Modeling a Meso-Scale Hollow Cathode Thruster

Joseph J. Wang
Virginia Polytechnic Institute & State University
Dept. Aerospace and Ocean Engineering
Blacksburg, VA 24061-0203

Andrew D. Ketsdever
Air Force Research Laboratory
Propulsion Directorate
Edwards AFB, CA 93524

Andrew J. Jamison
University of Southern California
Department of Aerospace and Mechanical Engineering
Los Angeles, CA 90089-1191

ABSTRACT

Recent studies have shown that a small hollow cathode provides an attractive micro-thruster concept which may overcome many difficulties associated with scaling down conventional Hall thrusters and ion engines. This paper presents a computer particle simulation model for small hollow cathode thrusters. The model is based on the particle-in-cell with Monte Carlo collision algorithm and utilizes a newly developed immersed finite element method to solve the electric field and treat plasma-material interface. The new field solve method allows one to treat the complex geometric/field boundary inside a discharge chamber accurately and computationally efficiently. To validate the simulation model, simulations are performed for a meso-scale hollow cathode[1] to allow a direct comparison between simulation results and measurements. Based on simulation results presented in this paper and measurements presented in a companion paper [1], we investigate the physics underlying micro-scale discharge and derive scaling laws for micro-scale discharge chambers.

[1] A. Ketsdever, A. Jamison, J. Cripps, and J. Wang, “Thrust Measurements of a Meso-Scale Hollow Cathode Discharge”, submitted to IEPC 2003.