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M4Or1A-04: Understanding Surface Flashover in Helium Gas Cooled High Temperature Superconducting Devices

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High temperature superconducting (HTS) devices enable high current densities to be achieved. For some applications the required operating temperature is less than 50 K and gaseous helium (GHe) is utilized as the cryogen instead of the commonly used liquid nitrogen. These applications include devices with MgB2 as the superconductor, and for HTS motors, generators and, magnets which operate with a higher internal magnetic field and require the lower operating temperature to achieve the necessary high current density. To achieve high power density, HTS devices need to operate in the medium voltage range between 5-20 kV. Advertently or inadvertently the cryogen will form part of the electrical insulation system of the HTS device and the low dielectric strength of GHe limits the operating voltage of GHe cooled HTS devices to less than 10 kV due to partial discharge. Our research over the last few years has focused on understanding the intrinsic dielectric properties of GHe and developing insulation materials and designs to increase voltage ratings of GHe cooled HTS devices. We discovered that adding small mol% of hydrogen to GHe significantly increases its intrinsic dielectric strength. It is now necessary to understand how this improvement relates to improving the voltage rating of GHe cooled HTS devices. The limiting voltage rating for a HTS device is not expected to be intrinsic breakdown through the gas but instead through other mechanisms like partial discharge or surface flashover, which occur at a significantly lower voltages than the breakdown. Surface flashover is electrical breakdown at the interface between the conductor and two electrical insulation materials with different electrical properties. This paper describes out efforts on understanding the relationship between the surface flashover and the combination of the dielectric strength of GHe and commonly used solid insulation materials for cryogenic temperature applications.

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