A Fully Microfabricated Planar Array of Electrospray Ridge Emitters for Space Propulsion Applications

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Electrospray thrusters work by extracting ions or charged droplets directly from a liquid surface using an electrostatic field and accelerating them in that field to produce thrust. This method could lead to more efficient and precise thrusters for space propulsion applications. The propellant liquid is generally placed at the tip of a needle to enhance the electrostatic field. The electrospray process limits the thrust from a single emitter needle. To get into the millinewton range will require an array with thousands of emitters. Batch microfabrication is well suited to making such an array.

We have designed and built a prototype thruster that consists of two silicon parts (Figure 1) made using deep reactive ion etching (DRIE) and SF6 plasma etching. The thruster base holds the electrospray emitters. Its surface is treated to control the areas where propellant can go. The extractor produces the electric field, which generates the electrospray. It is equipped with slits to allow the accelerated particles through. The two parts are positioned relative to each other using a kinematic mount, in which alumina balls rest in holes on the silicon dies (Figure 1). Alumina screws hold the assembly together.

In this design, we have replaced the needles that are typically used in electrospray thrusters by ridge emitters: vertical slabs with sharp tips spaced along their length (Figure 2). We have shown that our process for needles [1] can be extended to ridge shapes, and a modeling effort is underway to better control the shapes of the emitters.

Our thruster has been fired with the ionic liquid EMI-BF4. This experiment shows successful electrical insulation, even in the presence of the liquid. Challenges we now face are reducing the amount of emission that is intercepted by the extractor and determining where on the ridges the emission is coming from.

REFERENCES