Investigation of Plasma Propagation in Barrier Corona of Direct Current

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Modern plasma technologies are needed uniform sources of low temperature plasma used for the streams formation of the excited molecules, ions and chemically-active particles. According to [1], the surface discharges exited on stationary dielectric layers can be used for this aim. However, when this occurs, the uniform plasma creation is possible due to generation of short voltage pulses with dU/dt ≥ 10¹² V/s. In contrast to [1], our paper presents the experimental studies results of propagation uniform surface discharge (USD) produced by barrier corona of direct current [2]. Gas-discharge process in the atmospheric air is maintained between the high voltage cathode and the grounded anode because of a movement (from cathode to anode) the charged surface of the dielectric barrier (layer thickness is d = 0.3-1 mm) of a rotor electrode. During discharge generation, cathode and anode were spaced from moving dielectric by a gap h ≤ 0.5 mm. Linear speed of dielectric layer achieved 20 m/s and was sufficient for self-excitation of the uniform emission band at |U| < 20 kV and j ≤ 1 mA/cm. In this case, plasma layer is propagated from anode to cathode with overlapping the inter-electrode gap (20-40 mm) without sparking.

To describe the initial stage of the USD-excitation, the authors proposed a quasi-stationary physical model which considers the deposited charges on the moving dielectric as a virtual electrode. The model has respect to the processes of electron exit from traps by Poole-Frenkel mechanism as well as the subsequent breakdown of gas by Townsend's scenario. On the base of 2D-solutions, it was shown that zones of electron emission from dielectric and of the electron duplication in the gas are localized at the border of the electric charge structure. The modeling results of electron avalanches propagation in the inter-electrode gap under electric field action are supporting the hypothesis [3] about influence of collective ionization processes on gas breakdown during USD. It can explain the discharge stability at atmospheric pressure.

References

