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Multiscale simulation of nanoscale vacuum channel transistors[1]
JESSE SNELLING, GREGORY WERNER, JOHN CARY, University of Colorado, Boulder — A method is presented that accurately simulates steady-state field emission and space-charge-limiting effects in nanoscale vacuum channel transistors (NVCTs). NVCTs consist of a tip (radius 10nm) that field-emits electrons into a large voltage gap (1mm). A significant challenge of simulating NVCTs is the need to resolve vastly different length scales, from the 10nm tip to the 1mm gap. One approach to this problem would be use of a variable grid. However, this approach is complicated and the speed of particle pushing is severely limited by the crossing time of the smallest grid scale. A regular grid is preferable for simplicity and speed so is used for this method. Instead of simulating the entire NVCT, this method breaks the simulation into two linked finite difference electrostatic simulations with different grid scales. Simulation A focuses on the dynamics of field emission near the tip, while Simulation B resolves the space-charge-limiting effects. The simulations are linked by injecting emitted electrons from A into B and imposing a Dirichlet boundary condition on A determined by B. Successive iteration between the two simulations reaches a solution. This talk will discuss the advantages and disadvantages of this method as well as present an analysis of the NVCT.

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