§32. Electrical Insulation of Superconducting and Cryogenic Devices

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1. Surface discharge in cryogenic nitrogen gas

The cryogenic nitrogen gas phase is approaching the condition of the minimum breakdown voltage in Paschen curve of gaseous nitrogen. Thus the voltage induced at the quenching of HT superconducting coils would cause discharges. HT 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 cryogenic nitrogen gas. The new finding is the breakdown voltage of nitrogen gas in the relevant state being chiefly determined by the product(ρ·d) of nitrogen gas density(ρ) and thickness of spacer(d) rather independent of the diameter and thickness of spacers. Furthermore, when ρ·d is relatively large, surface discharge along the spacer predominates and the breakdown voltage turns out lower than that of nitrogen gas itself. When ρ·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 supercon- ducting magnets with abundant small gap spacers.[1]

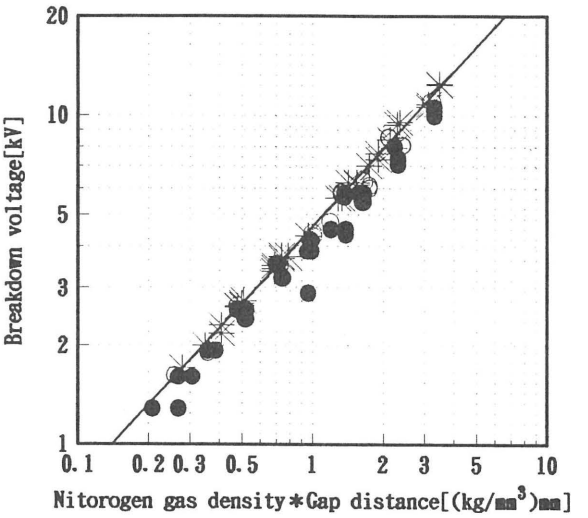

Figure 1: Breakdown voltage of cryogenic nitrogen gas with GFRP spacer

2. Bubble motion in liquid helium and nitrogen

The analyses of bubble motion in the cylinder and plane electrode system in liquid helium and nitrogen revealed that it follows gravity, viscosity and electric force and its trajectry follows the electrode allignment. When the bubble size in diameter of liquid helium being one third of that of liquid nitrogen, the bubble motion in both liquids are very similar. These results are beneficial in the proper designing of the superconducting coils since they are simulating the quenching of pool cooling superconducting magnets.

3. Breakdown characteristics of organic thin films in cryogenic region

The breakdown strength of polyimid thin films which has excellent mechanical properties in the cryogenic region for insulation of superconducting magnet wire were found to be more than 2MV/cm and free from the effects of electrode metals and polarity reversal of applied dc voltage.

Reference

[1] Hoshino,M.,IEEJ 115-A(1995)1243