

# PIC-DSMC Hybrid Simulation of the High-Voltage Hall Discharge with Wall Effects

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To help understand the internal workings of Hall Thrusters a group at MIT, together with NASA Glenn Research Center and Busek Co, is developing fully kinetic simulations of several different engines. Previous papers [1-4] presented successful simulations of the mini-TAL, and described a first round modeling of the SPT-type P5. After the single-stage SPT thruster is implemented, a sputtering module will be added, and a two-stage thruster will be modeled. When complete, the simulation will serve as both a research tool and a design aid.

The present work represents the latest developments of a full Particle-In-Cell simulation of the P5. The method is fully kinetic for all particles involved, and has been documented previously for a small TAL thruster. We are continuing to refine our methods with improvements to the diffusion model. The numerical method developed for the 2.5-D modeling of Hall thrusters is reinforced with new wall effects (secondary emission and erosion), and results for the ceramic-lined single-stage P5 thruster [3,4] at 300 and 500 volts are presented. Performance of the P5 is well simulated by the code, although discrepancies in the spatial distributions suggest some adjustments still need to be made to the kinetic model.

Comparisons to experimental data and 1D simulations are made for verification of the current model. The anomalous diffusion model is tested, and various transport mechanisms are discussed.

[1] Szabo, J.J., “*Fully Kinetic Numerical Modeling of a Plasma Thruster*”, Ph.D. Thesis, MIT, 2001.

[2] Blateau, V., Martinez-Sanchez, M., Batishchev, O., Szabo, J., “*PIC Simulation of High Specific Impulse Hall Effect Thruster*”, IEPC-01-037, 27 International Electric Propulsion Conference, Pasadena, CA, October 15-19-2001.

[3] Blateau, V., Martinez-Sanchez, M., Batishchev, O., “*A Computational Study of Internal Physical Effects in a Hall Thruster*”, AIAA-2002-4105, Joint Propulsion Conference, July 7-10, 2002, Indianapolis, Indiana.

[4] Kay Sullivan, Manuel Martínez-Sánchez, Oleg Batishchev and James Szabo, “*A Computational Study of Single and Double Stage Hall Thrusters*”, 28th International Electrical Propulsion Conference, Toulouse, France, 17-21 March, 2003