Uniaxial-stress control of magnetic phase transitions in CuFeO2

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In frustrated magnets, magnetic ordering is often accompanied by spontaneous lattice distortion which partially remove the spin degeneracy, and as a result, the spin-lattice coupled exotic ordered states are realized. The magnetic oxide CuFeO2 to be investigated here is a triangular lattice antiferromagnet providing very rich H-T magnetic phase diagram including multiferroic phase. As was revealed in recent Xray diffraction measurement, CuFeO2 is also a spin-lattice coupled system; to partially remove the spin degeneracy due to geometrical spin frustration, the triangular lattice spontaneously distorts so that the triangular lattice elongates in the direction of the in-plan propagation wave vector (q q 0) and contracts in the perpendicular direction. Therefore, if the lattice distortion was regulated by [1-10] uniaxial stress p which is conjugate to the anisotropic spontaneous lattice distortion, the magnetic phase transition can be controlled. Actually, in this context we have demonstrated uniaxial stress control of magnetic phase transitions in this system up to 100 MPa in our previous work [T. Nakajima et al. J. Phys. Soc. Jpn. 81(2012)094710].

In present study, extending the application of p up to 600 MPa, we performed neutron diffraction study by using the two-axis diffractometer E4 at Helmholtz-Zentrum Berlin in order to investigate how [1-10] uniaxial stress p modifies the propagation wave number q at the magnetic phase transition temperature from PM to PD phase (TN1). As is clearly seen in Figure, whileTN1 shows drastic increment of ˜5K at p=600 MPa, the wave number q0 at TN1 remain unchanged. Since we confirmed, in X-ray diffraction experiment under uniaxial stress, that anisotropic lattice deformation generated by application of [1-10] uniaxial stress p of 600MPa in PM phase is comparable to the spontaneous lattice distortion in 4SL phase, present result suggests at least that ratios of competing exchange coupling constants at TN1 are not modified even under the anisotropic lattice deformation, implying the spin-lattice coupling is not simply due to magneto-elastic exchange.

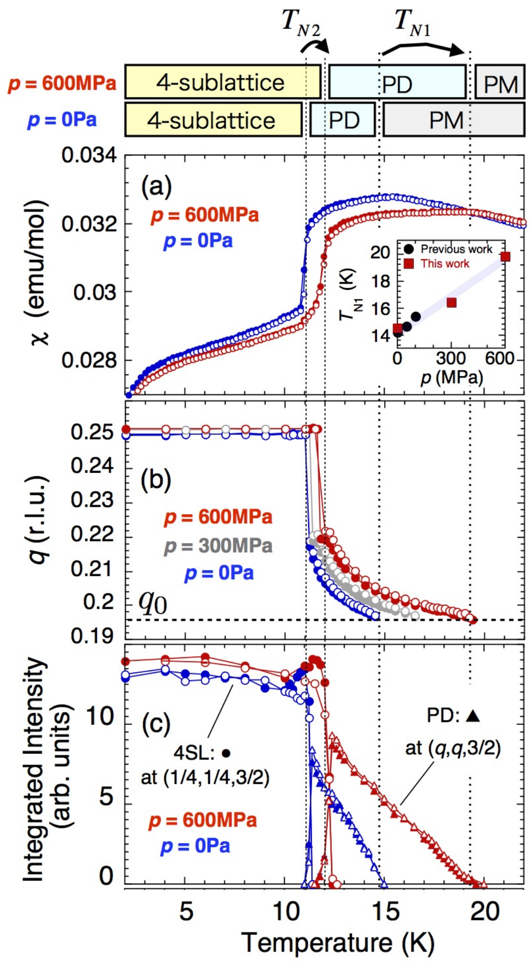

Fig. 1. Temperature dependence of (a) magnetic susceptibility, (b) magnetic propagation wave number and (c) integrated intensities, at various p.