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Evolutionary Mechanism and Damage Characteristics of "Gel-solid" Creeping Discharge of Power Device Package Insulation Under Coupled Temperature-Frequency Effects

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Abstract

The multi-energy conversion equipment power devices are prone to form creeping discharges at the interface of silicone gel and ceramic substrate. In this paper, the influence mechanism of coupled temperature-frequency effects on the creeping discharge of "gel-solid" insulation and the surface damage characteristics of ceramic substrate under high-frequency electrical stress were investigated; and the influence mechanism of specimen properties on the discharge was studied based on different degassing methods. The research results showed that the partial discharge initial voltage was independent of the change in frequency, but decreased with increasing temperature. The maximum discharge amplitude and the pulse recurrence frequency increase first and then decrease with the increase of frequency, and there is the phenomenon of "frequency-induced inflection point"; the trend increases with the increase of temperature, and the increase of temperature has a certain weakening effect on the phenomenon of "frequency-induced inflection point". Due to the nature of the material, the discharge activity of the vacuum-treated sample is slightly lower than that of the non-degassed sample. With the aggravation of surface damage and the generation of products in different discharge stages, the surface conductivity showed a gradual upward trend. The analysis concluded that the coupled temperature-frequency effects had a significant effect on the development of creeping discharge; the bubbles in the colloid and the air gap in the substrate were important factors affecting the discharge; and the creeping discharge pattern was mainly determined by the damage characteristics of the substrate.

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