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# Exploring Dependencies of Work Function on Topography and the Application to Micron-scale Field Emission Model for PIC-DSMC Simulations

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We present data from atomic-scale (nm) surface characterization using Scanning Tunneling Microscopy (STM), Atomic Force Microscopy (AFM), and Photoemission Electron Microscopy (PEEM) to show a connection between the surface's local (atomic-scale) work function on the local nanostructure and spatially varying atomic step density. Atomic step-terrace structure is confirmed with scanning tunneling microscopy (STM) at several locations on our surfaces, and prior works showed STM evidence for atomic step dipoles at various metal surfaces. From our model, we find an atomic step edge dipole μ = 0.12 D/edge atom, which is comparable to values reported in studies that utilized other methods and materials. The local field emitted current density from the Fowler-Nordheim equation has an exponential dependence on both the local E-field at the surface and the work function. Therefore, local variations in the work function can have a significant impact on vacuum arc initiation. Furthermore, here we argue that the existence of low work function regions on an otherwise pure/clean material surface occur due to large atomic step densities which also coincide with locally larger topographic field enhancement of the field and thus have an even larger effect on the field-emitted current density. We have taken the surface characterization data and generated a representative probability density function (PDF) of the work function and field enhancement factor (beta) for a sputter-deposited Pt surface. These PDFs are used in a model that generates stochastic, micron-scale field emission currents for use in Particle-In-Cell Direct Simulation Monte Carlo simulations of vacuum discharge at mm-scales.

## Topic

Experiments and Diagnostics

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