Neutron scattering study on PrFe4P12 under high pressure

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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 metal-insulator (M-I) transition occurs around Pc = 2.4 GPa (Hidaka et al.: Phys. Rev. B 71 (2005) 073102). In the insulating phase, we have observed the distinct antiferromagnetic magnetic Bragg peak with a wave vector q =(1,0,0) above Pc by using a new hybrid-type pressure cell (HAC) which is composed of a large sapphire anvil and a tungsten carbide anvil (Osakabe et al.: J. Mag. Mag. Mat. 310 (2007) 2725).

In order to get further microscopic information about the pressure-induced antiferromagnetic order, we have performed high-pressure neutron diffraction measurements on PrFe4P12 single crystal at low temperatures under high pressure and magnetic fields using the triple-axis spectrometer TOPAN at JRR-3M in JAEA and the HAC. Single crystals were grown by tin-flux method. The HAC was set inside a superconducting magnet with the [0,0,1]-axis vertical to the (h,k,0) scattering plane.

Figure 1 shows the temperature and magnetic field dependences of the antiferromagnetic Bragg peak with q = (1,0,0) under 3.2 GPa. The pressure-induced antiferromagnetic order is clearly suppressed by applying magnetic field. This result agrees with the reported field dependence of the electrical resistivity. This strongly indicates that the pressure-induced M-I transition is caused by the antiferromagnetic order. However, it is difficult to explain the mechanism of the M-I transition by a simple superzone gap formation at the Fermi surface due to the antiferromagnetic order, since the Fermi surface of an extra hole-like band exists. Further studies are necessary to clarify the mechanism of the M-I transition.

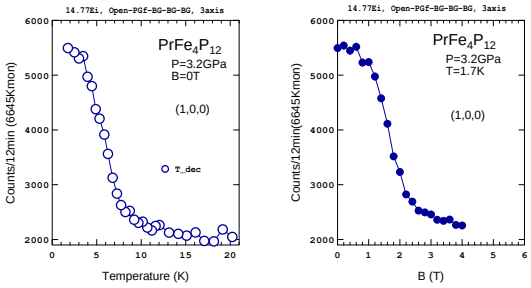

Fig. 1. Temperature and magnetic field dependences of the antiferromagnetic Bragg peak with q = (1,0,0) under 3.2 GPa.