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2P69 - A sequential characterization method for the insulation evaluation of the rod-plane gap under repetitive frequency nanosecond pulses in high-pressure nitrogen

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The high voltage repetitive frequency nanosecond pulse (RFNP) generator is an important equipment in many industrial and scientific applications, including the plasma-assisted combustion and plasma-surface interaction. The gas-insulated gap, one of the typical insulation infrastructures, is required to withstand RFNP. It is usually accepted that the insulation capacity of the gas gap under RFNP is much lower than that under single pulse due to the accumulation of metastable species, electrons and positive/negative ions. However, little research has been devoted to systematically characterize the dynamic evolution of the insulation capacity under RFNPs in high-pressure gas. In this paper, a sequential characterization method and typical influential parameters were investigated. Every voltage and emission light intensity in a sequence were acquired in the sequential acquisition mode to achieve the pulse sequence resolution.

Under positive RFNP, the number of pulses before breakdown Ni from 0.1 to 0.4 MPa was obtained with the same voltage working coefficient. It was found that Ni dramatically and nonlinearly depended on the pulse repetitive frequency (PRF). The emission intensity of corona discharge under positive RFNP was found in the discrete mode in a sequence and the repetitive frequency of corona discharge was closely related with the PRF. On the contrary, under negative RFNP, the corona discharges in a sequence were in the continuous mode. The latter average emission intensity of corona discharges was lower than that of the first corona discharge. Meanwhile, the inception time of following corona discharges decreased with the PRF.

The chemistry and diffusion dynamics during the pulse-off period was found to be vital for the discharge characteristics under RFNP. The proposed sequential characterization method illustrated advantages for the complete description of insulation strength evolution of the rod-plane gap under RFNP in nitrogen and was beneficial for understanding the space charge behaviors.

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