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VLM SYSTEM DEVELOPMENT FOR MICRO SATELLITE APPLICATION

Abstract

Low temperature co-fired ceramic (LTCC) technology is used to fabricate a vaporization liquid Microthruster (VLM). The VLM has shown its potential application in attitude control of microsatellites. This paper reports the design, fabrication, experimental setup and test results of simulated vacuum condition. A VLM is designed and fabricated using LTCC technology with internal heater on bottom substrate. Di-water is used as propellant for the ease of operation in lab. A new operational method for experimental testing of VLM system at vacuum conditions is proposed. A lab view program code is developed to synchronize the complete propulsion system. Two Microthruster chips of nozzle throat size 220 m 200 m and 220 m 300 m dimensions were fabricated and tested in sea level condition. The VLM of nozzle throat size 220 m 200 m outperformed VLM of nozzle throat size 220 m 300 m. Hence, the VLM with nozzle throat size 220 m 200 m is selected for the testing inside simulated vacuum condition. A maximum thrust of 960 N is measured for a liquid propellant flow rate of 2.0 mg/s at constant temperature mode operation with a jet temperature of 210 °C. At higher power, thruster reaches stable mode at 6 s from the startup which is same in constant temperature mode operation. This is the first report where the time taken for stable mode was only 6.0 s. This value is the best reported response time in the literature. VLM was made to run for 1000 s for some tests to prove the feasibility of generating a stable mode thrust for longer time. The performance study of VLM at constant power mode is made. A maximum specific impulse of 50 s was measured for a propellant flow rate of 2 mg/s at jet temperature of 210 °C. A maximum thrust of 715 N is measured for the input power of 12.8 W, which gives thrust to power ratio of 55.46 mN /W. Pulsed mode operation is required for the attitude control of microsatellites and is reported in this paper. The total impulse measured for 1.2 mg/s varies from 1.8410-3 N.s to 3.510-3 N.s and for 1.5 mg/s varies from 1.5810-3 N.s to 2.910-3 N.s with valve opening time from 100 ms to 5.0 s. The effect of dribble volume is also been reported.