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

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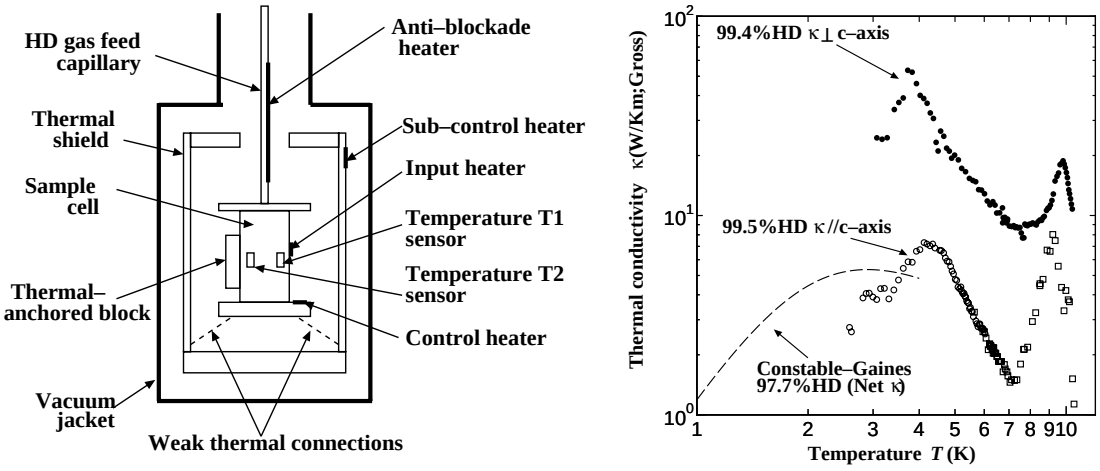
Our motivation of the present study is an improvement of the hydrogen-deuteride (HD) polarized target [1]. In its original design, about 20% by weight aluminium thin wires are included in the target solid HD in order to be cooled down to the mK-range. These wires accompany undesirable background contributions in photoproduction measurement. Therefore, a better option to employ a single crystal of 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 measured by Constable and Gaines on polycrystalline HD at 26 hours after solidification [4] becomes about 5 W/Km at about 3 K. Our initial measurements for the sample with the direct crystallization method of 93% purity HD gas in the cell were given in our previous report [5] for the thermal conductivity parallel to the c-axis of the single crystal in the temperature region above about 5 K.

Now, we extended the temperature region down to about 2 K with liquid helium pumping and improved the HD purity up to higher than 99% [6]. Furthermore, we could measure for the first time the thermal conductivity perpendicular to the c-axis by preparing a specially designed sample cell with a thermal anchored copper block, as shown in Fig.1(a). The contact between the block and the cell was broken off during the crystallization.

The measurements were performed in a liquid helium cryostat at the laboratory of the University of Toyama. The typical result of the measurements at 20 hours after crystallization is given with solid circles in Fig.1(b), compared to the Constable-Gaines result [4]. Our present results for about 99.5% HD purity indicate much higher thermal conductivity in the direction perpendicular to the c-axis than that parallel to the c-axis of the single crystal, just as our expectation [2]. The notation "Gross" in the ordinate means minor effects of the cell wall included. We estimate our present result could meet our initial requirement for applying to our polarized HD target, with the thermal conductivity higher than about 50 W/Km at about 4 K. The present performance will be comparable to that of 20% by weight, *i.e.* nearly 1% by volume, aluminium wires with 99.999% purity. A further higher thermal conductivity is expected with a higher HD purity of 99.9%. Thus, we are now preparing an actual single crystal HD target for the nuclear polarization without wires.



(a) (b)

Figure 1: Thermal conductivity measurement perpendicular to the c-axis of a single crystal HD sample: (a) the sample assembly inserted into a helium cryostat, (b) the preliminary result(solid circles).

References

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