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1D Microscale Breakdown Simulations using an Energy-Conserving, Implicit PIC-DSMC Method[1] CHRIS MOORE, MATTHEW HOPKINS, PAUL CROZIER, EDWARD BARNAT, JEREMIAH BOERNER, RUSSELL HOOPER, MATTHEW BETTENCOURT, LAWRENCE MUSSON, Sandia National Laboratories — An energy and charge conserving fully implicit formulation for electrostatic particle-in-cell (PIC) simulations with complex boundary conditions and direct simulation Monte Carlo (DSMC) particle collisions is used in this work to simulate atmospheric breakdown in small gaps. This method allows for energy conservation with arbitrarily large field-solve timesteps limited only by dynamic timescales. Momentum errors are reduced through the use of adaptive sub-stepping of the particle motion over the field-solve timestep allowing for vastly different ion and electron timesteps. Simulations of one dimensional direct current breakdown between two electrodes including electron-neutral elastic, ionization, and excitation interactions and emission of electrons from the cathode via Auger neutralization and field electron emission are presented here. The dynamics of breakdown are investigated and the breakdown voltages deviate from the Paschen curve if the Fowler-Nordheim emission flux is based on the near surface field which includes space charge effects. It is found that, early on, the primary electron generation mechanism at breakdown voltage changes from ionization/Auger neutralization in large gaps to Fowler-Nordheim emission in small gaps.

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