Uniaxial pressure induced magnetic phase of $CuFe_{1-x}Ga_xO_2$ $(x = 0.018)$

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A triangular lattice antiferromagnet $CuFeO_2$ is known as a spin-lattice coupled system, in which magnetic phase transitions are often accompanied by discontinuous changes in lattice constants[1]. This implies the possibility that the magnetic phase transitions can be controlled by an application of pressure, which might result in 'artificial' changes in lattice constants. In previous study, we have performed neutron diffraction measurements on $CuFe_{1-x}Ga_xO_2$ (CFGO) with $x = 0.018$ under applied uniaxial pressure[2]. As a result, we found that, at $T = 2.5$ K, two small peaks assigned as $(q, q, \frac{3}{2})$ and $(\frac{1}{2} - q, \frac{1}{2} - q, \frac{3}{2})$ with $q \sim 0.205$ coexists with a large peak at $(\frac{1}{4}, \frac{1}{4}, \frac{3}{2})$ corresponding to the 4-sublattice (4SL) magnetic ordering, which is the magnetic ground state of this system (see Fig. 1(b)). Temperature dependence of these incommensurate reflections implies that a small fraction of screw-type magnetic ordering, which originally shows up only in the temperature range of 7 K $< T <$ 9 K under zero pressure, was retained by the application of the pressure, down to 2.5 K[2]. In the present study, we have performed magnetic structure analysis for the small incommensurate magnetic reflections.

A single crystal $CuFe_{1-x}Ga_xO_2$ with $x = 0.018$ was cut into thin plate with dimensions of $\sim 3{\times}3{\times}1$ mm^3. We developed a uniaxial pressure cell along the pioneering work by Aso *et al.*[3]. Uniaxial pressure of 60 MPa was applied on the widest surface normal to the $[1\bar{1}0]$ direction, as shown in Fig. 1(a), at room temperature. The neutron diffraction measurements were performed using the four-circle neutron diffractometer FONDER installed at JRR-3 in JAEA. The incident neutron beam with wavelength 1.240 Å was obtained by a Ge(311) monochromator. The sample in the pressure cell was mounted on a closed-cycle He-gas refrigerator.

In Fig. 1(c), we show *hkl*-dependence of the spin orientation factor (SOF) defined as $|F_{hkl}|^2/f(q)^2$, where F_{hkl} and $f(q)$ are magnetic structure factor and Fe^{3+} magnetic form factor, respectively. Comparisons between the calculated and the observed SOFs show that the magnetic structure corresponding to the small incommensurate magnetic reflections is a screw-type structure, confirming that the intermediate phase is retained by the application of the pressure, down to low temperatures. The present result also suggests that the 'ellipticity' of the screw-type magnetic structure is affected by the application of the uniaxial pressure. In order to elucidate more details of the magnetic orderings in this system under applied pressure, further investigation is required.

References

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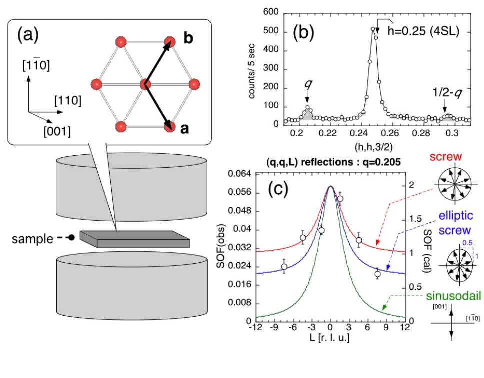

Fig. 1. (a) Schematic drawing of the experimental configuration. (b) Diffraction profile of $(h, h, \frac{3}{2})$ reciprocal lattice scan at 2.5 K. (c) The *hkl*-dependence of the observed SOFs.