Neutron diffraction under pressure in $CeRhIn_5$

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The interplay between magnetism and superconductivity (SC) is the interesting and important issue on condensed matter physics. In $CeRhIn_5$ [1, 2], it was very difficult to establish the coexistence of both two phases under pressure (P) because of the inhomogeneity of the P. There was open to argument if the coexistence is intrinsic.

Very recently G.G. Chen et al. [3] reported that high-quality single crystalline $CeRhIn_5$ display the SC at $T_{SC} \sim 90$ mK even under ambient P and its P-T phase diagram is drastically renewed. These findings indubitably indicate that the identical f electron plays both roles of SC and AFM. Therefore $CeRhIn_5$ is a very important material for the investigations on the coexistence of SC and AFM. To elucidate the coexistence mechanism of both SC and AFM, it is very useful to perform neutron diffraction under P which is a very powerful tool to directly determine the magnetic structure of the system.

The main goal of our study is to observe any changes through the SC transition temperature T_{SC} in $CeRhIn_5$. On the other hand, since the strong neutron absorption of Rh, In nuclei and pressure cell itself make the magnetic neutron diffraction under P extremely difficult, there has been little good information on the magnetic structure under P [4, 5].

In this work, we prepared a small CuBe-based pressure cell and succeeded in detecting magnetic reflections under P up to 1.5 GPa at the ISSP/GPTAS and HQR spectrometers in the research reactor JRR-3/JAEA. Figure 1 shows neutron diffraction profile thorough $Q = (0.5, 0.5, L)$ at $P \sim 0.25$ GPa. One can clearly recognized a pair of magnetic peaks at $L \sim 1.298$ and 1.702 at $T = 0.75$ K (below T_N), which are truly of magnetic origin since they disappear at 4.9 K (above T_N). Here we would like to emphasize that our results surpassed the past ones [4, 5] for the intensity of about 70 counts/min and SN ratio of ~ 1.3. These arise from the optimization of both the crystal and pressure cell sizes.

The incommensurability δ in the propagation vector $\tau = (0.5, 0.5, \delta)$ smoothly increase from 0.297 at $P = 0$ to 0.326 at 1.22 GPa, which is qualitatively different from the previous results. [4, 5] We believe that these difference comes from the used pressure transmitting media.

References

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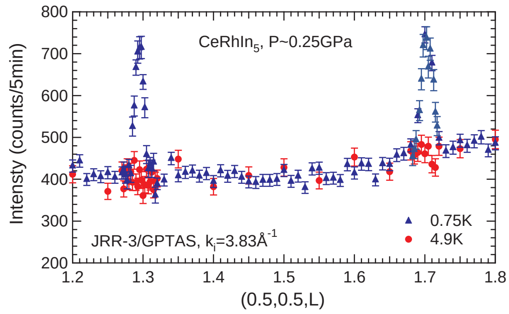

Fig. 1. Incommensurate magnetic Bragg reflections at $P \sim 0.25$ GPa.