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Optical and Illuminant Characteristics of Nanosecond-Pulse Diffuse Discharges in a Point-to-point Gap

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Diffuse discharge sustained by nanosecond pulses can generate volume discharge at atmospheric pressure, which has been widely studied since 2010s. Although the fast rising time limits the formation of spark stream under certain condition in nanosecond-pulse discharges, the pulse repetition rate and gap spacing may also affect the discharge mode. Our previous work showed that nanosecond-pulse discharge in an inhomogeneous electric field could generate various discharge modes (corona, diffuse and spark discharges) in air and other gases at atmospheric pressure. In this paper, the optical emission spectra and discharge images are investigated to analyze the optical and illuminant characteristics of nanosecond-pulse discharge at different discharge modes.

The emission spectra were used to analyze the optical characteristics of nanosecond-pulse discharge. The experimental results showed that the emission spectrum of diffuse discharge ranged from 300 nm to 425 nm. Typical spectral lines, such as OH, N₂, N₂⁺, are observed, among which the spectral lines at 337.1 nm had the largest intensity. The emission spectrum of spark discharge ranged from 200 nm to 950 nm. The spectral lines included NO, OH, N₂, N₂⁺ and O, among which the spectral lines at 777.1 nm had the largest intensity. Moreover, the intensity of spectral line for N₂ in spark mode was larger than that in diffuse mode, which indicated the existence of large discharge intensity in spark mode.

The grey-scale method was used to estimate the illuminant characteristics of different discharge modes in nanosecond-pulse discharges. The experimental results showed that the maximum grey values were 60, 180 and 255 when the discharge modes were corona, diffuse and spark, respectively. Three regions, such as near-anode region, central region and near-cathode region, could be distinguished according to the grey scale values in diffuse mode. Furthermore, effect of the pulse repetition rate and gap spacing on the diffuse mode was studied.

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