Study on metallic charge order of single crystalline YbPd by determination of magnetic structure

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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 revealed 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 suggested coexistense of magnetic and non-magnetic Yb ions in equal proportions at low temperatures [2]. Assuming that the difference in magnetism is ascribed to two Yb valence states, 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 electrical resistivity. 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 one valence state of Yb has a magnetic moment. In 2009, we performed powder neutron diffraction experiments of YbPd at low temperatures at IMR-HERMES and observed one magnetic Bragg peak of $Q = 0.3113$Å^{-1} at $T = 0.7$ K, which suggests a long-periodic, possibly incommensurate, magnetic structure. After that, we succeeded in growing a single-crystalline sample of YbPd by a self-flux method. We attemped to determine the direction of the Q-vector by using this sample,

The experiments were carried out at IMR-AKANE and 6G-TOPAN diffractometer installed at JRR-3M reactor. The sample with a dimension of $\sim 1 \times 1 \times 1$mm^3 was attached to the 1 K refrigerator.

Figure 1 shows the results of θ-2θ scan around $hkl = 0.0772, 0.1514, 0$, which corresponds to $Q = 0.3113$A^{-1}, measured at 0.8 K (below T_M) and 8 K (above T_M). A clear magnetic Bragg peak is observed. We could found a few satelite peaks at 0.8 K. 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.

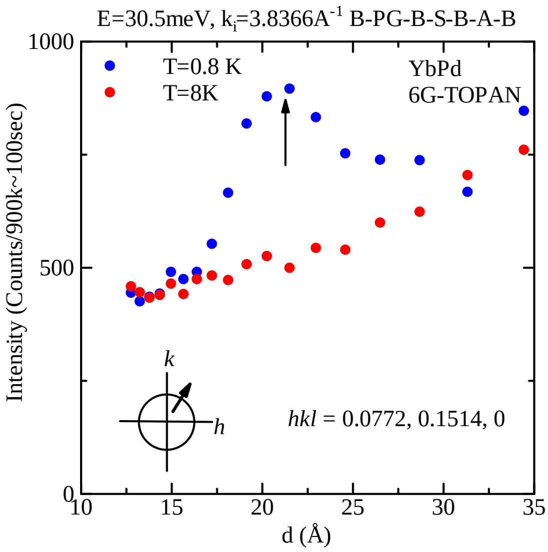

Fig. 1. The magnetic Bragg peak of hkl=0.0772, 0.1514,0 measured at 0.8K.