Magnetic phase diagram of the square lattice CuSb2-xTaxO6 with competing interactions J1 and J2

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Low-dimensional magnetism of Heisenberg antiferromagnets (HAF) has been a focus of intensive research since discover of high Tc copper oxides. CuSb2O6 compound has a tri-rutile type structure in which Cu2+ ions form a square lattice similar to La2CuO4 [1]. The magnetic susceptibility of CuSb2O6 indicates a typical behavior for S=1/2 one-dimensional HAF above 20K and shows a antiferromagnetic long-range order at 8.7 K in which Cu spins are aligned ferromagnetically along b-axis (namely collinear order) with a propagation vector (1/2, 0, 1/2) [2, 3]. If nearest neighbor coupling J1 is too stronger than next nearest coupling J2 along diagonal, Neel order will be stabilized. Then J2 interaction through Cu-O-O-Cu bond is dominant on the collinear order of CuSb2O6.
The substitution of Ta atom instead of Sb atom causes the decreasing of transition temperature of long-range order which disappears above x=1 [4]. TaO6 octahedron occupies inter CuO layers and the inter layer coupling may be decreased with the substitution of Ta atom; x. When J2 coupling is HAF, there are the spin frustrations between J1 and J2 couplings even if J1 coupling is ferromagnetic or antiferromagnetic [5].
Neutron diffraction measurements of CuSb2-xTaxO6 powder samples with x=0.3, 0.7 and 0.8 were carried out on the neutron powder diffractometer HERMES (T13) installed at the JRR-3M reactor at JAEA. Magnetic Bragg peaks were observed at (1/2, 0, 1/2), (1/2, 0, 3/2) and (3/2, 0, 3/2). Temperature dependences of Bragg peak for three kinds of samples were carried out on the neutron triple axis spectrometer HQR (T11) installed at the JRR-3M in JAEA. The transition temperature of antiferromagnetic long-range order were determined as 8.0K for x=0.0, 3.5K for x=0.7 and 3.8K for x=0.8. These data were plot in the figure 1 with the data of magnetic susceptibilities and heat capacities. In comparison of the experimental results of x=0.7 and 0.8 samples magnetic Bragg intensity of x=0.8 becomes extremely weaker than that of x=0.7 in spite of nearly same Tn. Then it is expected that above x=0.8 new magnetic phase will be appear.

References
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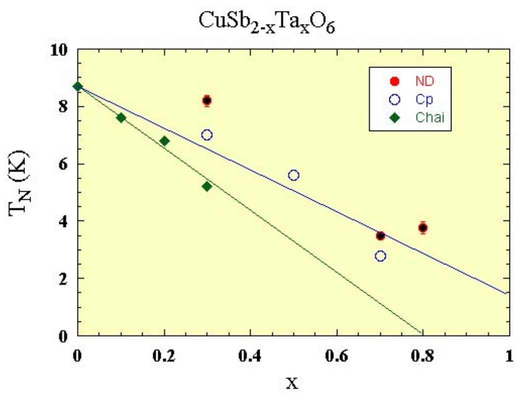

Fig. 1. Magnetic phase diagram of CuSb2-xTaxO6 obtained by neutron diffraction, heat capacity and magnetic susceptibility. The antiferromagnetic transition temperature decreases with increasing of substitution of Ta atom.