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OPTICAL EMISSION SPECTROSCOPY AS THRUST MEASUREMENT TECHNIQUE FOR MICROPROPULSION SYSTEMS FOR SMALL SATELLITES

Abstract

As the small satellite market continues to expand, microthrusters remain an area of significant growth in the space industry while new technologies mature. Advancing emerging technologies to flight readiness is still predominantly achieved on the ground, with microgravity testing reserved for suborbital and orbital launch opportunities. For microthrusters that generate thrust in the range of microNewtons, is not possible to use traditional thrust measurement devices (sensitive torsional thrust stands or microsensors intended for use on small satellites) for microthrusters on a rocket or crew capsule during a suborbital flight. A novel approach has been devised by which the plume from a thruster is ionized and analyzed by optical emission spectroscopy. Theory states that the relative intensity of a given wavelength observed correlates to the density of the species in the plasma. The density of the plume would be directly correlated to the thrust generated by a thruster during the experiment, as more propellant is consumed as thrust is increased. This method is best suited for cold gas, water, or monopropellant-based thrusters that don't use chemical combustion. This method has been successfully implemented in a laboratory setting, and shows that an increase in plume gas can be recorded by an increase in emission spectra intensity. By simultaneously measuring plume pressure and the spectra intensity, the relationship between thrust and spectra can be determined. Initial testing has been done for water, with argon, nitrogen to be investigated as well to complete initial investigation. This technique can be used as a secondary method of thrust verification, experimental plume density verification, and initial operation verification where other methods of thrust measurement are not available. When used in combination with another thrust measurement device, this can be considered as a method for verifying thruster operation on a suborbital payload when exposed to the space environment.