LOCALIZED THz DISCHARGE SUPPORTED BY FEL RADIATION: MODELING of BREAKDOWN AND glow regimes [[1]](#footnote-1)\*)

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A localized discharge supported by terahertz (THz) radiation in a noble gas stream seems quite promising for use as a point-like source of soft x-ray (extreme ultraviolet) radiation required for high-resolution projection lithography [1, 2]. This is due to the fact that the range of plasma densities corresponding to the optimal absorption of THz radiation is also the optimum transparency range for soft x-ray radiation with a wavelength of ~ 10 nm [3, 4].

To support the discharge, high-power radiation is required [5]. The most reliable of the existing sources of high-power THz radiation is a free-electron laser (FEL). However, the high density of the supported discharge and the extremely short (~ 100 ps) FEL pulse make it difficult to diagnose the internal spatial structure of the discharge and its evolution in time. As a result of this, the development of a theoretical model of such discharges is of great importance, as this makes it possible to restore the necessary parameters of the discharge from the averaged characteristics available for measurement, to study the possibilities of optimization of experiments.

The paper presents a model of breakdown and maintaining of a discharge in an inhomogeneous gas stream by a sequence of pulses of high-power THz radiation. The issues of localization of the discharge, plasma decay processes between pulses, achievable ionization degrees, and radiation of discharge ions are discussed.

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References

1. C. Wagner and N. Harned, Nat. Photonics **4**, 24 (2010)
2. V. Bakshi, *“EUV Sources for Lithography”*, SPIE Press, Bellingnam, 1057 p. (2005)
3. Y. Izawa, K. Nishihara, H. Tanuma et al. Journal of Physics: Conference Series **112**, 042047 (2008)
4. I. S. Abramov, E. D. Gospodchikov, and A. G. Shalashov, Phys. Rev. Applied **10**, 034065 (2018)
5. A. G. Shalashov, A. V. Vodopyanov, I. S. Abramov et al. Appl. Phys. Lett. **113**, 153502 (2018)
1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/XLVII/Lt/ru/ES-Abramov.docx) [↑](#footnote-ref-1)