§14. Thermal Conductivity of Stycast 1266 and 2850FT at Cryogenic Environment

Iwamoto, A., Maekawa, R., Mito, T.

Thermal conductivity of materials is an important property for cryogenic applications. It is applied for the stability analysis of superconducting magnet and the heat leak estimation of refrigeration systems. Therefore, measurements have been performed previously on various materials. However, the error among different measurements with same sample cannot be ignored because of its different setup. The development of measurement technique without the dependence on the setup is needed.

Thermal conductivity, k is defined as,

$$q = -k\nabla T$$

where q and ∇T are the heat flux and the generated temperature gradient, respectively. The temperature gradient is usually estimated from the sample length and the temperature difference between both ends. In order to measure the temperature, thermometer is inserted the hole of Cu block, and then it is usually attached on the sample by grease, epoxy resin or something like that. They might cause the thermal resistance between the sample and the Cu block.

We are going to develop the thermal conductivity measurement technique without the thermal resistance. It is expected that the thermal resistance can be cancel out by analyzing two measurements of the same sample with different length. The setup to measure the heat transfer was constructed, and then test measurements have been conducted. As the sample, Stycast 1266 and 2850FT are chosen because of its low thermal conductivity required precision measurement.

Fig. 1 shows the setup for the thermal conductivity measurement at the range from room temperature to cryogenic environment. The sample was put into the vacuum can. The achieved vacuum for the thermal insulation was less than 10^{-4} Pa. The sample was assembled with copper disks. The disk with the hole for a sensor was glued on both ends by the same Stycast. In this case, there is the only thermal resistance between Stycast and Cu. To measure the temperature of each sample end, PtCo senser was applied. Each sensor was calibrated within 50 mK accuracy. The sample assembly is put on the copper block which one side of is exposed to LHe or LN2. Its temperature is controlled constantly at any temperature by a heater. The sample was heated by the thermofoil heater on the opposite side of cold end, and the heat flux is generated by Joule effect.

Fig. 2 shows the thermal conductivity of Stycast 1266 and 2850FT at the range between room temperature and 80 K. The measured values are compared with the technical data of the resins. The estimated thermal conductivity contains the Cu-Stycast thermal resistance. However, the experimental result is consistent with the technical data. Therefore, the thermal resistance must be small. Unfortunately, we have not conducted another measurement with different thickness of the sample to cancel the thermal resistance yet. In this measurement, It can be only checked that the setup works enough to measure low thermal conductivity of resin.

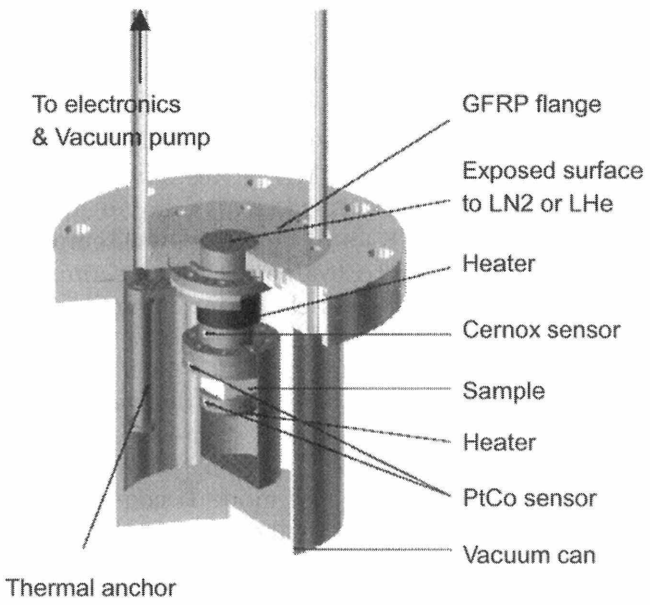

Fig.1. Schematic illustration of the setup

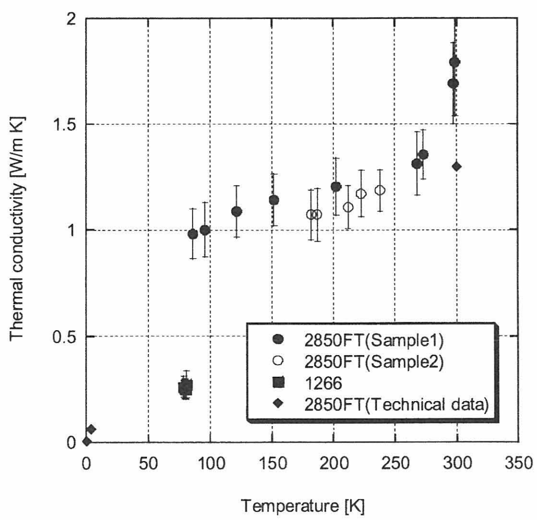

Fig.2. Thermal conductivity of Stycast