Magnetic structure of the rare-earth honeycomb compound $TbPt_6Al_3$

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Unconventional magnetic orders and novel quantum states in honeycomb lattice compounds have much interest in recent years [1,2]. The magnetic ordered states have been explored mostly for insulators and semiconductors. Among rare-earth intermetallics, only two series of compounds have a perfect honeycomb lattice to best of our knowledge [3,4]. The first series is RNi_3X_9 (R = Gd-Yb, X = Al and Ga) crystallizing in the trigonal structure with the noncentrosymmetric point group $R32$ [3]. The magnetic structures of the RNi_3X_9 series have been investigated by neutron and resonant X-ray diffraction experiments.

The second series is RPt_6Al_3 (R = Ce, Pr, Nd, Sm, Gd, and Tb) crystallizing in the trigonal structure with centrosymmetric space group $R\bar{3}c$ [4]. Our previous work with single-crystalline samples reported that $SmPt_6Al_3$ and $GdPt_6Al_3$ order into a collinear antiferromagnetic (AFM) and canted AFM magnetic structure, respectively [5,6]. However, the large absorption cross-sections of Sm and Gd nuclei for thermal neutrons make it difficult to determine the magnetic structures.

In order to gain insight into the magnetic structures of the RPt_6Al_3 series, we carried out a neutron powder diffraction experiment of $TbPt_6Al_3$. In a previous study with a polycrystalline sample of $TbPt_6Al_3$, an AFM order was observed at T_N = 3.6 K [4].

The neutron powder diffraction experiments were performed using the resolution powder diffractometer, HERMES, of the Institute for Materials Research, Tohoku University, installed at the JRR-3 reactor in Japan Atomic Energy Agency, Tokai. The polycrystalline samples of $TbPt_6Al_3$ were prepared by arc melting with subsequent annealing at 1100°C for 10 days. The powdered sample was introduced in the cylindrical vanadium sample holder with He-exchange gas, which was set in a 1 K refrigerator. The diffraction measurements were carried out in zero field between 0.7 and 6 K.

Figure 1 shows the powder neutron diffraction patterns of $TbPt_6Al_3$ at 0.7 and 6 K. The refinement of the crystal structure at 6 K yielded the trigonal lattice parameters a = 7.5053(4) Å and c = 38.801(2) Å, which values are in good agreement with the reported ones [4]. At 0.7 K < T_N, the peaks marked by the arrows are significantly enhanced compared with those at 6 K, which can be indexed with a propagation vector **k** = [0, 0, 0]. Further analysis of the magnetic structure for $TbPt_6Al_3$ is in progress.

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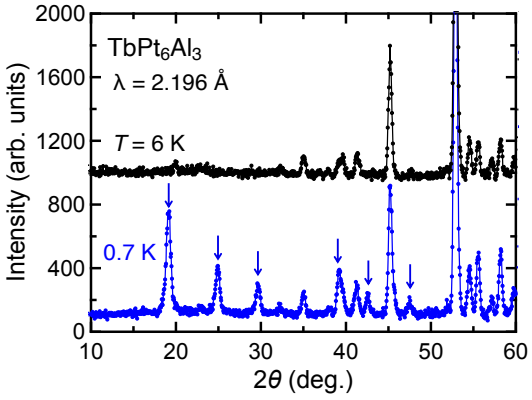

Fig. 1. Neutron powder diffraction patterns of $TbPt_6Al_3$ at 6 and 0.7 K collected at the HERMES. The down arrows show the magnetic Bragg peaks.