ATS Reflection of Magnetite (Fe_3O_4)

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Near absorption edge, anisotropy of the tensorial atomic scattering factor becomes so large that the reflections forbidden by screw and/or glide rule can be observed (ATS reflections).[1] Indeed, the ATS reflections have been observed in some crystals with linearly polarized synchrotron radiation.[2-5] ATS scattering is due to resonant effect and provides information about anisotropy of the local atomic environment. The anisotropy causes polarization anomaly, birefringence and dichroism (pleochroism) of crystals. X-ray magnetic scattering also causes these phenomena.

Magnetite (Fe_3O_4) has the inverse spinel structure. The 002 forbidden reflection of magnetite at room temperature was observed near the Fe K-absorption edge with linearly polarized radiation.[6] Its azimuthal dependence was well explained by the symmetric second-rank tensor, i.e. electric dipole transition. In this case, only the iron atoms at the octahedral B site contribute to the scattering.

In the present work, we investigated the property of the 002 reflection using circularly polarized incident X-rays. Circular polarization can be obtained by using a diamond phase plate equipped at BL39XU.

Figure 1 shows the energy spectra of the 002 reflection intensity near the Fe K edge with linearly and circularly polarized incident beams, where the spectra are normalized by the maximum intensity. The spectrum for circular polarization has two peaks just above and below the edge in accordance with that for linear one. Figure 2 shows the azimuthal dependence of the intensity for circular polarization at the energies of the two peaks. The observation is in good agreement with the calculation based on electric dipole transition.

We did not find the obvious difference for the 002 forbidden reflection of magnetite between linearly and circularly polarized incident radiations. For circular polarization as well as for linear one, the 002 forbidden reflection is well explained by the symmetric second-rank tensor of iron atoms at the B site. The influence of applied magnetic field on the reflection is the problem to be clarified.

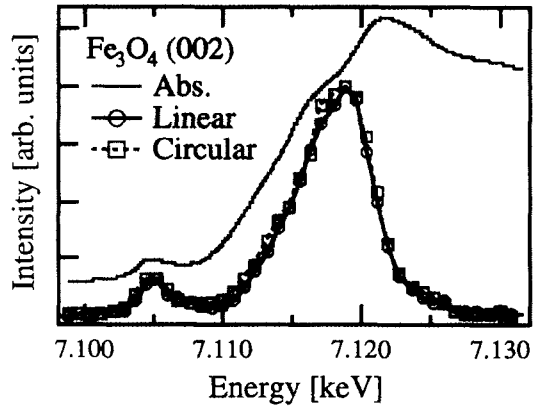

Fig. 1

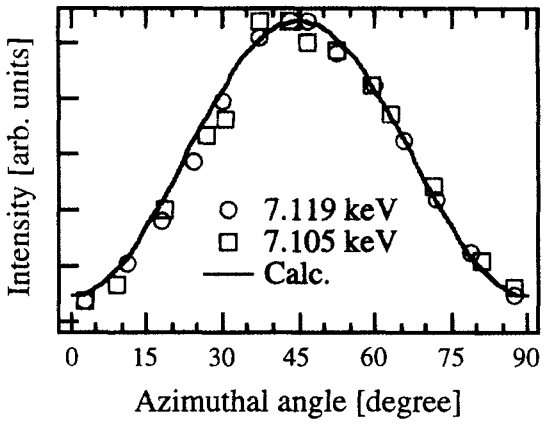

Fig. 2

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