Parameters of plasma and critical state of matter in a surface-nanofragments explosion model [[1]](#footnote-1)\*)

DOI: 10.34854/ICPAF.2023.50.2023.1.1.249

Tsventoukh M.M.

Lebedev Physical Institute of Russian Academy of Sciences (LPI RAS), Moscow, Russia, [mmtsv@lebedev.ru](mailto:mmtsv@lebedev.ru)

The plasma of a vacuum arc is formed by a sequence of electrical explosions of surface areas during the flow of a high-density emission current. Similarly to the boiling process, pulsed periodic bursts of emission current and plasma bunches are formed from the cathode material. Despite the essentially non-steady and non-uniform nature of the process, some properties of the plasma remain approximately constant, and changing for different elements. So the velocity of plasma ions flying from the cathode is about 5-20 km / s, and their average charge is from +1 to +3.

We have proposed models linking the critical state of matter and plasma parameters [1-3]. A model of an electric explosion of a nanoscale isthmus of a liquid metal jet under conditions of a vacuum arc cathode plasma was constructed. The two-temperature model allowed us to describe the value of the average charge of ions as *Zav* ≈ 1 + *Tcr*/eV and the plasma pulse attributed to the leaked charge as μ ~ 5 (*Mi*/*Mp*)1/2 g cm/(s C), where *Mi*/*Mp* – ion-to-proton mass ratio Agreement with the known (tabular) experimentally measured values was obtained.

Based on the results of measurements of the average charge and kinetic energy of the plasma ions of the vacuum arc, the critical temperature and cohesive energy for Nb-Al alloys were estimated within the framework of our model [4-5]. The use of the obtained values of the critical temperature in the empirical “cohesive energy rule” allowed us to describe the experimentally measured values of the cathode potential drop and reproduce the observed V-shaped deviation from the linear dependence. The obtained results allow us to estimate the critical temperature and binding energy of the substance from the parameters of the vacuum arc plasma. The decrease in binding energy may be due to the structure of the surface relief, namely the presence of defects larger than 1 nm. This is also associated with a decrease in the average charge of plasma ions of a vacuum arc burning on layers of tungsten nanofibers – W fuzz.

The work was carried out with the financial support of the RSF within the framework of the project 22-12-00274.

References.

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