OPTIMIZATION OF THE EXPERIMENTAL SCHEME for STUDYING THE POWERFUL PULSE EFFECT OF AN ELECTRON BEAM ON THE FIRST WALL OF PLASMA INSTALLATIONS MATERIALS [[1]](#footnote-1)\*)

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In powerful plasma and plasma-beam installations, including those focused on solving problems of controlled thermonuclear fusion, there is a problem of the safety of the first wall of the vacuum chamber facing the plasma. This is especially true of abnormal operation of accelerator installations, the hit of plasma or beams of accelerated particles on the wall in connection with the development of instabilities or in emergency situations. In this case, energy with densities up to hundreds of J/cm2 can be released on the surface. This can lead to serious degradation of the materials of the first wall (see, for example, [1, 2]).

In [3], it was proposed to use a high-current electron beam of the Calamary setup operating in the mode of low energy densities to simulate emergency situations with a powerful energy release on the wall of the vacuum chamber [4]. The first experiments demonstrated that even with relatively small exposures, significant damage to the samples occurs. At the same time, the deposition of the cathode material and the sample substrate onto the surface was observed, which made it impossible to estimate the amount of substance carried away from the sample surface.

In this paper, we propose a scheme of a diode unit that allows minimizing the effect of cathode plasma on the study of the effect of a high-current electron beam on the materials of the first wall of powerful plasma installations. The possibility of using a cathode and a substrate made of a refractory material (molybdenum) is considered. At first glance, such a solution seems obvious, but, as it turned out, there are a number of significant drawbacks. In addition to the fact that the mechanical processing of refractory materials is very difficult, and, therefore, individual parts are extremely expensive, such materials have increased fragility. At most high-current accelerators, the formation of the beam and its interaction with the target is accompanied by the development of powerful shock waves propagating along the body of the installation, which leads to the rapid destruction of the cathodes. This paper presents the results of experiments using molybdenum and stainless steel cathodes. An alternative combined scheme of the cathode is proposed, which makes it possible to minimize sputtering of the cathode and, at the same time, ensure its durability.

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References

1. Martynenko, Yu.V., Budaev, V.P., Grashin, S.A., and Shestakov, E.A., Brief Communications on Physics, FIAN. 2017. No. 6. S. 45–52.
2. V.P. Budaev // VANT. Ser. Thermonuclear fusion, 2015, vol. 38, no. 4, p. 5-33.
3. E. D. Kazakov, A.A. Kurilo, M.Yu. Orlov and others // Proceedings of the VI International Conference "Laser, Plasma Research"(LAPLAS-2020). 2020.Vol. 2 p. 265-266.
4. Demidov B.A., Efremov V.P., Kalinin Yu.G., et al Journal of Physics: Conference Series 2016 V. 774, Is. 1, 27, 012129
1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/XLVIII/Pt/ru/GV-Kazakov.docx) [↑](#footnote-ref-1)