§25. Electrical Insulation of Superconducting and Cryogenic Devices

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1. Electrical Breakdown in Saturated Superfluid Helium

Investigations were carried out on dc breakdown characteristics and the time lag of breakdown of superfulid helium (HeII) down to T=1.4K. The results were: HeI(4.2K) and HeII(1.85K) had similar area effect as the size effect and the cold field emission from cathode was a dominant source of initial electron. While dc breakdown strength of HeII was a little lower than HeI due to the increase of effective breakdown electrode area with lowering temperature, HeII did have little temperature dependence in its dc breakdown characteristics. However, the time lag of breakdown of HeII turned shorter with the decrease of temperature as shown in Fig. 1 . The latter result can be explained by the fact that the increase of electronic mobility of HeII with lowering temperature increased the probability of breakdown induction.

2. Surface Discharge Characteristics of Cryogenic Nitrogen Gas

The effect of spacers between parallel plate electrodes was investigated by inserting FRP disc shaped spacers of 1, 2, 3, 5mm thick and controlling the gaseous density by pressure and temperature. When a small gap was introduced between the electrode and spacer, the breakdown took place along the spacer surface without fail. The larger the area of the small gap, the lower the breakdown voltage than the one

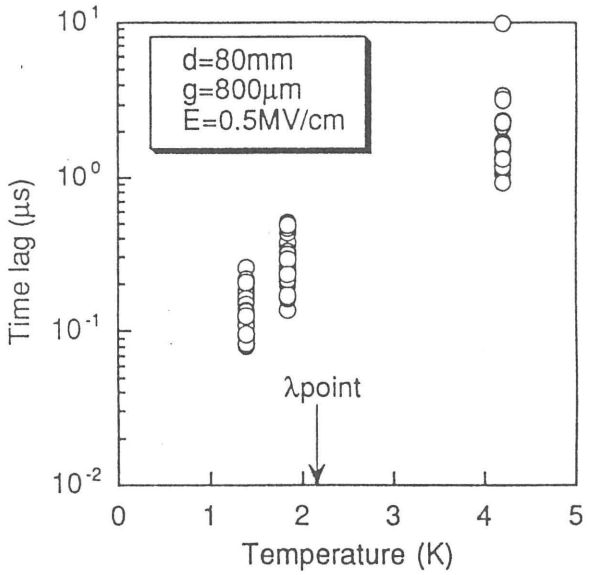

Figure 1: Temperature dependence of time lag of breakdown

predicted by Paschen curve. However, the good contact of electrode and spacer resulted in the breakdown between the metal plate electrodes. The breakdown voltage lowers when the surface of an electrode is roughened by an emery paper.

3. Short-circuited Treeing Phenomena of Ethylenepropylene Rubber in Cryogenic Region

To design dc superconducting cable insulated by extruded ethylenepropylene rubber(EPR), the short-circuited treeing characteristics were investigated. The results were very encouraging for the short-circuited tree resistivity at liquid nitrogen temperature increased dramatically compared to that at room temperature like ac treeing test; the ac treeing resistivity of EPR at liquid nitrogen temperature is more than three times that at room temperature. They were endorsed by the experimental evidence of the very limited space charge injection from evaporated metal electrode at liquid nitrogen temperature. This insulation design can be applied to the current bus bar of a large superconducting magnet.