Advances in SR diffraction techniques for magnetic and chiral materials

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X-rays interact with electron charge and spin through its oscillating electric and magnetic field, respectively. However, the amplitude of magnetic scattering relative to charge scattering is quite small. For investigation of magnetic structure, it is essential to discriminate magnetic scattering from charge scattering. The most distinct difference between the ordinary charge scattering (Thomson scattering) and magnetic scattering appears in the dependence on x-ray polarization. Therefore, polarization control and analysis techniques are quite important in x-ray magnetic diffraction experiments.

In this talk we present our recent works using circularly polarized x-rays. Right- and left-handed circular polarizations are not superposable on each other and being mirror images of one another. Using these chiral x-rays one can specify the handedness of helical magnetic structures. $MnWO_4$ and $DyMnO_3$ exhibit ferroelectricity induced by magnetic order. The origin of multiferroic behaviors was confirmed to be of the same type of $TbMnO_3$[1] by observing the correspondence of spin chirality to the direction of poling field [2]. Similarly, one can distinguish enantiomers using chiral x-rays. $CsCuCl_3$ has a chiral crystal structure and its handedness were readily identified using a screw axis ATS reflection (here ATS represents the anisotropy of the tensor of susceptibility)[3]. In addition, we developed a scanning x-ray microscope using the Kirkpatrick-Baez mirrors and visualized chirality domain distribution in this compound (see figure 1). This technique is applicable even though a specimen is opaque. Furthermore, control of the penetration depth enables us to analyze a depth profile of the chirality near crystal growth front[4]. Finally, a perspective of SR x-ray magnetic diffraction techniques is discussed from the point of view of x-ray polarization.

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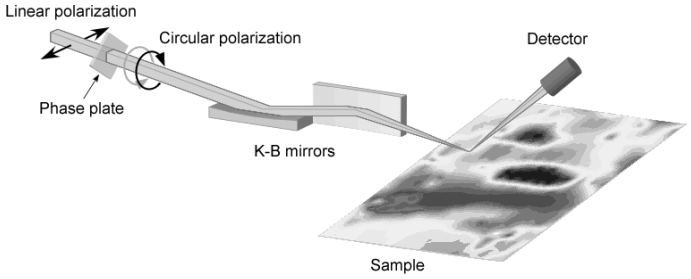

Figure 1. Scanning x-ray microscope. Linearly polarized x-rays are converted to circular polarization by the diamond phase plate and then are focused by the K-B mirrors.

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