ON A POSSIBILITY TO INCREASE THE RADIATION PROPERTIES OF THE PLASMA OF A LOW-POWER VACUUM DISCHARGE WITH LASER IGNITION

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The paper presents the results of experimental and theoretical studies of characteristics of the X-ray radiation from a pinched plasma within a vacuum discharge with a stored energy less than 28 J at a voltage of 16 kV, a current of 28 kA and its rise rate of up to 5∙1011 A/s. The discharge was ignited by a pulse from a neodymium laser of nanosecond duration of energy ≤500 mJ at a radiation power density within 1010 to 1012 W/cm2.

It is shown that the nature of plasma radiation is determined by the combination of the characteristics of the discharge and the laser pulse. It has been established that an increase in the discharge current and the laser pulse energy in the mode of sharp focusing of the beam on the cathode, leads to a significant increase in the radiation yield without increasing the plasma temperature. The defocusing of laser radiation, which modifies the mode of a laser plasma expansion from a quasi-spherical shape to a jet shape, leads to the formation of an area of increased density on the axis of the discharge. In turn, this leads to an increase in the energy of quanta   
(≥700 eV) and the intensity of radiation of the neck, which upper bounds are refined.

A description is given of the method for synthesizing VUV spectra within the framework of the model of collisional-radiative equilibrium and the results of the method application for determining the plasma parameters of the above-mentioned discharges. The basis of the method is the calculation of the spectral characteristics of the plasma for specified values of its temperature and density and the following fitting of the experimental spectra by a linear combination of the calculated ones. From the ratio of the weighting coefficients with which the calculated spectra are included in the resulting synthetic spectrum, the characteristic ranges of the plasma parameters are determined. Based on the simulation, it was concluded that the defocusing of the laser beam, which leads to a decrease in the power density of the radiation by two orders of magnitude, raises the plasma temperature in the neck by 30 eV and its density by half the order of magnitude compared to the sharp focusing mode. The achieved temperatures and density are 160 eV and 3∙1021 cm–3, respectively.

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