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END-OF-LIFE DISPOSAL OF SUB-3U CUBESAT WITH A PRINTED THIN-FILM VACUUM ARC THRUSTER

Abstract

Recently, the CubeSat population has increased while their failure rate remains relatively high, with one in four of all deployments resulting in a non-functional spacecraft. This, combined with the scarcity of miniaturised de-orbiting devices, means that most CubeSats are heavily reliant on atmospheric drag to de-orbit, which restricts their operation to low orbital altitudes. To overcome this restriction a reliable, miniaturised device capable of de-orbiting especially small CubeSats (sub-3U) are needed. In this presentation, we introduce the CubeSat De-orbiting All-Printed Propulsion System (Cube de ALPS), a thin-film Vacuum Arc Thruster being developed at the University of Southampton in collaboration with the European Space Agency which fills this gap. It is a flexible substrate on which coplanar arrays of vacuum arc micro-thrusters (micro-VAT) are printed, alongside supporting electronic subsystems.
We focus on the operations of a Cube de ALPS End-Of-Life disposal for an under-actuated spacecraft with uncontrolled spin. In this scenario, a single micro-VAT will ignite every time it points in the direction of the forward velocity vector. Orbital lifetime estimates performed in GMAT using simplified dynamics show Cube de ALPS can shorten the deorbiting time from 720 km altitude by up to 42%. Because most micro-thrusters are not aligned with the centre of mass, they can effect a torque on the spacecraft. We use this in conjunction with a closed-loop thrusting law, to despin the satellite while also deorbiting it.

These preliminary results are compared to high-fidelity simulations including full 6 degree of freedom coupled attitude and orbital dynamics. We also show the effect of different parameters on the performance, as well as including Passive Magnetic Attitude Control Systems commonly found in CubeSats.