Neutron diffraction study on magnetic structure in CaCoV2O7

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Among transition metal oxides, cobalt oxides provide a unique playground for the correlated electrons because of unquenched orbital angular momentum. In most cobalt oxides, a coupling between residual orbital degrees of freedom (L = 1, effectively) and spin S =3/2 is present, leading to an effective total angular momentum Jeff = 1/2. The collective magnetism of Jeff = 1/2 of the cobalt oxides can be interesting, since anisotropy of magnetic interactions between Co ions can be tuned by a distortion of the octahedra [1]. From this viewpoint, we have explored magnetism of cobalt oxides and found a cobalt oxide CaCoV2O7 [2]. This compound consists of two CoO6 octahedra which are crystallographically inequivalent. The two octahedra share their edge and form a dimer of Jeff = 1/2. Our preliminary magnetization measurements revealed possible complicated successive magnetic transitions at TN1 = 4 K and TN2 = 3.2 K. As the magnetic structure of the ordered phases are totally unknown, we performed neutron diffraction study.

The experiment was performed at ECHIDNA high-resolution neutron powder diffractometer of Australian Nuclear Science and Technology Organisation. The Ge 311 reflections were used for the monochromator to select neutrons with the wavelength 2.44 Ang. The powder samples were set in the 4He cryostat with the base temperature being 1.6 K. Diffraction patterns at several temperatures were measured between 1.6 K and 4.5 K to elucidate evolution of the magnetic structures in this temperature range.

As an representative result, Fig. 1 shows the neutron powder diffraction patterns measured at T = 1.6 K and 4.5 K. There are quite a few Nuclear Bragg reflections observed in the whole 2-theta range. Preliminary structural analysis confirms good quality of the sample used in the neutron diffraction study. At the base temperature T = 1.6 K, we can clearly see the development of the new peaks at low 2-theta region, indicating magnetic reflections appear below the magnetic ordering temperature. We are presently working on the analysis of the magnetic diffraction pattern using the representation analysis.

[1] M. E. Lines, Phys. Rev., 131, 546 (1963).
[2] E. V. Murashova et al., Zh. Neorg. Khim., 38, 1446 (1993).

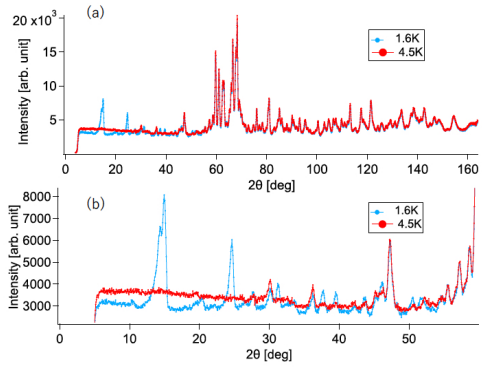

Fig. 1. (a) Neutron powder diffraction patterns measured at T = 4.5 K and 1.6 K using ECHIDNA high-resolution diffractometer at ANSTO. (b) Magnified plot for the lower 2-theta region.