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PERFORMANCE ASSESSMENT OF AN ELECTROSPRAY EMITTER MANUFACTURED THROUGH THE USE OF LASER ABLATION

Abstract

The rise in popularity of small satellites such as CubeSats in recent years has led to an increased need for suitable, affordable sources of propulsion. Electrospray propulsion has the potential to be a robust, cost-effective source of electric propulsion, particularly if novel methods of manufacture are adopted. This paper investigates the performance of an electrospray emitter which was manufactured solely through the use of laser ablation, using a flat plate of low permittivity material. Initial investigations indicate that this method of emitter manufacture is notably faster and more cost effective than traditional methods, such as deep reaction ion etching, without compromising on performance.

This was investigated by examining the performance of such an emitter in vacuum conditions intended to simulate Low Earth Orbit. The emitter was manufactured using a 355nm Picosecond laser to drill through 1mm thick sheets of Polytetrafluoroethylene, with the resultant hole serving as a channel for an ionic liquid propellant to flow. The performance of the emitter was quantified by measuring the voltages required to obtained electrospray emission, as well as the characteristic current produced by the emitted spray. The former parameter was determined by monitoring the voltage during experimental tests, and is important as it indicated the power supply that will be needed to run the system. The latter parameter was obtained through the use of custom manufactured Faraday cup apparatus, which was used to perform time-of-flight tests. These showed the charge over mass of the particles emitted by the thruster, which allowed for the thrust and specific impulse values to be mathematically determined.

By examining these parameters, the missions that this thruster is viable for can be deduced. The performance of the thruster can also be compared to the performance of other electrospray thrusters manufactured using more traditional methods. This presents an engineering trade off, where the difference in performance is compared to the difference in manufacturing time and cost, which will allow for the strengths and weaknesses of this design to be examined.