A puzzling magnetic phase in HoCu2Si2

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The ternary compound HoCu2Si2, having the tetragonal ThCr2Si2-type crystal structure (space group: I4/mmm), orders antiferromagnetically below TN=6.0 K [1]. An additional magnetic transition has been recently observed at Tt=5.1 K from measurements of magnetic susceptibility and specific heat [2]. The antiferromagnetic structure, reported from powder neutron diffraction study [3], is characterized by the wave vector k= (1/2, 0, 1/2), having Ho moments parallel to the [100] direction. The magnetic structure for Tt<T<TN has been, however, unknown yet.

In order to investigate the magnetic structure for the intermediate temperature region Tt<T<TN, neutron diffraction studies have been performed on a HoCu2Si2 single crystal using a double-axis mode of the triple axis spectrometer HQR installed at JAERI, Tokai, Japan. The a-axis of the single crystal was vertically oriented to obtain the distribution of neutron intensities in the a*-c* reciprocal plane.

The single crystal has been grown by the tri-arc Czochralski method. The single phase nature has been confirmed by X-ray powder diffraction

At low temperatures below Tt, an appearance of antiferromagnetic reflections associated with the propagation vector k1=(1/2, 0, 1/2) has been confirmed. These reflections disappear above Tt. In intermediate temperature region Tt<T<TN, new antiferromagnetic reflections appear around (1/2 0 1/2), indexed by (1/2+d1, 0, 1/2+d2) and (1/2-d1, 0, 1/2-d2) (d1=0.030, d2=0.033). They are associated with the propagation vector k2=(0.530, 0 , 0.533). No higher order harmonics are observed, suggesting that this magnetic structure is not an anti-phase one but amplitude modulated one. The temperature dependence of peak intensity for antiferromagnetic reflections is shown in Fig. 1. The (1/2 0 1/2) intensity rapidly decreases around Tt with increasing temperature. On the other hand, the (0.530 0 0.533) intensity develops around Tt and disappears above TN. Thermal hysteresis is observed around Tt, indicating the transition at Tt is of the first order. An analysis for magnetic structure of the intermediate temperature is now in progress.

References

[1] D. Gignoux and D. Schmitt, Handbook of Magnetic Materials, 1997, 239
[2] T. Shigeoka et. al., AIP conference proceedings (2006)1257
[3] J. Leciejewicz et. al., J. Magn. Magn. Mat. 53(1986)309.

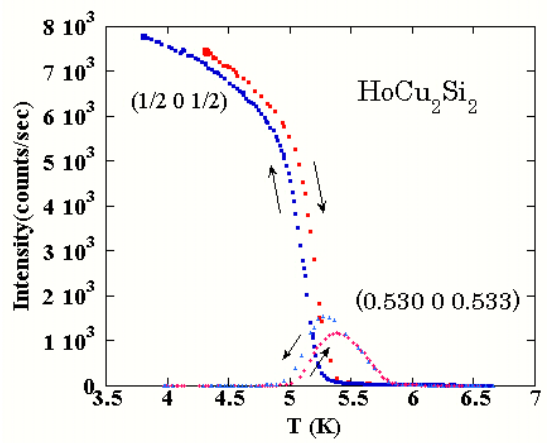

Fig. 1. Temperature dependence of antiferromagnetic reflections in HoCu2Si2