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Advancing electrode models for PIC-DSMC simulation of discharge between real electrodes

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We have developed a stochastic surface model for use in Particle-In-Cell Direct Simulation Monte Carlo (PIC-DSMC) simulations of vacuum discharge. In the present work, we simulate breakdown between two parallel Pt plates in which the modelled electrode surface elements are given a local work function and field enhancement factor (β) by drawing values from probability density functions based on the electrode material and preparation/conditioning. Presently, PhotoEmission Electron Microscopy (PEEM) measurements are used to inform the work function distribution. The distribution for the field enhancement factor is obtained by meshing the surface topology obtained via Atomic Force Microscopy (AFM), solving for the roughness-resolved (˜nm's) electric field and field emission, and then computing an effective emission area and β at PIC-DSMC (˜μm) element scales that yields comparable field emission. The framework of the model is extensible to the case where the properties vary in time (e.g. contaminant sublimation or electromigration); however, the current results assume the local properties are constant.

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