## §33. Electrical Insulation of Superconducting and Cyrogenic Devices

Kosaki, M., Nagao, M. (Toyohashi Univ. of Technology)
Hara, M., Suehiro, J., Takeo, M. (Kyushu Univ.)
Shimizu, N. (Nagoya Univ.)
Mizuno, Y. (Nagoya Inst. Technology)
Hoshino, M., Satoh, T.

1. Surface discharge in superfluid helium gas

The superfluid helium would be a coolant as well as insulating fluid in the second phase of the LHD project. The purpose of this research is to give the reliable design criteria of the electrical insulation of LHD.

The saturated superfluid helium phase is approaching the condition of the minimum breakdown voltage of helium gas. Thus the voltage induced at the quenching of superconducting coils would cause discharges. Superconducting coils are designed by employing spaces between conductors and turns and therefore, the surface discharge characteristics are very important. This year we have investigated the GFRP spacer performance between the parallel metallic electrodes in the saturated superfluid helium gas. The new finding is the breakdown voltage helium gas in the relevant state being chiefly determined by the product($\rho$·d) of helium gas density($\rho$) and thickness of spacer(d) rather independent of the diameter and thickness of spacers. Furthermore, when $\rho$·d is relatively large, surface discharge along the spacer predominates and the breakdown voltage turns out lower than that of helium gas itself. When $\rho$·d is small, however, the surface discharge voltage surmounts the breakdown voltage of helium gas itself and the breakdown takes place preferentially at the gap. These results summarized in Fig.1 are different from the generally accepted concept on surface discharge and therefore, might be an important knowhow for the insulation design of the superconducting magnets with abundant small gap spacers.

2. Source of initial electron in liquid helium

The electrode area and liquid volume effects on the production of the initial electron in the breakdwon of liquid helium have been systematically investigated. The results show that the statistical time lags have strong dependence on the applied electric field, which is discussed in terms of a mechanism of supplying initial electrons from micro protrusions on the cathode.

3. Breakdown characteristics of paper/ice composite in cryogenic region

The paper/ice composite (polypropylene synthetic paper) are immersed in liquid nitrogen and subjected to the breakdown tests. The surprising results were obtained: 1)the breakdown strength of paper/ice composite is significantly higher, more than 50% up than that of a ice free structure. 2)self-healing behavior can be expected to the paper/ice composite after breakdown. The insulation design of this type may find much variety of application.

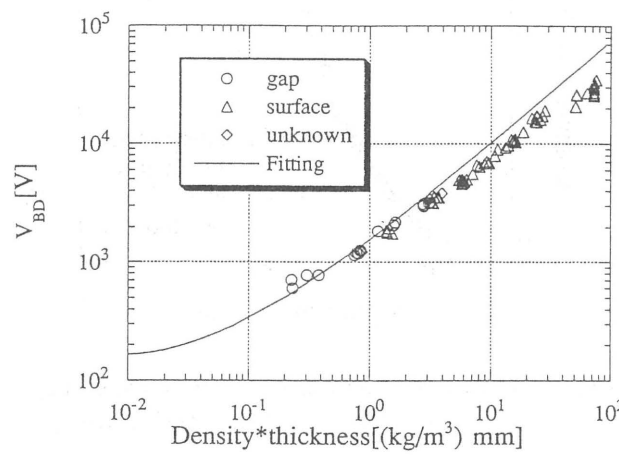


Fig.1. Breakdown voltage of cryogenic helium gas with GFRP spacer