Magnetic Structure Analysis in CuB2O4

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Helical magnet copper metaborate CuB2O4 has been paid much attention because its strange behavior of magnetization can be interpreted by lattice chiral XY model; magnetic properties are understood by a formation of magnetic soliton lattice [1]. It shows various magnetic phase transitions at low temperature: paramagnetic state above TN (= 20 K), commensurate phase with weak ferromagnetic ordering in the range of T* (= 10 K) < T < TN and incommensurate phase with helical magnetic ordering below T*. In the weak ferromagnetic phase, magnetic structure analysis with 4 circle diffractometer shows the commensurate structure with the propagation vector k0 = (0,0,0) [2]. However, the determined structure is inconsistent with NMR data [3] because of a few number of reflections with long incident wavelength of 2.36A. In order to argue the magnetic structure of incommensurate phase, it is important to determine magnetic structure of commensurate phase, because the lattice chiral XY model indicates that the strucure of the incommensurate phase reflects that of the commensurate phase.

Last year, we performed the neutron diffraction experiment at 4 circle diffractometer FONDER (T2-2), JRR-3M reactor in JAEA (Tokai) with short incident wavelength of 1.24A. However, we did not observe any magnetic scattering because of a small size of the sample, several magnetic domains under zero field and a small magnetic moment of Cu.

Therefore, in order to re-perform the experiments, we improved 2 points; 4 times larger size of the sample and field cooled measurement of 800 Oe along the <1,-1,0> by sandwiching permanent magnets, which were enough to saturate the spontaneous magnetic moment.

The single crystal, of which size was 5 x 4 x 7 [mm3], was grown by the spontaneous crystallization technique; slow cooling of CuO, Li2CO3 and B2O3, using enriched 11B2O3 to avoid the large neutron absorption due to 10B. The measurements were performed at 10 K and 30 K. Subtracting the intensities of 30 K from that of 10 K, we determined magnetic scattering intensities. We observed clear difference of scattering intensities between 10 K and 30 K. As shown in Fig.1, comparing (1,1,0) and (1,-1,0), magnetic scattering is observable only in (1,-1,0), which indicates that the magnetic domain of (h,h,0) reflection was well suppressed by the applied magnetic field. Now we are analyzing the magnetic structure with observed 40 reflections.

References

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[3] M. Chiba et al.: Proceedings of NATO Advanced Research Workshop, "Smart Materials for Ranging Systems" (2004) 1.

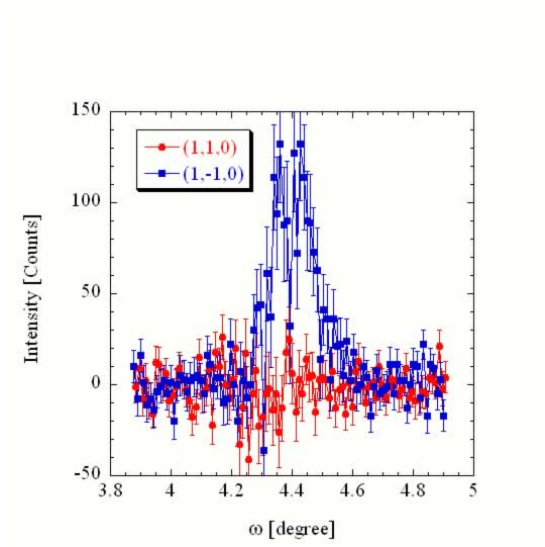

Fig. 1. Magnetic scattering in (1,1,0) and (1,-1,0)