DETERMINATION OF ABSORBED ENERGY IN METAL FOILS UNDER THE effect OF PLASMA IN THE PLASMA FOCUS INSTALLATION [[1]](#footnote-1)\*)

DOI: 10.34854/ICPAF.2020.47.1.163

1Nikulin V.Ya., 2Kolokoltsev V.N., 1Silin P.V., 2Maslyaev S.A., 2Borovitskaya I.V., 1Peregudova E.N.

1P.N. Lebedev Physical Institute of the Russian Academy of Sciences, [nikulinvy@lebedev.ru](mailto:nikulinvy@lebedev.ru) 2A.A Baikov Institute of Metallurgy and Materials Science of the Russian Academy of  
 Sciences, [vkolokolthev@mail.ru](mailto:vkolokolthev@mail.ru)

When studying the processes of interaction between pulsed plasma and the surface of solids in Plasma Focus type installations, there is a problem of finding the absorbed energy in the target. Measurement of the plasma pulse energy by calorimetric methods partially solves this problem, but cannot provide information on what part of the plasma flow energy the target absorbs. At the same time, for calculating the surface temperature, ablation of the target material, and other parameters under the influence of plasma, it is necessary to know exactly the absorbed energy in the target. The aim of the work was the experimental determination of the absorbed energy in metal foils: Al, Cu, V, and W when irradiated with plasma flows at the Plasma Focus PF-4 setup (LPI).

The experiments were performed on the PF-4 Plasma Focus setup with the Maser geometry of the electrodes. The capacity of the installation's capacitor bank 48 μF at a charging voltage of up to 12 kV provided energy in the electric discharge of ~ 3.5 kJ. The duration of the plasma pulse was <100 ns. The working gas was argon at a pressure in the discharge chamber of ~ 1 Torr. Metal foils were exposed to a single plasma pulse. When exposed to plasma, the metal melted, the particles of molten metal were carried away, and the metal evaporated in the form of steam. In this case, the flat surface of the foil under the influence of a plasma flow acquired the shape of a spherical segment. The absorbed energy was determined by the mass and ablation of the molten metal, which were calculated using the expression for the volume of the spherical segment. When calculating the absorbed energy, it was assumed that the mass loss associated with the evaporation of the metal is small. Energy losses due to the thermal conductivity of the metal were not taken into account in view of the small times of interaction of the plasma with the foil surface (<100 ns). The energy expended on the deformation of the foils and the kinetic energy of the particles of the molten metal during expansion were also not taken into account. The energy density determined by this technique on targets of Al, Cu, and V under the action of single pulses of argon plasma was 1.2–3.7 J / cm2.

It should be noted that when estimating the absorbed energy in metal foils, we used thermodynamic quantities and parameters that make sense under thermal conditions close to quasi-equilibrium. The application of the classical concepts of thermodynamics for the case of strongly nonequilibrium processes of heating and evaporation of matter seems to be insufficiently substantiated. For this reason, the found values of the absorbed energy can be considered as estimates in order of magnitude.

This work was supported by the Russian Science Foundation (project No. 16-12-10351).

1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/XLVII/Pt/ru/GR-Nikulin.docx) [↑](#footnote-ref-1)