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Author: Mr. Alberto Garbayo
Added Value Solutions (AVS), Spain, agarbayo@a-v-s.es

Mr. Chengyu Ma
University of Southampton, United Kingdom, machengyu19930408@gmail.com
Dr. Charlie Ryan
University of Southampton, United Kingdom, c.n.ryan@soton.ac.uk
Dr. Daniel Staab
AVS Added Value Solutions UK, Ltd, United Kingdom, dstaab@a-v-s.uk.com

PET-100: THE ULTIMATE ELECTROSPRAY THRUSTER FOR CUBESAT CONSTELLATIONS

Abstract

Electrospray thrusters are a promising micro-propulsion option for nanosatellites due to their high specific impulse at low power levels, and intrinsic suitability for miniaturisation. They do not suffer from the efficiency losses experienced by more established EP technologies when those are scaled down and are compatible with a simple passive propellant feed. An electrospray thruster extracts liquid propellant from an array of needle-like emitter tips, and accelerates the resulting ions or droplets via a high voltage grid. The polarity of grids and emission is alternated at a high frequency.

The PET-100 thruster is an electric propulsion system specifically tailored towards operation on board nano-satellites. It will offer high specific impulse (4000s) and thrust (0.6mN) at 20 W of input power, a power level highly suited towards medium to large CubeSats. It can be viewed as offering the same level of performance that Gridded Ion thrusters and Hall Effect thrusters offer larger satellites at 1000 W of electric propulsion input power, but operating within the power, volume and mass constraints of a CubeSat.

A breadboard of the thruster has been developed at the University of Southampton and successfully tested in a vacuum chamber using a time-of-flight system to characterize the particle velocities in the plume. The testing results demonstrated a relatively high thrust up to 250 μN, a specific impulse higher than 4,000 s, and a power efficiency of approximately 60% at an input power of 8 W, suggesting that it outperforms many other micro-propulsion options for nanosatellites.

AVS has developed a high voltage power processing unit for the propulsion system. The HV-PPU design is split into two stages: the first step uses a resonant H-bridge configuration, controlling a transformer to step up the 12V DC supply to 100V. The second step is the Cockcroft-Walton board that multiplies the voltage to reach the 1.5-3.5kV required. Two branches are used in order to provide a bipolar output. We developed a first generation, large board layout for initial testing, and applied the results to design a compact layout compatible with CubeSat interface requirements.

The thruster and PPU have been tested together in a vacuum chamber at the University of Southampton. We will present functional test results, including data from integrated testing of the PPU powering the thruster. We will give an outlook on future work to raise the system TRL from 4 to 6.