Uniaxial pressure induced 'single-domain' magnetic ground state in triangular lattice antiferromagnet $CuFeO_2$

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Geometrically frustrated magnet $CuFeO_2$ (CFO) exhibits 'spin-driven' lattice distortion in a collinear four-sublattice (4SL) magnetic ground state [1]. While the crystal structure of CFO is a trigonal structure in the paramagnetic phase, it becames a monoclinic structure in the 4SL phase. Owing to the trigonal symmetry of the original crystal structure, CFO has three types of monoclinic domains in the 4SL phase. Previous x-ray diffraction study have revealed that with decreasing temperature, the monoclinic a axis contracts, and on the contrary, the b axis elongates in each monoclinic domain [1]. In addition, the c-plane projections of the magnetic modulation wave vectors is confined to be parallel to the monoclinic b axis. Therefore, we have anticipated that uniaxial pressure applied perpendicular to the c axis favors the crystal/magnetic domains whose a axis lies along the pressure, and suppress those whose b axis lies along the pressure. To confirm this scenario, we have performed four-circle neutron diffraction measurement on CFO under applied uniaxial pressure.

We used four-circle neutron diffractometer FONDER installed in JRR-3. The incident neutron beam with wavelength of 1.24 Å was obtained by Ge(311) monochromator. We cut a single crystal of CFO grown by floating zone technique into thin plate shape ($\sim 6 \times 10 \times 2\mathrm{mm}^3$) with the widest surface normal to the $[1\bar{1}0]$ direction, on which we applied uniaxial pressure of 10 MPa so as to maximize the volume fraction of the magnetic domains having the Q-vector of $(\frac{1}{4}, \frac{1}{4}, \frac{3}{2})$. The sample was mounted in a pressure cell developed by Aso *et al.*[2], and was cooled in a closed-cycle He-gas refrigerator down to 2.5 K.

We have measured intensities of 32 magnetic Bragg reflections. We have performed least-square fitting analysis, in which we used the established magnetic structural parameters of the 4SL phase presented in ref. [3], and have refined the volume fractions of the three domains. As a result, we have found that the volume fractions of the magnetic domain having the wave vector of $(\frac{1}{4}, \frac{1}{4}, \frac{3}{2})$ is $\sim$ 97%, indicating that only 10 MPa of the uniaxial pressure results in almost 'single-domain' 4SL state [4].

References

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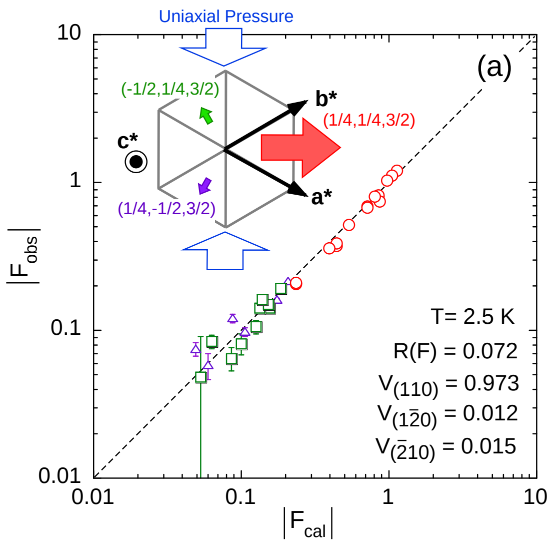

Fig. 1. Comparison between the observed and calculated magnetic structure factors. (Inset) Directions of the Q-vectors and applied uniaxial pressure.