Effect of uniaxial stress on magnetic phase transitions in a frustrated magnet $CuFe_{1-x}Ga_xO_2$ $(x = 0.018)$

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A triangular lattice antiferromagnet $CuFeO_2$ is a spin-lattice coupled system, in which the magnetic orderings are accompanied with the lattice distortions to lift the degeneracy in the frustrated exchange interactions[1]. In previous study, we have reported uniaxial-stress control of the volume fraction of magnetic domains in this system[2]. In addition, we also found a faint indication that the ferroelectric incommensurate magnetic (FE-ICM) state is induced in the four-sublattice (4SL) ground state of $CuFe_{1-x}Ga_xO_2$ (CFGO) with $x = 0.018$, by application of uniaxial stress.

In present study, we have performed neutron diffraction measurements on single-crystal CFGO with x = 0.018, to investigate the uniaxial stress dependence of the magnetic phase transitions in detail. We used triple-axis spectrometers HQR(T1-1) and GPTAS(4G) installed at JRR-3 in JAEA. We used a single crystal sample of CFGO with dimensions of $\sim 5 \times 3 \times 1$ mm^3. CFGO$(x = 0.018)$ exhibits three magnetic phases on cooling under zero uniaxial stress, as shown in Fig.1(b). Below 14 K, the system exhibits the partially disordered (PD) phase. In the temperature range of 7 K $< T <$ 9 K, the FE-ICM phase shows up as an intermediate phase. The ground state of this system is the 4SL phase.

We have found that under applied uniaxial stress of 150 MPa, the FE-ICM phase remains down to 2K and coexists with the 4SL phase, as shown in Fig.1(b) as well as in the diffraction profiles in Fig.1(a), where two magnetic peaks corresponding to the FE-ICM ordering are observed at $(q, q, \frac{3}{2})$ and $(\frac{1}{2} - q, \frac{1}{2} - q, \frac{3}{2})$ where $q = 0.205$, and coexist with a strong magnetic peak corresponding to the 4SL magnetic order at $(\frac{1}{4}, \frac{1}{4}, \frac{3}{2})$. The volume fraction of the FE-ICM ordering against that of the 4SL magnetic ordering is estimated to be 8% for uniaxial stress of 150 MPa, as shown in the inset of Fig.1(b). We have also found that the transition temperature from the paramagnetic phase to the PD phase increases with applied stress, as is seen in Fig.1(b).

References

[1] N. Terada *et al.*: PRB **75** 224411(2007).

[2] K. Yoshitomi *et al.*: ISSP-NSL report #1327.

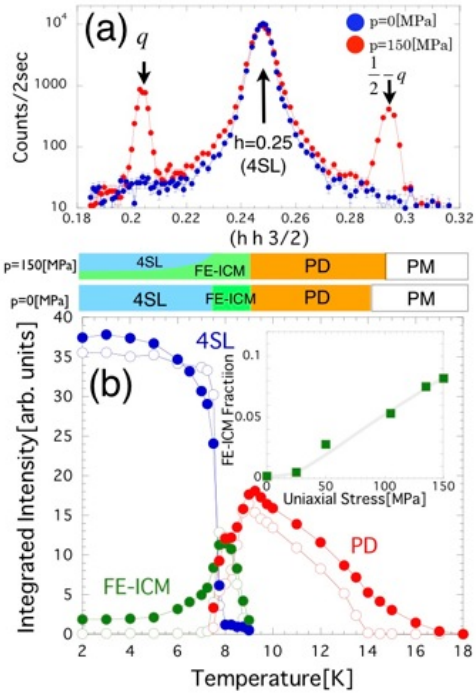

Fig. 1. (a) Diffraction profiles of at 2 K. (b) Temperature dependences of integrated intensity of magnetic Bragg reflections(open and closed circles represent 0 and 150 MPa data); Inset shows uniaxial-stress dependence of FE-ICM volume fraction.