Generation of High Density and Energetic Electron Beam from Pseudospark Discharge Based Plasma Cathode Electron Source

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Abstract

Pseudospark discharge based plasma cathode electron (PD-PCE) sources are novel way to generate high density ($\geq 10^4$ A/cm^2) and energetic (~20keV) electron beams with fast current rise ~10^{12} A/s and power density ~10^9 W/cm^{-2} [1-2]. The generated electron beams are self-focused and propagated without use of any external guiding magnetic field [1-2]. The exceptional properties of pseudospark discharge based sources make them suitable for plasma switches, electron beam generation, EUV/X-ray radiation, microwave sources etc [1-4]. The PD-PCE sources are primarily comprised of hollow cathode (HC) and/or planner anode and classified in single and multi-gap arrangements [1-3]. The high energy and quality e-beams are generated in a multi-gap PD-PCE source arrangement [5-7]. In fact, electron beam generation is a complex discharge process which is influenced by geometrical and operating parameters [5-7]. The paper presents the complex discharge mechanism for the generation of e-beam with different discharge phases in single-gap as well as multi gap PD-PCE source with the help of 2-D PIC simulation code. The study has been carried out for different HC geometries, seed electron energies, cathode aperture sizes, gas pressures, for applied voltages 20-40kV. It has been observed that operating parameters strongly influence the peak current and size of e-beam. The size of generated e-beam also depends on the potential profile in the PD-PCE source. Increasing the gas pressure, results an early appearance of e-beam at anode surface with higher peak current, while for higher cathode apertures, the peak current of electron beam reduces. Experimental study has also been carried out at different operating conditions to validate the simulated results.

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