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INVESTIGATION OF THE GENERATION PROCESSES OF MULTIPLY CHARGED HEAVY METAL IONS IN VACUUM ARC PLASMA*

A.G. NIKOLAEV[1], V.P. FROLOVA[1,2], E.M. OKS[1,2], G.YU. YUSHKOV[1]

[1] Institute of High Current Electronics SB RAS, 2/3 Academichesky Ave., Tomsk, 634055, Russia,
Email: nik@opee.hcei.tsc.ru, phone: +7(3822)-491776
[2]Tomsk State University of Control Systems and Radioelectronics, 40 Lenin Ave., Tomsk, 634050, Russia

In a vacuum arc operating at an arc current pulse amplitude of hundreds of amperes, a pulse duration of more than tens of microseconds, and at a residual gas pressure of 10^{-4} Pa, without special measures to increase the charge states of the ions, the average charge of the plasma ions of the cathode material and, accordingly, the formed based on the ion beam, ranges from 1+ for carbon to 3+ for heavy metals. A further increase in the charge states of the vacuum arc plasma ions makes it possible to increase the ion energy in the extracted beam without a corresponding increase in the accelerating voltage. This expands the technological capabilities of ion sources in solving problems of ion-beam modification of surface properties.

The charge states of the ions can be significantly increased in the case of a vacuum arc with a short pulse duration. Previously [1], we showed that the use of such a discharge with a pulse duration of a few microseconds and a kiloampere current range makes it possible to obtain the 19+ charge state for bismuth ions at an average charge state of 17+ ions. This report presents a study of the processes of generation of multiply charged heavy metal ions on the example of a tantalum cathode. The duration of the arc current pulse was further reduced to a submicrosecond level with a corresponding increase in the current and discharge power. As a result, record charge states for tantalum were obtained up to 13+ at a record average charge of tantalum ions 11+.

REFERENCES

[1] G. Yu. Yushkov, V. P. Frolova, A. G. Nikolaev, E. M. Oks, “High-charge-state ion beam generation in a high-current pulsed vacuum arc source,” IEEE Transactions on Plasma Science, vol. 47, pp. 3586-3589, August 2019.

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