P2-15

Properties of new filled skutterudite $TbFe_4P_{12}$ prepared at high pressure

K. Takeda[1], J. Hayashi[1], R. Nakada[1], K. Kihou[1], C. Sekine[1], I. Shirotani[1], Y. Ohishi[2], T. Yagi[3]

[1]Muroran Institute of Technology, Mizumoto, Muroran 050-8585

[2]Japan Synchrotron Radiation Research Institute, Mikazuki, Sayo-gun 679-5198

[3]Institute for Solid State Physics, University of Tokyo, Kashiwa 277-8581

Ternary metal pnictides LnT_4X_{12} (Ln = lanthanide, actinide; T = transition metal; X = pnicogen) crystallize with a filled skutterudite-type structure. This structure is cubic, space group $Im\bar{3}$, Z = 2. The skutterudite compounds show interesting electrical and magnetic properties at low temperatures. We have studied electrical and magnetic properties of new filled skutterudite $TbFe_4P_{12}$ prepared at high pressure. Powder x-ray diffraction patterns of $TbFe_4P_{12}$ with synchrotron radiation have been measured at ambient pressure and high pressures.

The skutterudite compounds were prepared by reaction of each metal and red phosphorus or powders at high pressure and high temperature. Using synchrotron radiation, powder x-ray diffraction patterns of these compounds were measured with a diamond-anvil cell and an imaging plate at high pressures. A 4:1 methanol-ethanol solution was used as pressure medium. Four-lead electrical resistance measurements were performed at low temperatures. The dc magnetic susceptibility was measured in the range of 1.8 - 300 K.

The crystal structure of $TbFe_4P_{12}$ was refined by the Rietveld analysis of powder x-ray diffraction data at ambient pressure. Figure 1 shows the observed x-ray diffraction pattern, the calculated profile and these differences for $TbFe_4P_{12}$. The structure of $TbFe_4P_{12}$ is refined to R_{wp} = 4.0 %. The positional parameters, bond distances and bond angles are obtained. Powder x-ray diffraction patterns of $TbFe_4P_{12}$ were measured with synchrotron radiation at high pressures. The volume vs. pressure curve is fitted by the Birch equation of state. Bulk modulus and its pressure derivative of this phosphide are 129(3) GPa and 10(1), respectively. The electrical and magnetic properties of $TbFe_4P_{12}$ have been investigated at low temperatures. An effective magnetic moment of $TbFe_4P_{12}$ was estimated to be 9.48 μ_B. $TbFe_4P_{12}$ showed the ferromagnetic transition at around 10 K.

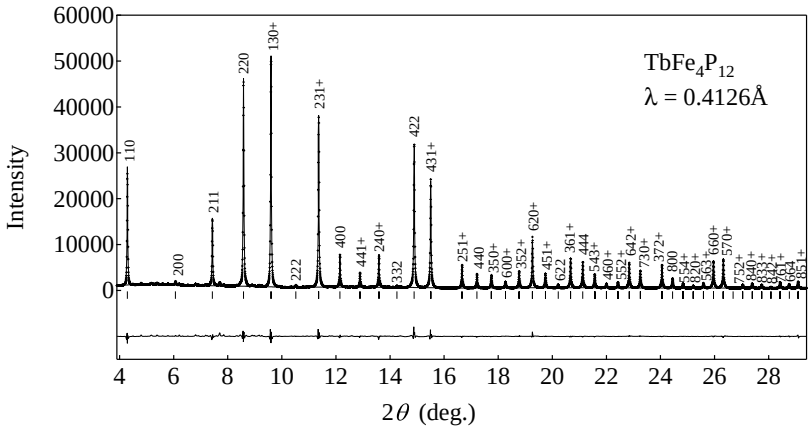

Figure 1 Observed x-ray diffraction pattern, calculated profile and these differences for $TbFe_4P_{12}$.