Neutron diffraction experiments of valence fluctuating YbPd

A. Mitsuda[A], M. Sugishima[A], K. Ohoyama[B], H. Wada[A]
[A]*Dept. of Phys., Kyushu Univ.*, [B]*IMR, Tohoku Univ.*

The cubic CsCl-type compound YbPd is known to be a valence fluctuating compound and to undergo 4 phase transitions at 0.5, 1.9, 105, and 125 K [1]. ^{170}Yb Mössbauer studies reveal that the one at $T_M = 1.9$ K is due to magnetic order [2]. However, the mechanisms of the other three phase transitions remain unknown. The Mössbauer studies also suggest magnetic and nonmagnetic Yb ions coexist in equal proportions at low temperatures [2]. Assuming that the difference in magnetism is ascribed to two Yb valence states, of which are nonmagnetic Yb^{2+} and magnetic Yb^{3+}, the two valence states should arrange regularly at low temperatures to make entropy zero. Such behavior, which is called 'charge order', is observed in Yb_4As_3, Fe_3O_4 and so on. These compounds have low carrier density, while YbPd exhibits metallic behavior. We are interested in the charge order of the metallic compound. We take notice of the fact that magnetic order and charge order coexist below 1.9 K according to the Mössbauer studies. If we can determine the spin structure, the structure should include information on structure of the charge order since only Yb^{3+} ions have a magnetic moment. Therefore, in the present study, we perform powder neutron diffraction experiments of YbPd at low temperatures to determine spin and charge structure.

The experiments were carried out at IMR-HERMES powder diffractometer. A powdered sample (about 3 grams) was loaded in the vanadium cell with the diameter of 8.6 mm, and then attached to the 1 K refrigerator. The powder diffraction patterns were taken at 0.72 K and 3.62 K, which is below and above magnetic ordering temperature of 1.9 K. The measurements were carried out twice at the same temperature.

Figure 1 shows the results of the experiments measured at 0.72 K and 3.62 K. The overall diffraction patterns at both temperatures can be indexed as the cubic CsCl-type structure, suggesting absence of the structural transition. At 0.72 K, however, a shallow shoulder is found at around $2\theta = 5°$. Since there exists no shoulder in the patterns at 3.62 K, the shoulder is a magnetic Bragg peak. The low angle of 2θ indicates a long-periodic, possibly incommensurate, magnetic structure. The magnetic Bragg peak, which is obtained by subtracting the diffraction pattern at 3.62 K from that at 0.72 K, is small and not broadened, which suggests shrinkage of the magnetic moment and long-range magnetic order. Analysis of structure of magnetic order and charge order is now in progress.

References:

[1] R. Pott et al., Phys. Rev. Lett. **54** (1985) 481.

[2] P. Bonville et al., Phys. Rev. Lett. **57** (1986) 2733.

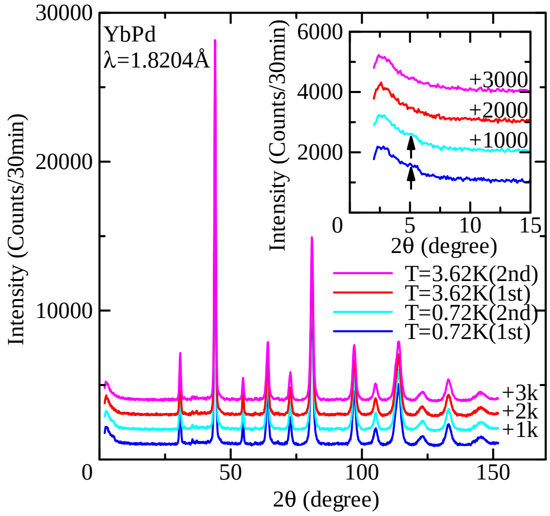

Fig. 1. Neutron diffraction patterns of YbPd at 3.62 and 0.72 K. The inset exhibits an enlarged graph around $2\theta = 5°$. The arrows show a magnetic Bragg peak.