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Experimental Studies on the Design and Characterisation of a Dielectric Barrier Discharge Plasma Thruster for Microsatellite Propulsion

The rapid expansion of satellite missions has created a growing demand for compact, low-power propulsion systems capable of delivering precise micro-Newton thrust for orbit correction, station keeping, and attitude control. Conventional propulsion technologies often rely on mechanical complexity or propellant-intensive processes that limit scalability for small platforms. Plasma-based electric propulsion offers an attractive alternative, particularly for devices that operate with minimal moving parts and low energy requirements. There are different kinds of advanced plasma propulsion systems, such as Hall-effect, pulsed plasma, Dielectric Barrier Discharge (DBD) thrusters, and helicon plasma thrusters, that have been investigated worldwide. In the past, several studies have been conducted on the DBD plasma actuators for aerospace applications. The studies are limited to DBD plasma for aerodynamic flow control and DBD plasma thruster for the atmospheric or near-space environment. DBD plasma thrusters provide a simple and robust architecture for generating directed plasma jets and electrohydrodynamic forces under near-atmospheric conditions. Still, there is a need to investigate a novel micro-propulsion technology based on DBD plasma within a single-thruster architecture.

In this study, an atmospheric-pressure DBD plasma thruster has been designed and fabricated to evaluate its feasibility as a micro-propulsion source. The device operates with flowing noble gases such as helium and argon, and is driven by a bipolar pulsed high-voltage supply to produce stable, non-equilibrium plasma jets. A systematic parametric investigation is performed to examine the influence of applied voltage, excitation frequency, mass flow rate, and dielectric barrier thickness on discharge characteristics, power deposition, thrust output, and thrust-to-power efficiency. Experimental measurements demonstrate clear scaling of thrust with electrical input parameters and reveal optimal operating regimes that maximise propulsion efficiency while maintaining discharge stability. Overall, this study provides fundamental insights into the operating physics and performance trends of DBD-based plasma microthrusters, establishing a baseline for future optimisation and scalable designs for next-generation propulsion technologies.

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