In this study, changes of XEOL intensities for ZnO epitaxial thin film were measured with varying the sample orientation.

The measured sample was ZnO/MgO/c-Al_2O_3 epitaxial thin film. Thickness of ZnO layer was 520 nm. ZnO thin film emits strong luminescence at 373 nm under liq. N_2 cooling. We analyzed this emission by a grating, and detected it by a photon counter (H7155-20). The intensities were measured as a function of azimuthal angle ϕ and polar angle θ within the range of $0^\circ \leq \phi \leq 360^\circ$ and $0^\circ \leq \theta \leq 70^\circ$.(Fig. 1)

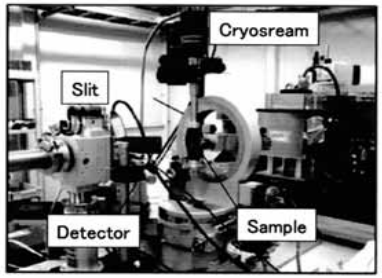

Fig.1 Experimental setup.

Figure 2 (a) shows the hologram by the XEOL. Since observed pattern is not clear, we averaged hologram pattern along k_y direction as shown in Fig. 2 (b). X-ray standing wave line (break line) markedly indicated (2 -1 -1 0) line of ZnO film.

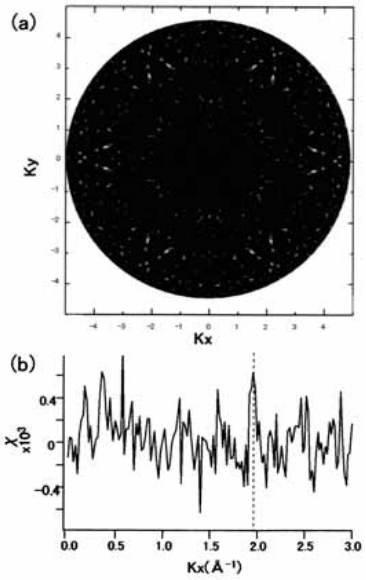

Fig.2 Hologram by XEOL

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Study of Ferro-antiFerro magnetism transition in $Ce(Fe_{0.8}Co_{0.2})_2$ by X-ray emission spectroscopy

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The compounds $CeFe_2$ with the C15 Laves phase ($MgCu_2$-type) structure is a ferromagnet with the Curie temperature T_c = 230 K in which a unique magnetic characteristic is observed. It loses ferromagnetism at lower temperatures by substituting a small amount of impurity for Fe. With the substitution of Al, Co and Ru for Fe, a ferromagnetic (F) state is replaced by an antiferromagnetic (AF) one below a temperature T_0 lower than T_c. In the case of $Ce(Fe_{1-x}Co_x)_2$, the AF ground state appears for $0.04 < x < 0.3$ and long-range AF order was confirmed by neutron diffraction. The cause of the behaviors of $Ce(Fe_{1-x}Co_x)_2$ is still unknown.

The objective of the present study is to obtain informations for the origin of the F-AF transition using x-ray emission spectroscopy (XES) together with magnetic circular dichroism (MCD).

The measurements of XES were performed at BL37XU for the sample temperatures of 30K(AF), 100K(F) and 300K(paramagnetic), using x-ray emission spectrometer designed by the present authors (Tohoku Univ. group).

The composition of the sample was $Ce(Fe_{0.8}Co_{0.2})_2$. The energy of incident x-ray was between 5700eV and 5750eV near the CeL_3 absorption edge. The magnetic field of the sample was kept to 2.0T.

The temperature dependence of the spectra was found to be very small. Typical spectra are shown in Fig.1 for the case at 30K. Clear difference has, however, observed only for the incident x-ray energy of 5713eV as shown in Fig.2, which suggests that the appreciable change of the density of states exists at the corresponding band.

The analyses in detail are in progress.

Figure 1

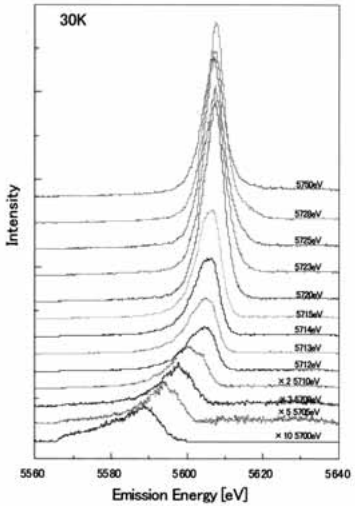

Figure 2