Phase 2 Project Summary

Firm: Tech-X Corporation
Contract Number: NNX11CC57C
Project Title: Next-Generation Ion Thruster Design Tool to Support Future Space Missions

Identification and Significance of Innovation: (Limit 200 words or 2,000 characters whichever is less)

Ion thrusters are being studied for high-power and high-power-to-thruster operating conditions and thus anything that can be done to improve the understanding of these devices and to make designing them easier is a benefit. Computational modeling would significantly reduce the expenses for NASA in testing and designing ion engines.

Technical Objectives and Work Plan: (Limit 200 words or 2,000 characters whichever is less)

Make the fully coupled PIC-MCC ion thruster discharge chamber model developed in Phase I stable.

Reduce the runtime of the fully coupled PIC-MCC ion thruster discharge chamber model developed in Phase I.

Make the fully coupled PIC-MCC ion thruster discharge chamber model developed in Phase I easier to use.

Implement non-uniform grid,s two-dimensional domain decomposition, particle fragmentation and merging, semi-implicit numerical procedures, add a GUI interface to the computer code so that it is easier to use.

Technical Accomplishments: (Limit 200 words or 2,000 characters whichever is less)

Accomplishments are:
Non-uniform grids were successfully implemented. This has reduced computational times by approximately a factor of 2.

A two-dimensional computational domain decomposition was successfully implemented in the fully coupled PIC-MCC ion thruster discharge chamber model. This has reduced computational times by about a factor of 2.

Particle fragmentation and merging techniques were successfully implemented in the fully coupled PIC-MCC ion thruster discharge chamber model. This has reduced computational times by about a factor of 2 to 4.

Two new semi-implicit numerical procedures were developed and tested. These procedures failed to show improvements over the traditional fully explicit technique.

Results were generated for the TL-35 and TL-64 operating conditions of NEXT.
A GUI interface was successfully added to the computer code.

NASA Application(s): (Limit 100 words or 1,000 characters whichever is less)

The purpose of this work was to make the fully coupled PIC-MCC ion thruster discharge chamber model developed in Phase I user friendly so that NASA could easily use it to design future ion thrusters. Such a computational tool could save NASA millions of dollars in ion engine development costs. Computational times have been reduced significantly, from many months to a couple of weeks. The fully coupled PIC-

MCC ion thruster discharge chamber model is stable using relative electric permittivities above 100. While it was hoped to reduce computational times to days and to have stable operation at relative electrical permittivites of 1 (this is the physically correct permittivity), there were a number of problems encountered that prevented these goals from being achieved.

Non-NASA Commercial Application(s): (Limit 200 words or 2,000 characters whichever is less)

Accurate plasma modeling and sputter erosion tools have applications in other government organizations, as well as the aerospace, satellite, ion source and plasma processing industries.

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