Numerical study of current flow in a vacuum diode with laser ignition

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In [1,2] there were experimentally studied the dynamics and emission properties of plasma rapid laser induced vacuum discharge of low and medium power in a wide range of energy and power density of the laser pulse. In particular, there were shown that the time of discharge (the formation of plasma closing between the anode and cathode) is determined by the laser power density on the cathode, and the process of plasma pinch current flow in the diode is dependent on the mass of material ablated by laser radiation. In the future, it is important to construct a mathematical model of aggregate plasma processes occurring in the discharge for the development of X-ray sources, VUV- radiation of multiply charged ions on the basis of such discharges. Adjustment of the model to experimental data allows to perform calculations for predictive modeling and optimization of system parameters to achieve the characteristics of the discharge required in various applications.

The presented paper concerns with processes occurring in a vacuum diode which is initiated the action of an electric current resulted from illumination of a cathode by a short laser pulse. The study is carried out by means of numerical simulation. The governing system describes the above mentioned processes in terms of MHD S.I.Braginskii model and is taken for the case of cylindrical RZ-geometry. The complete numerical model describes a stage of a plasma "plume" formation resulting after a laser pulse action as well as an advanced stage of MHD effects, e.g. “pinching” caused by the passage of electric current through the plasma, and Z-pinch plasma dynamics.

The results of numerical experiments permit us to suggest that the numerical model adequately reflects the physical picture of the current pulse in the diode when filling it by a laser plasma. We can state good qualitative and satisfactory quantitative agreement with experimental data [ 4] and theoretical estimates as concerns to the time and location of the pinch forming, and the values of temperature and density.

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