Development of a Single Crystal Hydrogen-Deuteride (SC-HD) polarized target for near future LEPS experiments at SPring-8

T. Kuwai[1], M. Utsuro[2], T. Ohta[2], Y. Isikawa[1], H. Kohri[2], M. Fujiwara[2], K. Fukuda[3], T. Kunimatsu[2], C. Morisaki[2], M. Tanaka[4], M. Uraki[2] and M. Yosoi[2]

[1] *Department of Physics, Faculty of Science, University of Toyama, Gofuku, Toyama 930-8555, Japan*

[2] *Research Center for Nuclear Physics (RCNP), Osaka University, Ibaraki, Osaka 567-0047, Japan*

[3] *Graduate School of Medicine, Kyoto University, Sakyo-ku, Kyoto 606-8507, Japan*

[4] *Kobe Tokiwa College, Kobe 654-0838, Japan*

In the original target design of the hydrogen-deuteride (HD) polarized target project [1], about 20% by weight aluminium thin wires must be contained in the target solid HD in order to cool down the HD to the mK-range with a sufficiently high thermal conductivity for overcoming the conversion heat in the target. However, these aluminium wires bring undesirable background contributions in photoproduction measurement.

A better option to employ single crystal HD was proposed [2] to remove the aluminium wires by utilizing the high and drastically anisotropic thermal conductivity observed in hexagonal parahydrogen crystal [3]. The thermal conductivity of 99.999% purity aluminium wires in the original target [4] is estimated as about 10^3 W/Km at 4 K and decreases with the temperature, steeply below about 0.5 K [5]. The thermal conductivity measured on polycrystalline HD [6] becomes the maximum of about 10 W/Km at 4 K, also with the decrease below about 0.5 K, and well explained by the phonon scattering theory on rotational impurities and boundaries [6].

Therefore, as the first step of the present development, a conductivity measurement on single crystal HD in the temperature region around the maximum was undertaken with a liquid helium cryostat at the laboratory of the University of Toyama. The sample assembly shown in Fig.1(a) was immersed in liquid helium bath of the cryostat and the cell temperature was precisely controlled during the direct crystallization process of HD gas in the cell. After crystallization, the conductivity measurement was carried out, the result of which is given in Fig.1(b), indicating possible thermodynamical difference due to the different crystallization temperatures. To our knowledge, Fig.1(b) is the world first report on thermal conductivity of the single crystal HD. The conductivity will be further enhanced with (i)higher HD purity (>99.9%) prepared with a distillation apparatus [7] to reduce the impurity contributions [8]; by about 10^2 times, and (ii)heat flow perpendicular to the c-axis of the single crystal [3]; by about 50 times. These improved measurements will be performed soon.

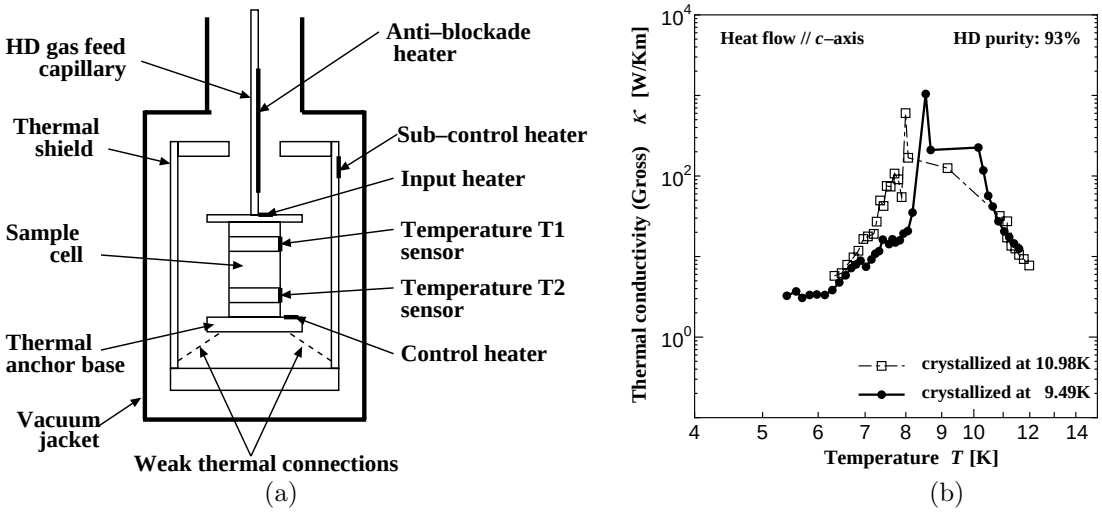

Figure 1: Experiment of thermal conductivity measurement on a single crystal HD sample: (a) the sample geometry inserted into a helium cryostat, (b) the preliminary result.

References

[1] M. Fujiwara *et al.*, Photoproduction Experiment with Polarized HD Target at SPring-8, LEPS/RCNP proposal (2003).

[2] M. Utsuro, informal proposal paper, 2006 (in Japanese).

[3] O.A. Korolyuk *et al.*, J. Low Temp. Phys., **111** (1998) 515-520.

[4] Christopher M. Bade, Dissert. Ph. D., Ohio Univ., March 2006.

[5] A.L. Woodcraft, Cryogenics, **45** (2005) 421-431 and 626-636.

[6] J.H. Constable and J.R. Gaines, Phys. Rev., **B8** (1973) 3966-3977.

[7] T. Ohta *et al.*, Ann. Rep. of RCNP, Osaka Univ. (2006), 19.

[8] R.W. Hill and B. Schneidmesser, Z. phys. Chem. Neue Folge, **Bd.16** (1958) 257-266.