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NUMERICAL SIMULATION OF INDIVIDUAL CELL OF THE ELECTRON BEAM SOURCE WITH A PLASMA CATHODE

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Investigations on the formation of an electron beam in a source with a plasma cathode [1] were recently carried out at the INP SB RAS. A source with a multiaperture diode EOS was used to generate the beam.

Previous experimental and theoretical studies of plasma emitters of electrons [2] made it possible to obtain a qualitative and semi-quantitative physical picture of the processes for different emission regimes. The use of numerical simulation for the quantitative calculation of plasma emission sources of electron beams was difficult due to the lack of codes adequate to the problem. In most cases, simulations are performed using programs for calculating ion beams in the positron simulation mode [3, 4, etc.]. These, as well as existing codes for modeling electron sources, for example [5, 6] assume that electron emission occurs from an open plasma boundary. But, as a rule, in beam sources used for applications, plasma emitters operate in the regime of layer emission stabilization [2, p.46]. This mode was generally not considered in numerical simulation codes. Therefore, it seems necessary to check the applicability of any of the available universal codes for modeling these modes.

For this purpose, the KARAT code developed on the basis of the "particles in cells" (PIC) method [7] is considered. The steady state problem is solved for the formation of electron and ion flows in the plasma emitter of an electron beam source [1]. The main problem in formulating the problem was the lack of data on the parameters of the real emission plasma. Therefore, the parameters used in the model are typical for such emitters. At the first stage, the analysis of the obtained physical picture was carried out – the structure of the potential and fluxes of the plasma components during the formation of the electron beam. Two regimes of emitter operation are demonstrated: the regime of layer emission limitation and the regime of a partially open plasma boundary. Quantitative dependences of the beam characteristics on the source parameters are obtained. Conclusions are drawn about the scope of this code.

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