Resonant X-ray Diffraction from Antiferro-toroidic Ordering in Hematite Fe_2O_3

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A toroidal moment is represented by a time-odd polar vector, which changes sign under both time inversion and space inversion. From symmetry point of view, the toroidal moment is related to the linear term of magneto-electric (ME) effect, and thus plays an important role for magnetic and electric coupling phenomena. A polar ferrimagnetic $GaFeO_3$ in which the toroidal moments are align cooperatively, so-called ferrotoroidic, has been investigated by the techniques of x-ray absorption spectroscopy (XAS) [1] and resonant x-ray diffraction (RXD) [2]. These studies have clarified that the x-ray absorption processes in the vicinity of Fe K edge depend on the direction and length of the toroidal moment.

We investigated the resonant x-ray anisotropic tensor diffraction from hematite Fe_2O_3. In the material, the toroidal moments are inversely-polarized because the Fe ions displace from the center-symmetric positions in the ligand cages and the spins couple antiferromagnetically. This technique can clarify the *antiferro-torroidic* ordering by measuring the azimuth angle dependence of RXD in the vicinity of Fe K edge.

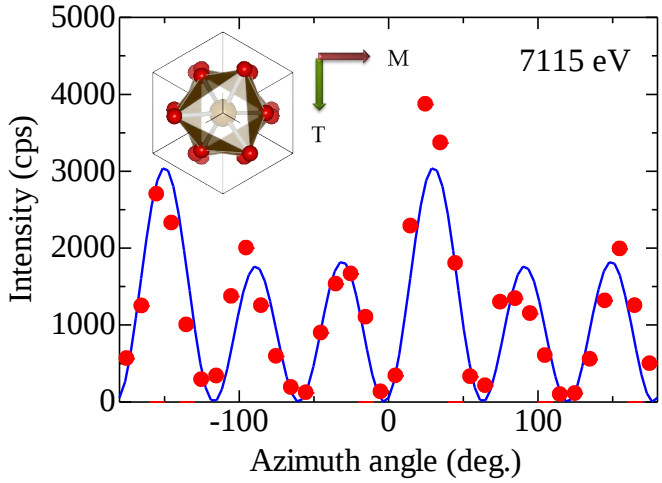

FIG 1. The azimuth angle dependence of 111 reflections at the resonant energy 7.115 kev in hematite Fe_2O_3. The solid line is the curve fitting result by taking into account the crystal structure, antiferromagnetic ordering and *antiferro-toroidic* ordering.

[1] M. Kubota *et al.*, PRL 92, 137401 (2004). [2] T. Arima *et al.*, JPSJ 74, 1419 (2005).