PARTICLE-IN-CELL DIRECT SIMULATION MONTE CARLO MODEL OF BOHM DIFFUSION IN A LOW PRESSURE BACKGROUND GAS

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Out-gassing of materials in cross-field vacuum devices, such as magnetrons, causes many problems and must be accounted for in the design, experimentation, and modeling of these devices. Contaminant gasses produced in vacuum devices by electron/ion bombardment of surfaces are at reasonably high pressure near the surface (0.01-0.1 Torr) after initial out-gassing and then expand into the vacuum of the device. To model the evolution of the gas in a vacuum device, a Particle-in-Cell (PIC) Direct Simulation Monte Carlo (DSMC) code is developed. This modeling method provides self-consistent coupling between a high energy plasma and low pressure neutral gas[1]. Accurate simulation of ion Bohm diffusion across an anode cathode (AK) gap in a low pressure gas was achieved with the model, using electron and ion densities, magnetic and electric field parameters similar to a magnetron. Using this code, we investigate the increase in the probability density in the tail of the neutral gas velocity distribution due elastic and charge exchange collisions with high energy ions as well as the resulting increase in anomalous diffusion of the neutral gas from the surface of the anode. We determine the macro particle numbers, PIC and DSMC grid spacing, and time scales that are necessary to accurately model anomalous and Bohm diffusion. By comparing diffusion rates of the simulation to those obtained with an analytical diffusion model, we quantify the impact to the accuracy of the solution when the spatial and time scales are not properly resolved.

1. V. S. Serikov, Kawamoto, S. and Nanbu, K., Particle-in-Cell Plus Direct Simulation Monte Carlo Approach for Self-Consistent Plasma Gas Simulation, IEEE Trans. On Plasma Sci., 27, Issue 5, 1999 pp. 1389-1398.

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* Work supported by Air Force Research Laboratory