Contribution ID: **730** Type: **Poster**

4P05 - Features of the millisecond arc discharge generating emission plasma in the forevacuum plasma-cathode source of large-radius electron beam

Thursday 27 June 2019 16:00 (1h 30m)

The pulsed low-energy (up to 15 keV) forevacuum plasma-cathode electron sources, operating at pressures 3-30 Pa, provide direct processing of dielectric materials (ceramics and polymers) due to compensation of negative charge on the dielectric surface by beam-produced plasma and by non-self-maintained discharge between charged surface of the dielectric and a grounded vacuum chamber. In addition, the beam-produced plasma also can be used for surface modification. For some applications of the large-radius electron beam and beam-produced plasma (e.g. surface modification of high temperature materials), it is necessary to increase the pulse energy (energy density). While at current up to 100 A and gas pressure of 3-30 Pa maximal accelerating voltage is limited by breakdown of accelerating gap, one of the ways to obtain the required beam energy per pulse is to increase pulse duration up to several milliseconds. For stable generation of emission plasma with millisecond pulse duration, we have used an arc discharge with cathode spot. A copper cathode with diameter of 5 mm, and a hollow anode with height of 90 mm and diameter of 110 mm, have been used. Our study has demonstrated that gas type and gas pressure strongly affect on the arc parameters in 3-30 Pa pressure range. Increase of pressure and the use of gas with greater ionization cross section results in decrease of arc discharge voltage. At distances more than 40 mm from the cathode, increase of gas pressure leads to plasma density growth. Depending on the gas and its pressure, significant increase in plasma density can occur only up to 1 ms. Thus, at the pulse duration of more than 1 ms, the arc discharge operates in quasi-stationary mode in the forevacuum pressure range.
The work was supported by Russian Foundation for Basic Research, grant No. 18-38-20044.

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Session Classification: Poster - Charged Particle Beams and Accelerators and High Energy Density Plasmas and Applications

Track Classification: 3.1 Plasma, Ion and Electron Sources