Magnetic Structure in the Shastry-Sutherland Lattice Tb1-xYxB4

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Rare-earth tetraborides RB4 have a tetragonal crystal structure with a space group P4/mbm which is characterized by the 2-dimensional orthogonal dimers in the c-plane. Such dimer systems are equivalent to the Shastry-Sutherland lattice (SSL) where nearest-neighboring dimers have geometrical frustration.

TbB4 has successive antiferromagnetic transitions at TN1 = 44 K and TN2 = 24 K. The magnetization curve of TbB4 at 1.3K shows at least nine magnetization jumps above 16T for B//c and it is remarkable concerning the origin. In order to approach the mechanism of multi-step magnetization, we studied Y-substitution effect on TbB4 for magnetic susceptibility, magnetoresistance and specific heat. From these macroscopic measurements the characteristic temperature TN2 was found to be smeared out around x=0.2.

In order to clarify whether such lower temperature phase below TN2 truly disappears at x=0.2 or not, we have measured the powder neutron diffraction for x=0.10 and 0.25. The isotope boron 11 enriched up to 99.75% was used for sample preparation and these samples were crushed to powder. The neutron powder diffraction experiment was performed by using HERMES. Measured temperature region were from 3 to 50 K. For x=0.1 this alloy shows successive antiferromagnetic phase transition at TN1 = 40 K and TN2 = 20 K. Below TN1, magnetic peaks at (100), (210) and (111) gradually grow with decreasing temperature. Furthermore these magnetic peaks grow again below TN2 = 20 K. On the other hand, magnetic peaks for x=0.25 gradually grow below TN1 = 35 K and these intensities saturate at 20 K. From these measurement, we could not find another phase transition correspondent to TN2 for x=0.25.

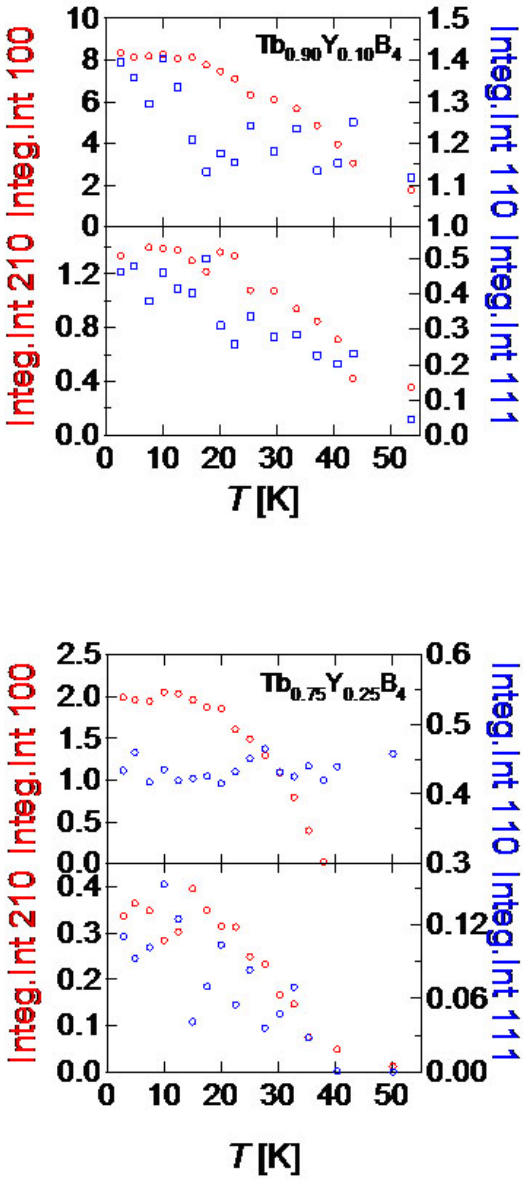

Fig. 1. Temperature dependences of some magnetic peaks at (110), (111) and (210) in x=0.10 and 0.25.