Electrical diagnostics and nanosecond imaging of vacuum surface flashover

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When an insulator in vacuum between an anode and cathode becomes electrically stressed due to the application of a fast high voltage pulse on the anode, the surface of the insulator is typically the first location to breakdown. An experimental apparatus and diagnostics have been designed which localize anode-initiated vacuum surface flashover so that the relationship between voltage, current, and temporally resolved images may be derived to characterize this phenomenon. The high voltage source is an 8 stage Marx generator that stores 20 J of energy and can provide a voltage pulse up to 240 kV. The voltage and current are monitored using a capacitive voltage divider (CVD) and current viewing resistor (CVR). The optical diagnostics include an intensified charge-coupled device (ICCD), with nanosecond resolution allowing for temporally resolved imaging. In addition, time-integrated images are captured using a DSLR which provides the full evolution of the flashover path.

The electrode geometry consists of a hemispherical anode with a 2 cm radius and a planar cathode; the electrodes are separated by 0.6 cm. The insulator geometry under investigation is a positive 45-degree wedge made of cross-linked polystyrene (Rexolite). This geometry aims to pull electrons away from the surface of the insulator, preventing electron multiplication, the driving mechanism of cathode-initiated flashover. The dominant mode of breakdown then becomes anode-initiated vacuum surface flashover; however, little is known about the underlying mechanisms initiating this process. The primary model of anode-initiated flashover was outlined by Anderson [1], who postulated that an initial plasma forms around the anode, with dielectric or gaseous inclusions potentially playing a role. This plasma then creates a cascade of localized bulk-dielectric breakdown propagating toward the cathode due to field enhancement around the edge of the plasma formation. This model and other contributing mechanisms are ultimately what is under investigation, and experimental results are compared to the Anderson-model of anode-initiated flashover where appropriate.

References

[1] R. A. Anderson, “Anode-initiated surface flashover”, *Conf. on Electr. Insul. & Dielec. Phen.*, Oct. 1979, bl 9.

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