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Manuscript

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HIGH-CURRENT LOW-PRESSURE QUASI-STATIONARY DISCHARGE IN A MAGNETIC FIELD: EXPERIMENTAL RESEARCH

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Ph.D. Thesis in Physics and Mathematics

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INTRODUCTION.

Low-pressure discharges in a transverse magnetic field are the subject of intensive research due to their wide use in technological magnetron devices, closed-electron-drift plasma accelerators, and as plasma emitters in electron and ion injectors.

An analysis of the literature shows that the properties of the discharge in a transverse magnetic field with closed electron drift in the area of transition from a magnetron discharge with a growing current-voltage characteristic to an arc discharge are practically unknown. There are no sound theoretical and experimental data to determine the limit regimes of the magnetron discharge in which most technological devices operate. The study of high-power pulsed discharges used for the generation of dense homogeneous plasma indicates the possibility of existence of stable forms of discharge in a magnetic field, not transiting to a contracted phase at high currents, and generally corresponding to the arc regime of the current-voltage characteristic of such discharges.

Purpose of the research:

To study the current-voltage characteristics and the regimes of existence of the high-current quasi-stationary low-pressure discharge in magnetic fields of different configurations.

To determine the local plasma characteristics of the above-mentioned forms of discharge.

To study the possibility of using a high-current discharge plasma to generate dense plasma formations and intense flows of charged particles.

Scientific novelty and practical value of the work:

In carrying out this work, we have investigated a range of parameters and regimes of high-current forms of quasi-stationary low-pressure discharge in magnetic fields of different configurations.

A new stable form of quasi-stationary discharge in a transverse magnetic field was discovered, which is an intermediate stage of transition from the magnetron discharge to the arc discharge (high-current diffuse mode) and has the following main characteristics: voltage $\simeq$100 V, duration of several milliseconds, and current intensity range between 10 A and 2 x 10^3 A. A qualitative model is proposed, explaining the possible mechanism of emergence and existence of this type of discharge.

We have established the existence of a high-voltage high-current form of quasi-stationary magnetron discharge (high-current magnetron regime), characterized by high voltage (up to 1200 V) and high cathode current density (up to 25 A/cm^2). The duration of this type of discharge can exceed 20 ms.

We have indicated the possibility of obtaining plasma formations with a density of up to 1.5 x 10^{15} cm^{-3} in a volume of up to 1000 cm^3, which ensures the emission of an ion beam with a density of more than 10 A/cm^2 and an energy of 100 eV.

We have also demonstrated the possibility of intensive cathode sputtering and creation of high density flows of sputtered material particles.

The results obtained are used:

- In new plasma technology for ion-stimulated etching and in building a plasma reactor for rapid layer etching (NPO [*Nauchnoe-*

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