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The Multiple Use Plug Hybrid for NanoSats (MUPHyN) Miniature Thruster

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The Multiple Use Plug Hybrid (for) Nanosats is a prototype thruster is being developed to fill a niche application for NanoSat-scale spacecraft propulsion. When fully developed, the MUPHyN thruster will provide an effective and low-risk propulsive capability that could enable multiple NanoSats to be independently re-positioned after deployment from a parent launch vehicle. Because the environmentally benign, chemically-stable propellants are mixed only within the combustion chamber after ignition and the flow rate of the fuel is determined by a pyrolysis mechanism that is nearly independent of pressure or fuel grain defects, the system is inherently safe and can be piggy-backed near a secondary payload with little or no overall mission risk increase to the primary payload.

The MUPHyN thruster uses safe-handling and inexpensive nitrous oxide (N2O) and acrylonitrile-butadiene-styrene (ABS) as propellants. Fused Deposition Modeling (FDM), a direct digital manufacturing process, is used to fabricate short-form-factor solid fuel grains with multiple helical combustion ports from ABS thermoplastic. This manufacturing process allows for the rapid development and manufacture of complex fuel grain geometries that are not possible to extrude or cast using conventional methods. This technology enables the construction of fuel grains with length-to-diameter ratios appropriate for incorporation into CubeSats while maintaining high surface areas and regression rates that allow the system to maintain a near-optimal oxidizer to fuel ratio.

The MUPHyN system provides attitude control torques by using secondary-injection thrust vectoring on a truncated aerospike nozzle. This configuration allows large impulse ΔV burns and small impulse attitude control firings to be performed with the same system. To ensure survivability during extend duration burns, the MUPHyN incorporates a novel regenerative cooling design where the N_2O oxidizer flows through a cooling path embedded in the aerospike nozzle before being injected into the combustion chamber near the nozzle base.