SPACE PROPULSION SYMPOSIUM (C4)
Interactive Presentations (IP)

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INVESTIGATION OF SELECTIVE LASER MELTING (SLM) FOR PRODUCTION OF MICROWAVE ION THRUSTER ACCELERATOR GRIDS

Abstract

Electron cyclotron resonance (ECR) gridded ion thrusters generate a plasma using microwaves in the presence of an imposed magnetic field to induce electron resonance. As this method of plasma generation does not require a discharge cathode, the immediate advantages are a simplified power supply and the elimination of life issues associated with the hollow cathode. Since the plasma production profile within the discharge chamber is controlled, this leads to more uniform beam profiles compared to those of electron-bombardment thrusters, reducing localized grid erosion and extending grid life. This form of thruster has great potential for the applications of both orbit-raising and station-keeping for geostationary telecommunication satellites.

On the other hand, developing an accelerator grid system that is capable of producing both high and low thrust modes is still a major challenge. However, the potential mass and cost savings that could be achieved by replacing chemical propulsion systems for station-keeping and orbit-raising mean that there is a high benefit for building a robust, all-electric propulsion system with this capability. Therefore, the focus of this research project is the development of accelerator grids that are versatile enough to support various levels of thrust using a new approach to grid manufacture in the form of additive manufacturing. The scope of this paper comprises design of the grid aperture geometry, additive manufacturing, post-production analysis and testing.

The crux of the design phase is to introduce changes in the plasma dynamics using the grids to enable operation in a range of thrust modes. Ion thrusters usually have a high specific impulse (Isp) but extremely low propellant flow rate and so the thrust they produce is low. In the high thrust mode, the grids must extract a higher ion current density from the plasma sheath while accelerating them to lower velocity with higher thrust to power ratios. These requirements are conflicting and demand a novel approach to grid design.

The latter stages of this project involve test sample production and assessment of the build quality by means of computed tomography (CT) scanning, surface profilometry and scanning electron microscopy. To gain insight into the mode of operation of SLM, multiple grid samples varying in design are manufactured and analyzed. Consequently, the relative significance of SLM build parameters on the quality of production grids is evaluated. Finally, suggestions are made as to the design methodology, which yields the best results for grid production in conjunction with SLM.