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Dielectric boundary for an unstructured 2D radial-axial fluid simulation of a Hall thruster

G. Bogopolsky, O. Vermorel, B. Cuenot

CERFACS, 42 Avenue Gaspard Coriolis, 31057 Toulouse, France
SAFRAN AIRCRAFT ENGINES, Campus de l'Espace, 1 avenue Hubert Curien, 27207 Vernon, France

Following the gain of interest in Hall thrusters in recent years, a need for accurate and fast numerical simulations has arisen. Multi-fluid models solving the Euler equations for each plasma species with self-consistent electric field and chemical source terms were found to be promising to recover global plasma parameters if closure terms account for kinetic effects.

However, previous Hall thruster simulations have shown that the macroscopic plasma parameters are very sensitive to the boundary conditions, especially in the radial direction, where the commonly used metallic wall condition fails to represent the behavior of the dielectric ceramic used in thrusters.
To improve the simulation, a dielectric boundary condition is therefore necessary.
This work presents the development and validation of a dielectric wall boundary condition for the unstructured multi-fluid solver AVIP. The new condition is first validated on analytical cases, then an extensive evaluation is performed for a 2D radial-axial configuration with comparisons to the metallic wall boundary condition and PIC simulations with dielectrics. Results have shown a significant improvement on the channel modeling and macroscopic plasma parameters.

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