X-Ray Resonant Magnetic Scattering and Polarization Dependence

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On this beamline, a linear undulator was adopted as a light source, and a phase retarder assembly and a polarization analyzer assembly have been also installed for tunability and analysis of polarized X-rays. Horizontal linear polarization (π-polarization) are originally available, and vertical linear polarization (σ-polarization) can easily and efficiently alternate with the π polarization by the phase retarder operated as a $\lambda/2$ phase plate. In order to examine such an efficiency of this system, X-ray resonant magnetic scattering (XRMS) has been made; in particular, we paid attention to observation of difference between dichroic spectra under the π and σ polarizations.

Fe *K*-edge XRMS was made for the 200 Bragg reflection in pure Fe single crystal, shaped a disk of 6 mm in diameter and (100) oriented parallel to the surface. Dichroic effect is manifested by the flipping ratio defined as

$$R_a = (I^{\uparrow} - I^{\cdot})/(I^{\uparrow} + I^{\cdot}), \qquad (1)$$

where $I^{\uparrow}$ ($I^{\cdot}$) indicates the intensity for the magnetization parallel (antiparallel) to the cross products ($\boldsymbol{k}\times\boldsymbol{k}'$) of the wave vectors of the incident and scattered X-rays. The magnetic field of 2 kOe parallel to a [100] direction was reversed every 2 sec, and data accumulation was made 40 times at each energy point.

Figure 1 shows the R_a spectrum at the Fe *K*-edge using the horizontal (π) and vertical (σ) linearly polarized X-ray. The usual R_a spectrum, recorded by the π polarization, has a dispersion type profile near the edge, which is in good agreement with the early data taken at 2nd generation SR facility [1]. This spectrum is consistent with the X-ray magnetic circular dichroism (XMCD). On the other hand, the R_a spectrum under the σ polarization indicates no change of the sign in the higher energy side, which is different from the XMCD spectrum. This difference originates from the polarization dependence of dichroic term in XRMS [2,3], and that will give us the rigorous information on a distinction between the dipolar and quadrupolar transitions.

The present system demonstrates the efficiency for diffractometry with the polarization dependence. The vertical linear polarization is suitable for the present geometrical configuration. Linear polarization dependence will open out various applications.

References

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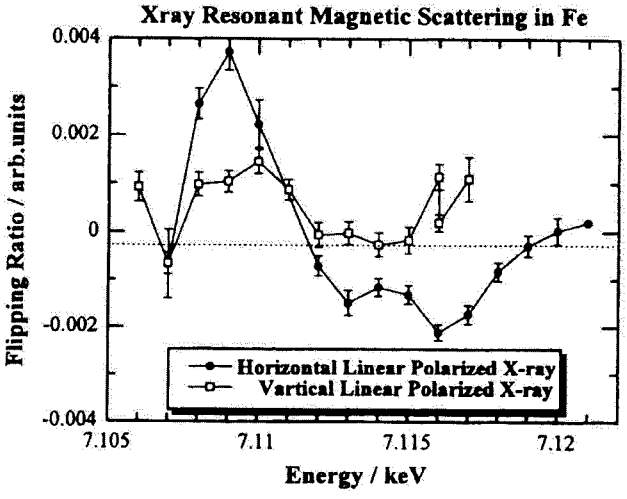

Fig.1. Flipping ratio spectrum at the Fe *K*-edge under the π and σ polarizations.