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* NUMERICAL STUDY OF DIRECT CURRENT ATMOSPHERIC PRESSURE DISCHARGE: FROM GLOW TO ARC DISCHARGE IN ATOMIC AND MOLECULAR GASES *

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. In the presented work, a self-consistent physical and mathematical model of direct current gas discharges is formulated, which in a unified way describes the processes occurring in the discharge gap and electrodes [1-3]. The model is based on equations for an extended fluid description of processes in a gas-discharge plasma, taking into account secondary and thermionic or thermofield emission from the cathode, heat balance equations for electrodes that describe the distribution of temperature fields in them, continuity equations for the current density in the electrodes, and an equation for an external electric circuit. Within the framework of the formulated model, numerical studies were carried out in 1D and 2D approximations on the formation of parameters of direct current discharges in atomic and molecular gases of atmospheric pressure in a wide range of currents.

As a result of numerical experiments, for one-dimensional geometry, the dependence of the voltage drop across the discharge on the current density was obtained, and for the two-dimensional geometry, the current-voltage characteristic (CVC) of the discharge, which reproduces the formation of glow, transition from glow to arc, and arc modes of direct current discharges in argon and nitrogen. The distributions of the main mechanisms of electrode heating are presented, as well as the values of their temperatures at the boundary with the discharge, depending on the current density. It is shown that in a discharge with refractory (tungsten and graphite) electrodes, an arc discharge is formed with a diffuse current spot completely covering the cathode surface. In a discharge with copper (non-refractory) electrodes, supported by thermionic field emission, an arc discharge is formed with a contracted current spot on the cathode. For various DC discharge modes, the distributions of plasma parameters are presented: the concentrations of charged and excited particles, the intensity and potential, the temperature of electrons and neutral particles, and also the vibrational temperature.

In addition, a study was made of the effect of electrode material evaporation on the distributions of the main plasma parameters in arc discharges of atmospheric pressure in argon with graphite (refractory) electrodes and copper (non-refractory) electrodes. In addition to plasma-chemical processes in argon [1], for a discharge with graphite electrodes, a fairly detailed set of plasma-chemical reactions was compiled, taking into account the formation of neutral carbon particles C, C_2, C_3, their ions C^+, C_2^+, C_3^+ and excited states C*, C_2*, C_3* . For a discharge with copper electrodes, a set of elementary processes with the participation of copper atoms was taken into account, taken from [4], in which processes with the formation of atomic copper ions were taken into account. As a result of numerical experiments, it is shown that when the critical value of the current density is reached, an abrupt change in the plasma parameters is observed: on the current-voltage characteristic of the discharge and on the dependences of the charged particle concentrations averaged over the gas-discharge gap on the current density. A transition is observed from an arc discharge in an argon atmosphere to an arc in carbon vapor or copper vapor.

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