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ON THE STRUCTURE OF THE HIGH PRESSURE DISCHARGE FRONT PROPAGATING DUE TO PHOTOIONIZATION BY ITS OWN EUV RADIATION *)

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In a series of experiments to develop the concept of an extreme ultraviolet (EUV) radiation source based on a laser discharge with multiply charged ions in a high-density xenon flow, it was experimentally demonstrated that when focusing Nd:YAG laser radiation with an energy of 0.8 J and a pulse duration of 7 ns on a supersonic xenon jet it is possible to obtain EUV radiation in the range of 11.16±0.13 nm with an energy of up to 10 mJ, which corresponds to a conversion efficiency of >1% [1]. To explain such high efficiency, a new mechanism of discharge propagation beyond the focal region was proposed, associated with photoionization of the surrounding gas by EUV radiation and subsequent heating of the resulting plasma by a heat flow from the focal region due to electronic thermal conductivity [2]. The proposed mechanism made it possible to explain the experimental data and indicate ways to increase the efficiency of laser radiation conversion in EUV radiation sources for high-resolution projection lithography [3].

In this report the structure of the front of a combined wave, formed by the combined influence of the processes of radiation, photoionization and nonlinear electronic thermal conductivity is discussed. The distributions of plasma concentration and temperature in this front and the dependence of the speed of propagation of the ionization wave on the parameters of the laser discharge are studied.

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References

[1]. V.E. Guseva, A.N. Nechay, A.A. Perekalov, N.N. Salashchenko, N.I. Chkalo, Investigation of emission spectra of plasma generated by laser pulses on Xe gas-jet targets, **Appl. Phys. B 129**, 155 (2023)

[2]. I.S. Abramov, S.V. Golubev, E.D. Gospodchikov, and A.G. Shalashov, Expansion of laser discharge in xenon jet improves EUV-light emission, **Appl. Phys. Lett.**, **123,** 19350 (2023)

[3]. I.S. Abramov, S.V. Golubev, E.D. Gospodchikov, and A.G. Shalashov, *Propagation of Laser Discharge in Gas Flow due to Extreme Ultraviolet Radiation Of Multiply Charged Ions*, 51 Zvenigorod International conference on plasma physics and controlled fusion March 18 – 22, 2024

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