Contribution ID: **723** Type: **Oral**

Thrust-to-power ratio improvement of micro-cathode arc thruster by addition of the magnetoplasmadynamic stage

Friday 28 June 2019 16:00 (30 minutes)

Addition of the acceleration stage to the micro-cathode vacuum arc thruster (μCAT) allows increase of the thrust and the specific impulse and finally the overall efficiency of such miniature thruster for CubeSats. In this work, we propose to use a magnetoplasmadynamic (MPD) approach for such improvement.
Significant advantages of the μCAT-MPD approach in comparison with gridded ion acceleration stage is its griddles construction, a design that helps to overcome the loss of ions along the grid cells, with lower voltages on the accelerating electrodes.
In the considered approach, the quasi-neutral plasma, produced by the single μCAT as the first stage, is additionally accelerated by the Lorentz force that is generated with just one additional dc-biased electrode, and one pulsing magnetic coil.
Using a thrust stand for indirect thrust measurements, combined with thrust calculation with experimental values of ion velocity, ion current and erosion rates, together with calculating the powers, dissipating in both stages and magnetic coil, we show that the second accelerating stage based on MPD approach allows improvements not only to the thrust (almost twice, from 9 to 18 μN), but also to the thrust-to-power ratio (in 53%, from 3.2 to 4.9 μN/W) of the low-power (several W) miniature (several cm - size) μCAT, firing at 10 Hz.
Further increase of TPR will require the optimization of the coil current, the accelerating voltage values, and the thruster's electrodes geometry. Since the thrust of the system with MPD stage is proportional to j×B, to improve TPR it is necessary to increase the amplitudes of the current density and the magnetic field in solenoid within the single pulse, for the same values of dissipating power.
The work was supported by a Vector Space Systems and NASA DC Space Grant Consortium, the National Science Foundation, grant 1747760.

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Session Classification: 6.3 Plasma Thrusters

Track Classification: 6.3 Plasma Thrusters