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END-TO-END MODEL OF A ICRF STREAM DISCHARGE AT INTERMEDIATE PRESSURE *)

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The urgent task of innovative industrial development and qualitative changes in the modern industrial cycle is to increase the reliability and durability of products made of organic and inorganic materials and to give them qualitatively new properties. One of the effective ways to improve the characteristics of materials is their processing in a plasma jet of a radio frequency (RF) low-pressure discharge [1].

RF discharge plasmas with gas flow at pressure p = 13.3-133 Pa are used to modify the surfaces of various materials, such as steel, titanium, polyethylene, leather, fur, etc. [2].

The plasma created by this type of discharge has the following properties: the degree of ionization is 10^{-4}-10^{-5}, the electron concentration is 10^{15}-10^{19} m^{-3}, the electron temperature is 1-4 eV, the temperature of atoms and ions in a plasma clot is 0.2 — 0.3 eV, in a plasma jet 0.03 — 0.07 eV.

The experimental data obtained [1] show that the type of discharge under study does not belong to any of the existing ones, since both azimuthal H_φ and axial components E_z of electric and magnetic field strengths are found in the RF plasma jet in the vacuum chamber, which is atypical for the H-form of the discharge. It is worth noting that only H_z and E_φ are detected in the discharge chamber, that is, in the discharge chamber the discharge is in H-form, as the results of experimental studies show [1]. In addition, the birth of charged particles occurs along the entire length of the vacuum chamber, and is not a stream of decaying plasma. That is, the jet is an independent new type of discharge, which can be called a " flow discharge".

To describe a ICRF stream discharge at intermediate pressure, a mathematical model has been developed that includes the Boltzmann equation for the carrier component of the plasma, the energy conservation equation for the electron temperature, telegraphic equations for the RF component of the plasma, the Poisson equation in the Lorentz calibration for the ambipolar component of the electromagnetic field, continuity equations for electrons, ions and metastabilities. The coefficients of mobility and diffusion are determined from the electron energy distribution function recorded taking into account the presence of an RF field.

Thus, a mathematical model is constructed that allows calculating the main characteristics of the discharge and the jet, determining the parameters of the positive charge layer. As a result, it was found that under the above conditions, the ion energy can vary from 30 to 100 eV, and the ion current density from 0.5 to 15 $A \cdot m^{-2}$.

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