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Influence of Ion Effects on a Space Charge Limited Field Emission Flow: From Classical to ultrarelativistic regimes[1] M.C. LIN, P.C. CHANG, J.P. VERBONCOEUR, NSSL, DEPT. OF PHYSICS, FU JEN CATHOLIC UNIVERSITY COLLABORATION, DEPT. OF NUCLEAR ENGINEERING, UNIVERSITY OF CALIFORNIA COLLABORATION — The effects of ions in space charge limited field emission flow is studied using a self-consistent model, and confirmed by particle-in-cell (PIC) simulations. The field emission of electrons is described quantum mechanically by the Fowler–Nordheim equation. The cathode plasma and surface properties are considered within the framework of the effective work function approximation. Ionization effects at the anode as well as electron space-charge effects are described by Poisson's equation coupled with the energy conservation equation including relativistic effects. The closed form of formulas has been derived and the numerical calculations are carried out self-consistently to yield the steady state of the bipolar flow from classical to ultrarelativistic regimes. The upstream ion current included in Poisson's equation has been treated as a tuning parameter. The field-emission currents in the presence of saturated ion currents are enhanced by 1.8, 1.5, and 1.4 times of the case with no ion current in the classical, intermediate, and ultrarelativistic regimes, respectively. The solutions have also been verified using 1D PIC simulations as implemented in the OOPD1 code developed by the PTSG of UC Berkeley.

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