Neutron diffraction study of PrFe4P2 under high pressure

K. Kuwahara(1), T. Osakabe(2), D. Kawana(1), K. Iwasa(3), M, Kohgi(1), D. Kikuchi(1), H. Sugawara(4), Y. Aoki(1), H. Sato(1)

(1) Department of Physics, Tokyo Metropolitan University, Tokyo 192-0397, (2) Neutron Materials Research Center, Japan Atomic Energy Agency, Ibaraki 319-1195, (3) Department of Physics, Tohoku University, Sendai 980-8578, (4) Faculty of Integrated Arts and Sciences, Tokushima University, Tokushima 770-8592

PrFe4P12 undergoes the non-magnetic phase transition at TA = 6.5 K under ambient pressure. By applying pressure, the non-magnetic ordered phase disappears and the insulating phase appears around Pc = ˜ 2.4 GPa (Hidaka et al.: Phys.Rev.B 71(2005)073102, J.Phys.Soc.Jpn. 75(2006)094709). In order to get the microscopic information about the order parameter in this pressure-induced insulating phase, we have performed high-pressure neutron diffraction measurements on PrFe4P12 single crystals up to 3.8 GPa at low temperatures under magnetic fields using the triple-axis spectrometer TOPAN at JRR-3M in JAEA and a new hybrid-type pressure cell which is composed of a large sapphire anvil and a tungsten carbide anvil (Osakabe et al., International Conference on Magnetism, Kyoto, Japan, 2006 [PHYSICA B, in press]). The pressure cell was set inside a superconducting magnet with the [0,0,1]-axis vertical to the (h,k,0) scattering plane.

We have observed the distinct magnetic Bragg peak with a wave vector q =(1,0,0) in the insulating phase above Pc. Figure 1 (a) shows the profile of the theta-two theta scan around (1,0,0) under 3.8 GPa. The superlattice peak at lowest temperature 1.6 K corresponds to an antiferromagnetic long-range order characterized by q = (1,0,0) with the large magnetic moments of about 2 mB/Pr along the [0,0,1] direction. The result indicates that the 4f electronic states of Pr ions under the cubic crystal field are magnetically degenerate in low energy region. By measurements of the temperature and magnetic field dependences of the antiferromagnetic peak, as shown in Fig. 1 (b), furthermore, we found slight but distinct anomalies below about 4 K in the insulating phase, suggesting some change of the magnetic structure around 5 K.

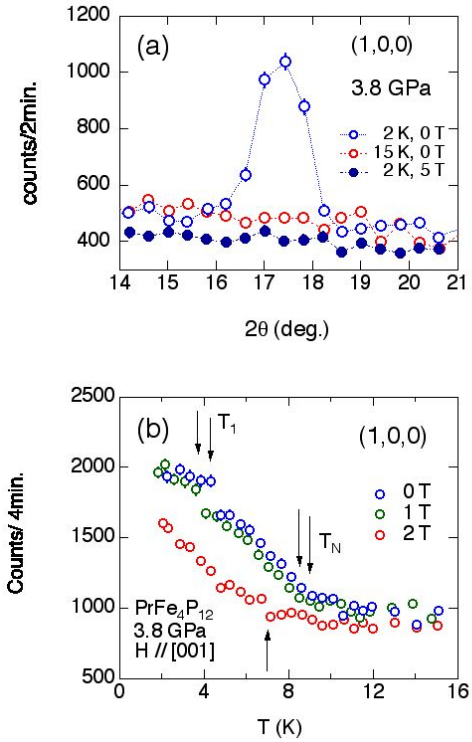

Fig. 1. (a) antiferromagnetic Bragg reflection at (1,0,0) under 3.8 GPa and (b) the temperature dependence of the (1,0,0) antiferromagnetic peaks in several magnetic fields under 3.8 GPa in the pressure-induced insulating phase of PrFe4P12.