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OPTIMIZATION OF DOUBLE SHELL HYBRID GAS-PUFF WITH OUTER PLASMA SHELL FOR EFFICIENT GENERATION OF K-SHELL RADIATION IN THE MICROSECOND IMPLOSION REGIME*

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Studies of Z-pinch plasma as X-ray source were carried out on the GIT-12 generator (4.7 MA, 1.7 μs) in the IHCE SB RAS, Tomsk. The main purpose of the research was optimization of load parameters for efficient generation of the argon K-shell radiation in the microsecond implosion regime. A new type of a Z-pinch load, a hybrid gas-puff with an outer plasma shell, was tested. The inner argon shell is actually a solid gas jet on the axis of the system with a small initial diameter. An outer deuterium shell plays the role of an implosion stabilizer for the inner gas jet. The third component is the outer plasma shell, which provides the initial conductivity. The outer deuterium shell, together with the outer plasma shell, has proved its effectiveness in past experiments, providing stable implosion at times of the order of μs [1][2]. In these experiments, the diameter of the inner argon jet was 20 mm, the diameter of the annular deuterium shell was 81 mm, and the outer plasma shell was generated by 48 plasma guns located at the diameter of 350 mm. The experiments were carried out at constant parameters of the outer deuterium and plasma shells with varying parameters of the inner argon jet. An electromagnetic valve with separate volumes formed a hybrid gas-puff consisting of an annular outer shell and an inner central jet.

To increase the K-shell radiation yield, the following initial load parameters were changed: the mass of the gas-puff, the time of gas injection, and the transparency of the grids of the interelectrode gap. To study the dependence of the K-shell yield on the implosion dynamics, we analyzed the initial density profiles of the gas-puff [3], and B-dots data. The K-shell yield increased when the matter of the central argon jet did not propagate from the central region to the periphery. This was achieved by reducing the mass of argon jet, the injection time, and the absence of a grid under the central argon jet. As a result, K-shell radiation yield increased from 1.0 kJ/cm to 1.5 kJ/cm, and the power increased from 380 GW/cm to 535 GW/cm at a peak implosion current of 2.8 MA. This radiation yield is 70% of the theoretical yield at this current level, calculated by the two-level model [4]. Previously [5], for a double shell argon gas-puff with outer plasma shell (with cascade parameters jet/shell of 20/100 mm), the K-shell radiation yield was 60% of the theoretically expected yield for a current level of 3.1 MA, and the power reached 280 GW/cm. Thus, the hybrid gas-puff proved to be promising for a further increase in the yield of K-radiation in the microsecond implosion regime, which is the subject of our further investigations.

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