

Developing Field Emission Models Employing Nanoscale Surface Characterization

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A popular approach for modeling field emission in particle-in-cell (PIC) simulations is to employ a calibrated Fowler-Nordheim emission model. In this approach, the calibrated geometric enhancement factor, β , is often tuned to extremely large values (10-1000) to reproduce experimentally observed currents. It is an open question if such high- β features actually exist, and thus whether this approach has an actual scientific basis or if the artificially high β is compensating for incomplete physics. We are pursuing an approach that will model field emission with a distribution of β , as well as the work function ϕ , where these distributions are taken from direct material surface measurements. A step in this analysis is to simulate fields in a domain with directly measured nm-sized surfaces from microscopy to produce actual β field enhancement factors. PIC simulations of mm-sized electrodes cannot resolve atomic-scale (nm) surface features and therefore we generate micron-scale models using probability distributions for effective “local” β , ϕ , and emission areas. We compare simulated nm-scale Fowler-Nordheim field emission currents with the currents generated using the micron-scale model on a coarse mesh with a perfectly flat model surface.

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Summary

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