

XMCD analysis of CoO by Diffraction Anomalous Fine Structure

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Introduction

Recently, the method called Diffraction Anomalous Fine Structure (DAFS) [1] was developed and applied in various fields. DAFS method is capable of resolving a site-specific local structure of materials, which would be averaged over all sites with XAFS method.

However, DAFS method which utilizes the polarization property of synchrotron radiation X-rays has not been developed yet. Therefore, we are aiming at developing a polarization DAFS in which polarization analysis and DAFS are combined and at applying to more detailed elucidation of the local structure.

Firstly, we performed site-specific MCD measurements of antiferromagnet (CoO, NiO) as a demonstration of polarization DAFS and measured spin arrangements in different net planes (for example Fig. 1)

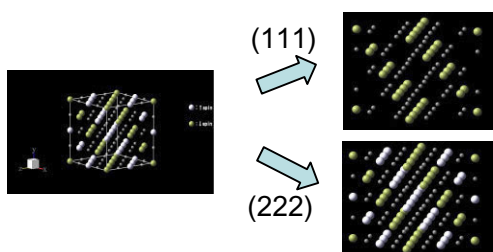


Fig. 1 Spin arrangement separated by (111) plane

Experimental

The experiments were carried out at BL 8C. The sample used was a CoO crystal. We chose the (511) and (100) net plane as the diffraction planes. Right- and Left-circularly polarized X-rays were generated by double-quadrant phase-retarder [2] and we measured the spectra of the (511) and (100) X-ray intensities diffracted by the sample. The X-ray energy was set in the vicinity of the absorption edge (Co=7.712 keV). We evaluated the difference in diffracted intensities for right and left circularly polarized X-rays.

Results and Discussion

As is shown in Fig. 2, we have observed 5 % difference in intensities diffracted by (511) plane for right and left circularly polarized X-rays. This result can be reasonably explained by the fact that (511) plane of CoO includes either up-spin alone or down-spin alone.

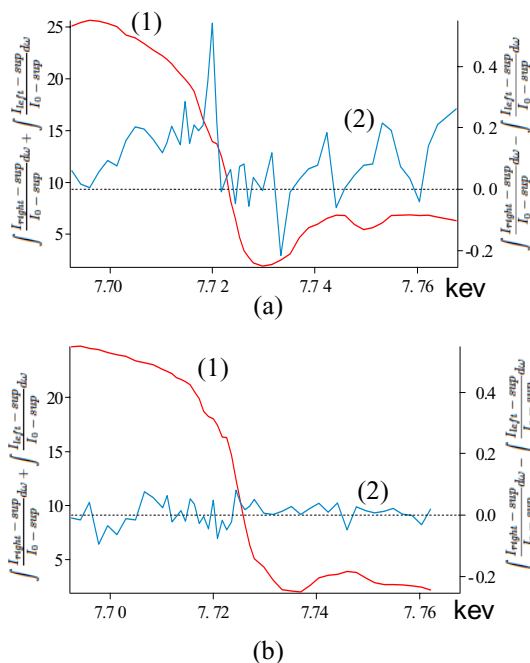


Fig. 2 (a) The sum (1) and the difference (2) of X-ray intensities diffracted by CoO (511) plane when right and left circularly polarized X-rays are incident. (b) The sum (1) and the difference (2) of X-ray intensities diffracted by CoO (100) plane when right and left circularly polarized X-rays are incident.

On the other hand, for (100) plane, no difference was observed for right and left circularly polarized X-rays. This result can also be reasonably explained by the fact that (100) plane includes both up-spin and down-spin equally. Therefore, we can conclude that we have successfully demonstrated the usefulness of polarization DAFS by detecting site-specific spin arrangements of CoO.

References

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- [2] K. Okitsu et. al, J. Synchrotron Rad. 8, 33 (2001).

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