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MICROTHRUSTER DEVELOPMENT FOR TRAJECTORY CORRECTION ON UPPER STAGES AND SATELLITES

Abstract

We present the development of one shot solid microthrusters as well as hybrid microthrusters for trajectory correction applications. The solid microthrusters are one shot and are applicable for precisely defined trajectory corrections while hybrid thrusters can be fired multiple times allowing more correction to be made while increasing the overall mass of the system. Solid microthrusters with a range of 10 Ns to 120 Ns have been developed and burning times of 0.1 to 0.5 seconds. A full internal ballistic model is developed for both end burning and core burning. Comparison to measured parameters on a rocket motor test stand is performed and several key performance parameters are outlined. The solid fuels investigated are both sorbitol-based propellant as well as composite propellant. All the solid microthruters have been developed with DeLaval nozzle is designed to expand the combustion products to sea level atmospheric pressure. Hybrid microthruster has also been developed using small NO2 cartridge as an oxidizer tank and acrylic plastic as fuel. The total impulse is 11 Ns with burn time of 1 second. Measurements have been performed on the previously mentioned test stand and comparison with an internal ballistic model is performed looking especially at key performance parameters. Computed specific impulse and total impulse is compared with the measured parameters on the test stand. Technological solutions for reducing further the mass of the hybrid thruster are done. The nozzle is also DeLaval nozzle designed to expand the combustion products to sea level atmospheric pressure. We apply an adjoint optimization method in order to minimize the diameter of the thruster but keeping the total impulse delivered and allowing a small variation in the burn time. The materials used in building the thrusters are low cost and allow their fabrication with standard mechanical tools available in the average workshop. Emphasis has been made on their flexibility for a wide application domain.