

Phase I Project Summary

Firm: Tech-X Corporation

Contract Number : NNX11CE23P

Project Title: Predicting Hall Thruster Operational Lifetime Using a Kinetic Plasma Model and a Molecular Dynamics Simulation Method

Project Summary

Identification and Significance of Innovation:

For Hall thrusters, the most important life-limiting process is the erosion of the channel walls. However, experimental verification of lifetime is time-consuming and expensive. Therefore, we have proposed to develop a computational tool which can predict Hall thrusters' lifetime more cheaply in time and money.

Technical Objectives and Work Plan:

The objectives of the Project are to demonstrate: (1) the feasibility of the Hall thruster channel plasma simulation using an axisymmetric kinetic model (2) the feasibility of the Hall thruster channel wall erosion simulation using an axisymmetric kinetic model and a molecular dynamics method.

In order to achieve the two objectives, Tech-X Corporation has divided the Phase I project into four major tasks: (1) Implement potential functions of Xe, and hBN into a molecular dynamic simulation tool LAMMPS (2) Calculate the sputter yields of hBN using LAMMPS (3) Implement axisymmetric electrostatic Poisson solver into VORPAL (4) Investigate the lifetime of the Hall thruster under various operational conditions.

Technical Accomplishments:

During Phase I, Tech-X Corporation has accomplished (1) Implemented potential functions of Xe, and hBN into LAMMPS (2) Calculate the sputter yields of hBN under various ion energy, and temperatures using LAMMPS (3) Implemented axisymmetric electrostatic Poisson solver into VORPAL (4) Investigated the lifetime of the Hall thruster under various operational conditions.

Tech-X Corporation has also made additional achievements: (1) Calculated the sputter yields of hBN under various ion incident angles.

Experience was gained in area of a molecular dynamics simulation, an erosion model implementation in VORPAL, and simulation of Hall thruster channel plasma. These experiences along with the prior expertise of the developers in the area of electric propulsion device research make Tech-X Corporation ideally suited to continue the development of a molecular dynamics model and kinetic model.

Taxonomy – (Propulsion): Spacecraft main engines