§14. Peak Heat Flux Measurements with Various Surface Areas in He I

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Accuracy of stability analyses for pool boiling superconductors which are large size depends on heat transfer from the conductor surface to liquid helium. Previously, many heat transfer measurements from copper plates have been reported. These heat transfer surfaces were different in size and in condition. At the same heat flux, a surface area increases, the quantity of bubbles is also increasing. Free convection in the liquid helium around the surface is considered to be influenced by bubbles. It is assumed that various surface areas take different heat transfer characteristics. In this study, area dependence of the peak and the minimum heat fluxes were investigated as changing the surface orientation.

The heat transfer of copper plates have been measured as a function of heat transfer surface area. We studied four types of heat transfer surface areas including : a) 10 × 18 mm, b) 18 × 18 mm, c) 40 × 18 mm, and d) 76 × 18 mm. Schematic illustration of the sample is shown in Fig.1. The surface roughness is less than 10 μm. The surface is heated by a thermofoil heater attached on the reverse side of the heat transfer surface. Temperature difference between the surface and liquid helium was measured using AuFe-Chromel thermocouples. It is well-known that the heat transfer characteristics depend on surface orientation. To estimate the dependence for these samples in this study, the surface orientation was changed from 0°(horizontal, heat transfer surface upward), through 90°(vertical), to 180°(horizontal, downward) at the interval of 15°.

Measurements of peak and minimum heat fluxes with various surface areas were conducted. Figure 2 shows the area dependence of the peak and the minimum heat fluxes at several surface orientation. The peak heat flux depends on the surface area. It tends to increase at all surface orientation as decreasing the surface area. Between 0° and 90°, the peak heat flux with the surface length of 18 mm is maximum. On the other hand, the minimum heat flux takes a almost same trend. It is thought that free convection in liquid helium around the surface is influenced by changing the quantity of generated bubbles on the different surface area. The heat transfer characteristics are also affected. In the stability analyses of large sized superconducting magnets, the variation of the characteristics must be noticed.

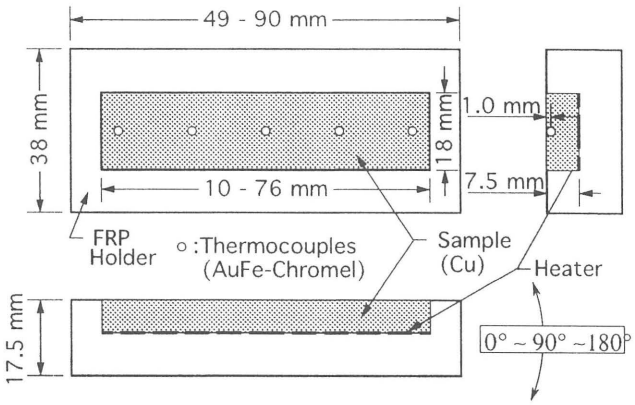

Fig.1. Schematic illustration of the sample

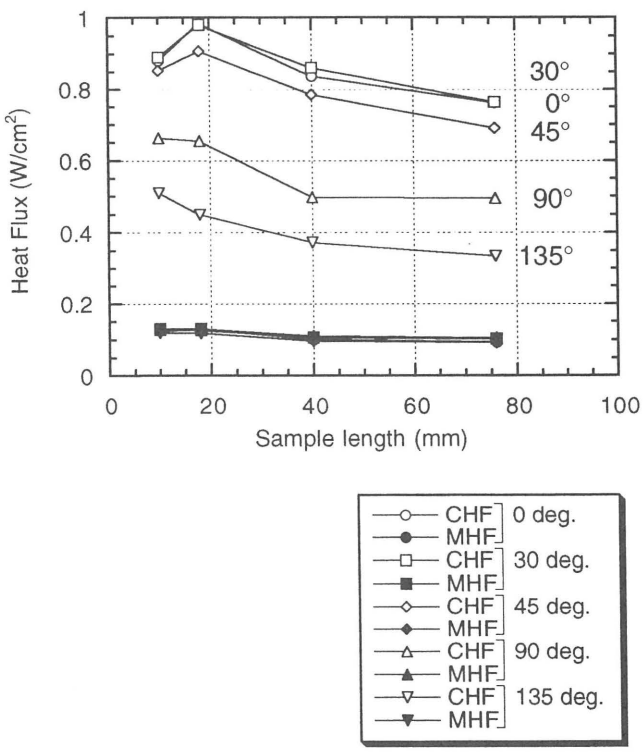

Fig.2. Dependence of the peak and the minimum heat fluxes on surface area