Self-organization of current structures on electrodes of glow and arc micro-discharges at atmospheric pressure

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For gas discharges of direct current at high pressures, including atmospheric pressure, a violation of spatial homogeneity is characteristic. This is due to the fact that a uniform distribution of the current density over the cross section is unstable and current structures are formed. In addition, at high pressures, in cases of sufficient heating of the electrodes, the glow discharge passes into an arc. In this transition was simulated and various scenarios of current-voltage characteristics (CVC) were shown. However, without due attention, the study of the formation of various current structures in the entire range of currents corresponding to the independent discharge remained. In the work presented, numerical studies of the formation of current spots on the cathode and anode in micro discharges of direct current in an argon atmosphere were carried out. A hybrid discharge model based on the continuity equations for charged and excited particles, heat balance equations for the electronic and heavy plasma components, Poisson's equation for describing the electric field, and the heat balance equations for describing the thermal fields in the cathode and anode was considered. On the solid-plasma boundaries, self-conjugate effect, taking into account the heating of the electrodes, were considered. As a result, the onset of thermionic emission was taken into account at the cathode. Transport coefficients, as well as inelastic processes involving electrons, were determined from the local boltzmann kinetic equation. The formulated model described the main parameters of a gas discharge (glow and arc discharges) in a wide range of discharge currents and to obtain its classical current-voltage characteristic. In this case, violation of the radial uniformity of the plasma parameters of the discharge, which are noticeable near the surface of the electrodes, appeared across all sections of the CVC through a characteristic time. Perturbations occurred randomly both on the axis of the computational domain, forming a classical current spot, and at an arbitrary distance from the axis, forming a ring. It is worth noting that the ring current structures appeared on the CVC section corresponding to a normal glow discharge. In certain cases, the ring formed was unstable, its radius decreased and the formation of a stationary spot occurred, as in the first case. At high values of the discharge current characteristic of the arc discharge, the dynamics of the formation of a contracted current spot was obtained. The study was carried out with the financial support of the Russian Foundation for Basic Research in the framework of the scientific project No. 16-38-60187 Mol_a_dk.

Biography

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