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THE STUDY OF ELECTRIC DISCHARGES IN CENTIMETER GAPS TAKING INTO ACCOUNT THE CHARACTERISTICS OF THE ELECTRIC CIRCUIT *)

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A numerical study of the influence of an external electric circuit on the formation of a columnar contracted discharge in nitrogen is carried out. The computational algorithm is based on the diffusion-drift model and the Euler system of equations. The continuity equations included in the model are solved using the second-order Godunov method, and the Poisson equation is solved using the iterative Gauss-Seidel method with upper relaxation. The problem assumes axial symmetry. Two plane-parallel round electrodes with a radius of 0.9 cm are placed at the ends of the gas-discharge gap, the distance between them is 0.6 cm. The plasma, gas parameters and boundary conditions are taken in accordance with [1]. At the initial moment of time, a spot of quasi-neutral plasma in the form of a Gauss profile near the cathode is located [2].

In the first problem, an electric field source with $\mathscr{E}$=25 kV is connected to the electrodes, while the external resistance is negligibly small (R=0). As a result, an unlimited growth of the plasma channel thickness is observed at the stage after the closure. Figure 1 (for all three problems) shows the time sweep of the electron density in the cross-section z=0.2 cm. The radial expansion is associated with the process of propagation of secondary ionization waves between the electrodes near the channel boundaries, which subsequently leads to the occurrence of "pulsations" in the temperature and pressure profile [1].

In the second problem, a ballast resistance R=2.5 kOhm is added to the external circuit (the current source is the same). In Fig. 1b) it is evident that the external resistance allows the current value in the circuit to be adjusted in such a way that the expansion of the plasma channel tends to saturation. This leads to an increase in conductivity, an increase in current magnitude and, as a consequence, an increase in voltage on the resistor and a drop in potential on the anode [3].

In the third problem, the current source is a capacitor with a capacity of C=2 pF, initially charged to a voltage of U=25 kV. The external resistance is R=100 Ohm. During the discharge of the capacitor, the channel width first reaches its maximum value, after which it remains almost constant, despite the gradual drop in the current and voltage across the discharge gap (Fig. 1c) [3].

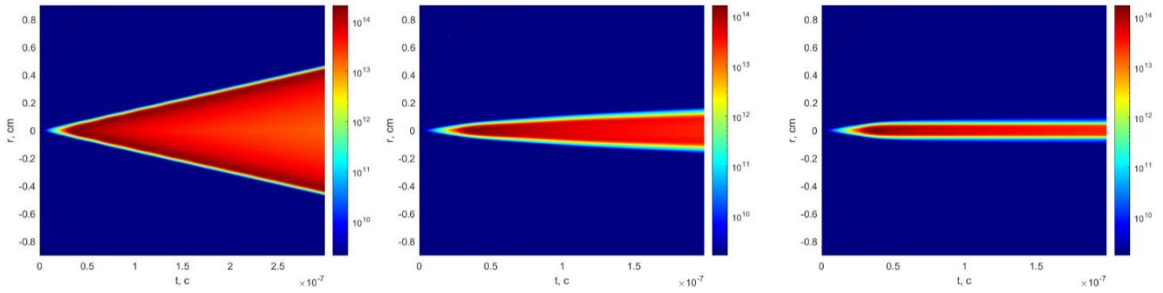

Fig. 1. Time sweep of electron density ne: a) $\mathscr{E}$=25 kV, R=0, b) $\mathscr{E}$=25 kV, R=2.5 kOhm, c) U=25 kV, C=2 pF, R=100 Ohm

References

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