STUDIES OF 2D CHILD LANGMUIR SPACE-CHARGE-LIMITED CURRENT USING ICEPIC*

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The 2D space-charge-limited (SCL) current density in a diode is an important problem for electron beam generation in High Power Microwave (HPM) devices. The SCL current in this research is defined as the largest current that can be emitted from a 2D region such that the resultant electron beam can propagate without reflected particles. Recently Rokhlenko and Lebowitz [1] derived the SCL current in 2D using a semi-analytical solution to the boundary value problem. They found that the current wings near the boundaries have width about 1/3 of the current. This makes the mean current density for narrow beams much greater than the SCL current. Watrous *et al.* used particle-in-cell (PIC) codes to study this problem for a variety of beam widths *w* and anode-cathode *(AK)* gap spacings *d* and found that, although the current density profile varies with both *w* and *d*, the total current is a function of the dimensionless ratio *w/d* [2]. In this work we study two geometries: (i) a wide electron beam on a wider cathode, eliminating edge effects from narrow cathodes, and (ii) a parallel-plate capacitor floating in vacuum with the entire cathode emitting, resulting in a narrow beam, which includes knife edge effects from the cathode. In ICEPIC simulations of the first geometry we are improving on earlier results with a higher degree of accuracy. Our results are in close agreement with earlier simulation results [2] and the semi-analytical solutions of [1]. We are analyzing the effects of various parameters of the simulation space. The resolution and aspect ratio of the cells are analyzed as well as the emission method and particle distribution. The parallel-plate capacitor geometry is also simulated with different numerical parameters to determine the optimal set of parameters to simulate this kind of cathode. The effects of knife edge emission are compared to the analytic theory of Rokhlenko and Lebowitz[1].

1. A. Rokhlenko and J.L. Lebowitz, J. Appl. Phys., vol. 102, 023305-1 (2007). And A. Rokhlenko J. Appl. Phys. vol. 100, 013305 (2006)
2. See, J.J. Watrous, J.W. Luginsland, and M.H. Frese, Phys. Plasmas, vol. 8, 4202 (2001), and references therein.