§58. Electrical Insulation of Superconducting and Cryogenic Devices

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1. Motion Behavior of Particle under Electric Field in Liquid Nitrogen Motion behavior of spherical metallic particles under uniform and non-uniform electric fields is studied theoretically at first. Next the behavior under non-uniform electric fields is studied experimentally and discussed. Further the microdischarges between the spherical particle and electrodes are observed and discussed. The results show that the tested particle is lifted off at much lower voltage than the breakdown voltage and the particle is trapped on insulator after complicated motion in the test cell. Microdischarge occurs with the approach of the particle to the electrode and its intensity becomes stronger at higher electric field on the electrode surface. Associated bubbles with the microdischarge and particle motion have not been recognized in this experiment.

2. Surface Discharge Characteristics of Cryogenic Nitrogen Gas and Liquid along Small Gap Spacer

In gaseous nitrogen, when the small gap spacer has good contact with electrodes, flashover occurs mostly not along the spacer surface, but at the point apart from the spacer. Flashover voltage followed Paschen's law and depended only on the product of gas density and gap distance, even though there existed the spacer between electrodes. However, when the contact between the spacer and the electrode was not good and there existed a small gap, the flashover voltage decreased and depended on the small gap area directly connected to the spacer edge rather than the total gap area. In liquid nitrogen, flashover occurs along the spacer and the flashover voltage depended on the spacer and small gap area when the spacer existed between the electrode.

3. Electrical Breakdown of Paper-Ice Composite Insulating System in Cryogenic Region

The AC breakdown performance of paper-ice composite insulating system immersed in liquid nitrogen were investigated. The electric strength (Fb) in this paper-ice composite system is higher than that of paper-liquid nitrogen system. Furthermore this system shows a self-healing type breakdown behavior. Among the many kinds of liquid to be immersed and frozen to the ice, deionized water gives the highest Fb. The Fb increased with the paper density. The paper-ice composite insulation system is thought to be one of good candidate for the electrical insulating system at cryogenic temperature.