§13. Steady State Heat Transfer Characteristics in Saturated He II from a Polished Copper Surface

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Steady-state heat transfer from a polished copper surface in saturated He II has been measured. For thermal insulation, the copper block was installed in a vacuum can with a GFRP flange, except for the exposed heat transfer surface. It is expected that heat leak to the bath via a sample holder is low. Heat transfer characteristics of He II from the copper surface are discussed compared with other studies.

A diagram of the present sample for heat transfer measurement is shown in Fig. 1. The sample, which is an oxygen free copper cylinder with 70 mm in length and 20 mm in diameter, is mounted in a vacuum can. The can is made of stainless steel. The exposed surface is facing upward to the bath of saturated He II. The surface was polished by 0.3 μm alumina powder. To minimize the heat leak to the bath via the can, the cylinder is attached to an FRP flange with low thermal conductivity, and then the flange is installed to a stainless steel flange which is a part of the can. Indium was used for the seal between the flanges. The gap between the cylinder and the FRP flange was filled up by vacuum grease. The can is connected to the high vacuum system at room temperature. It was evacuated through a pipe. During measurements, a vacuum of 8×10^{-4} Pa was achieved. The sample was heated by a thermofoil heater on the opposite side of the heat transfer surface. The heater was bonded to the cylinder by epoxy resin. The resistance of the heater is 74.5 ohm at room temperature. Heat flux is calculated from the voltage and current through the heater. The heat flux was inputted up to 5 W/cm^2. The temperatures were measured by calibrated germanium resistance temperature sensors. The thermometers were placed in holes drilled in the cylinder with Cry-Con Thermal Conductive Grease for good contact. The surface temperature is estimated by a temperature gradient in the cylinder.

The experimental results of Kapitza conductance of the copper surface are shown in Fig. 2. The bath temperatures are 1.78 K and 1.90 K. The sample with a repolished surface was cooled down to 1.78 K twice. The experimental results are consistent with the other studies.1)2) The surface condition influences Kapitza conductance. Nevertheless, the variation of the surface temperatures between the cool-downs at 1.78 K is negligibly small. Judging from the measurements, the surface preparations by 0.3 μm alumina powder polish were practically the same for every cool-down. Generally, heat flux in Kapitza regime is written:

$$q = a\left(T_s^n - T_b^n\right) \quad (1)$$

where a and n are fitting parameters, and T_s and T_b are the surface and the bath temperature, respectively. The fitting parameters of the Kapitza conductance for the polished surface are given in Table I.

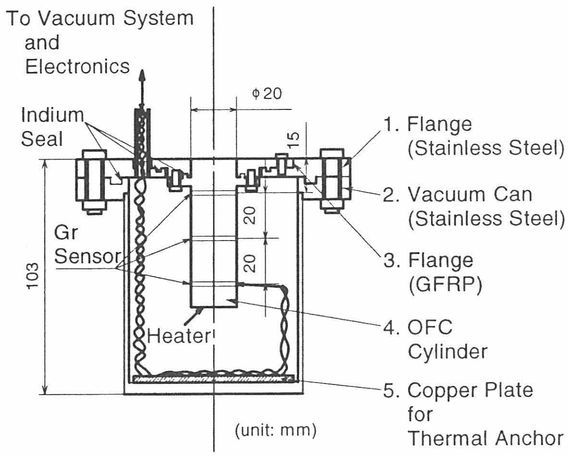

Fig.1. Schematic illustration of the sample.

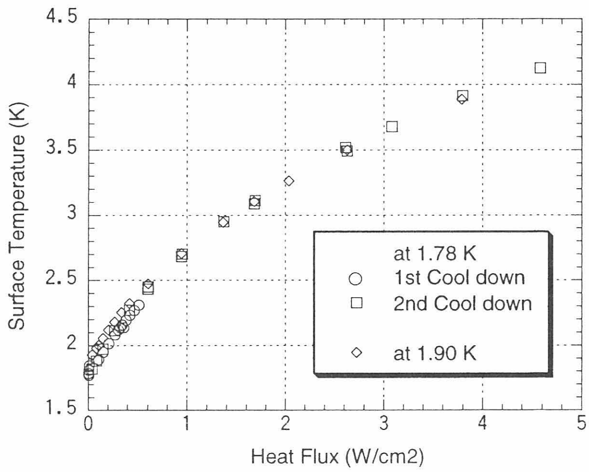

Fig.2. Experimental Results of Kapitza conductance at 1.78 K and 1.90 K.

Table I. The fitting parameters

Bath temperature	a	n
1.78 K	0.07016	3.001
1.90 K	0.07346	2.996

References

1) Kashani, A. and Van Sciver, S. W. : *Cryogenics* 25(1985)238.

2) Claudet, G. and Seyfert, P. : Advances in Cryogenic Engineering 27(1981)441.