FILAMENTATION OF CURRENT CHANNALES AT THE SPARK STAGE OF NANOSECOND DISCHARGE IN AIR

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High-voltage nanosecond gas discharge at different pressures has wide range of applications in many fields of science and technology. Nevertheless, the complexity of diagnosing small-scale (micron-sized) fast processes of plasma formation and, as a consequence, a lack of information about these processes in the nanosecond time range, does not allow obtaining a complete picture of the discharge, which would describe both the initial and subsequent stages of breakdown. This is due to the fact that the characteristics and structure of the discharge depend strongly on many parameters: the pressure of the working gas and its composition, the magnitude and distribution of the electric field in the gap, the front of the high-voltage pulse and the surface condition of electrodes. Therefore, the systematization of various experimental data on the parameters of a nanosecond discharge is important both from a fundamental point of view, and from an applied one (in particular for gas-filled switchers).

Investigations of the breakdown of strongly overvoltaged gaps with the geometry of the "needle-plane" or "cone-plane" geometries of electrodes were conducted in the air over a wide range of pressures. The use of a point cathode made it possible not only to create a strong field near the surface of the electrode, but also to initiate a discharge at a particular point, and also to maximize the spatial resolution of the optical recording system when tuning to the cathode point. To study the dynamics of the parameters of plasma formations in the discharge gap, laser probing methods [1] on the basis of the developed 6-channel 18-frame registration system with optical channels spaced in time were used. The average delay time between two adjacent channels was in the range 1-3 ns. The spatial resolution of the optical registration system was ~ 2 μm. The exposure time of each frame equals to the pulse duration of the probing laser - 70 ps at a wavelength of 532 nm.

In the course of the experiments it was found that at the stage of closure of developed cathode and anode clots of dense (~ 1019 cm-3) plasma, a complex filamentary microstructure of current channels with a high degree of ionization and electron density gradients arises. The complex of filiform channels with characteristic micron diameters eventually forms a spark channel connecting the electrodes. It was found that the complex microstructure of the current channels, starting from the moment of their formation, is preserved even in the stage of the already developed spark channel. It should be note that a complex spatial microstructure of the spark discharge was previously indirectly confirmed in other works [2,3].

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References

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