IMPROVED FIELD EMISSION ALGORITHMS FOR MODELING FIELD EMISSION DEVICES USING A CONFORMAL FINITE-DIFFERENCE TIME-DOMAIN PARTICLE-IN-CELL METHOD

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This work introduces a conformal finite-difference time domain (CFDTD) particle-in-cell (PIC) method with improved field emission algorithms to accurately and efficiently study field emission devices. The CFDTD method is based on the Dey-Mittra algorithm or cut-cell algorithm, as implemented in the VORPAL code. Locally distorted cells with edges tangential to the metallic surface are used. The fields in these distorted cells are computed using a modification of the conventional FDTD update equations. Complicated electromagnetic structures can be well described by cut-cells in the CFDTD method. For the field emission algorithm, we employ the elliptic function $v(y)$ found by Forbes and a new fitting function $t(y)^2$ for the Fowler-Nordheim (FN) equation. With these improved correction factors, field emission of electrons from a cathode surface is much closer to the prediction of the exact FN formula derived by Murphy and Good. In addition, divergent problems or singularities in PIC numerical simulations can be well taken care of. As the emission behavior is strongly dependent on the surface electric fields, the local fields, field enhancements around complicated field emission tips, and the corresponding electron emission can be predicted more accurately and efficiently using this new modeling method, both quasi-statically and dynamically.

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* Work supported by the U.S. Department of Defense under Grant No. FA9451-07-C-0025.