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Studies of low current back-discharge in point-plane geometry with dielectric layer

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The paper presents results of spectroscopic investigations of back-discharge generated in the point-plane electrode geometry in air at atmospheric pressure, with the plane covered with fly ash layer. Four forms of the discharges were studied: onset streamers, glow, breakdown streamers and low-current back-arc discharge. Both polarities of the active discharge electrode, positive and negative, were tested.

The back discharge is a type of DC electrical discharge, which take place when the passive plane electrode is covered with a dielectric layer. The layer can be made of solid material or a packed bed of dust or powder of low conductivity. The charge produced due to ionisation processes in the vicinity of the active point electrode is accumulated on the dielectric surface, and generates high electric field through this layer. When critical electric field through the layer is attained an electrical breakdown of the layer take place. The point of breakdown becomes a new source of ions of polarity opposite to those generated by the active electrode. The dielectric layer on the passive electrode causes that gaseous discharges such as breakdown streamers or arc start at lower voltages than they could in the case of normal corona discharge. The visual forms of the discharge were recorded and correlated with the current-voltage characteristics and optical emission spectra.

Emission spectra of the discharge were measured in the light wavelength range of 200 to 600 nm to get information about excitation and ionisation processes. The light spectra were analysed by monochromator SPM-2 Karl-Zeiss-Jena with diffraction grating of 1302 grooves/mm and photomultiplier R375 (Hamamatsu) and signal preamplifier unit C7319 (Hamamatsu). The spectral analysis showed that the nitrogen molecular bands were dominant, but the emission of negative ions from the dielectric layer material were also detected. The most noticeable light emission in the range from 280 to 490 nm due to second positive system of molecular nitrogen (SPS), can be also used to calculate the number density of the excited nitrogen molecule and its vibrational temperature. The vibrational temperature can be determined from the light emitted by second positive band of N_2.

The interest in these studies is motivated by detrimental effects of this discharge in the electrostatic precipitators.