Topic number 8

Formation of electrical potential profile in DC reflex discharge

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In the paper reflex DC discharge in helium was explored. It was studied the effect of parameters such as magnetic field of 0.03 to 0.2 T, the pressure of 0.1-100 mTorr, discharge voltage of 0-1,2 kV, the distance cathode-cathode and cathode-anode on plasma column potential. It was shown that the dependence of the plasma column potential on pressure has two maxima. The position of the maxima was determined by the magnetic field. By single floating probe was measured radial profile of the plasma potential. Using a double probe was measured concentration and the electron temperature. The range of the potential oscillations of the plasma column in different modes was defined.

1. Introduction

The question about the formation of a defined spatial profile of the electric potential in the plasma is important in the plasma separation method of spent nuclear fuel [1]. The combination of electric and magnetic fields leads to spatial separation of «light» (m<160 u) and «heavy» (M~240 u) component of spent fuel. At the ends of the cylindrical chamber are the electrodes. To these electrodes is applied a negative voltage. A grounded vacuum chamber in conjunction with these electrodes forms a reflex discharge. This discharge generates a radial profile of the electric plasma potential. The work is devoted to the study of this profile.

2. Experimental setup and methods

We use single floating probe to measure plasma potential. Such measurement gives us a value with errors less than 10%. Electron temperatures and plasma density we measure by double probe method.

Schematic setup of the experimental facility is presented on Fig. 1. Cylindrical vacuum chamber (anode) 1 with diameter 856 mm has the length of 1900 mm. Helmholtz coils 2 are positioned coaxially with the chamber. The coils have inner diameter of 100 cm, and they stand at a distance of 50 cm from each other. Cathodes 3 are fixed on the chamber end planes on dielectric plates 4. We have used circular and ring shape cathodes. In addition, we have used superposition of them. Cathodes positioning on the opposite end planes is absolutely identical in all tests. In this connection hereafter in this text we will always discuss the electrodes positioning on one end plane only, having in mind that at the other end the layout is exactly the same. The plates screen the conductive chamber's end planes from the discharge gap. Thus, the cylindrical surface of the grounded chamber serves as a discharge anode.

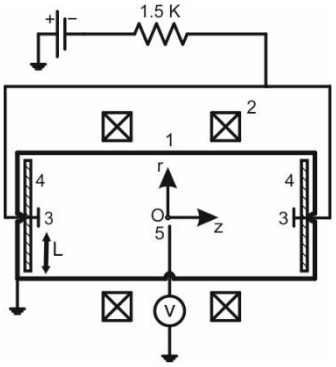

Fig. 1 Experimental setup

3. Results

Considered different geometries of the electrodes. Distance between anode and cathode is an important parameter, the smaller that distance is the lower is the electrostatic potential reproduced in the plasma volume. Increase of the discharge voltage up to 1.2 kV leads to the growth of the potential maximal value. However, at further increase of the discharge voltage, the plasma potential practically does not change. Varying the magnetic field value it is possible to change both – plasma potential and discharge current. Plasma potential monotonously grows with the growth of the magnetic field, and the dependence of the discharge current on the magnetic field has its maximum at B=40 mT. The value of plasma column potential is up to 800 V depends on conditions.

Acknowledegements

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4. References

[1] V.P. Smirnov, A.A. Samokhin, N.A. Vorona and A.V. Gavrikov Plasma Phys. Rep. 39, (2013).