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Plasma simulation of hollow cathode effect in a blind hole

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The hollow cathode effect can be used for deposition of amorphous hydrogenated carbon films on inner surfaces of blind holes. In dependence of the aspect ratio between blind hole depth and blind hole diameter, the plasma states vary within the geometry. Due to the different plasma states, it is difficult to deposit homogeneous thin films in terms of their structure and thickness. In the following, a simple argon hollow cathode discharge is considered to give an understanding of the various processes taking place.

In the present investigation, a probabilistic simulation based on the Monte Carlo methods has been used to develop a better understanding of the hollow cathode effect in blind holes with an aspect ratio >> 1. First, pressure gradients inside the blind hole were investigated with a direct simulation Monte Carlo (DSMC) method. Then, the resulting pressure distribution has been used as input for a Particle-in-Cell Monte Carlo (PICMC) plasma simulation to determine the energy input to the hole wall and the charge carrier distribution along the tube. Subsequently, the results were compared to corresponding experimental results, such as pressure measurements, argon ion etching rate, substrate heating rate and results of space-resolved optical emission spectroscopy (OES), to verify the simulation.

Keywords
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