SPACE PROPULSION SYMPOSIUM (C4)
Propulsion Technology (3)

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DEVELOPMENT OF A NITROUS OXIDE MONOPROPELLANT MICRO-THRUSTER AT BUAA: 2009

Abstract

Nitrous oxide (N2O) has been suggested to be a potential monopropellant for micro-thrusters applied in micro-spacecrafts due to its special properties, such as nontoxicity, self-pressurization, and self-sustaining reaction. Beijing University of Aeronautics and Astronautics (BUAA) has been dedicated in developing the sub-Newton-thrust micro-propulsion system based on the monopropellant catalytic decomposition of N2O for fine attitude control of small spacecrafts since 2005. This paper presents some latest research progress on the N2O micro-thruster. The primary target of current research is to verify the static performance parameters of the micro-thruster under the vacuum condition, such as the vacuum thrust and the vacuum specific impulse. For such purpose, a ground vacuum experimental system was employed, which consists of a vacuum chamber and a micro-thrust measuring stand. The 1.8-meter-diameter and 3-meter-long vacuum chamber, with the capability to produce a chamber pressure as low as 5 Pa at the mass flow rate of 0.1 g/s, was used to create a specified vacuum condition for static testing. The micro-thrust measuring system, using electromagnetic force to compensate the micro-thrust and thus making the system under the state of indifferent equilibrium to eliminate the influence of pipes and wires, was adopted for precise measuring of steady micro-thrust. Based on the former experimental research concerning the catalytic decomposition performance of N2O, the structures of the micro-thruster were improved by means of reducing the frame volume as well as increasing the effects of thermal insulation. The vacuum thrusts of two thrusters with different catalytic bed configurations were measured, which were around 0.1 N and 1 N respectively. The corresponding steady specific impulse exceeded 1500 N*s/kg. Additionally, the outside surface temperature distribution of the micro-thruster was also measured in hot-fire tests using an infrared thermal imager for evaluating thermal insulation performance of current structures, results of which indicated that there was a potential structural modification for performance improvement. Furthermore, a MEMS valve was utilized as the control valve of the micro-thruster. This leak-tight and low-power MEMS valve, developed at BUAA, was a combination product of the piezoelectric actuation concept and the lithographical image technology. Through altering the working duration of the MEMS valve, the impulse bits of different magnitudes were obtained in the micro-propulsion system tests. Future work will be aimed at continuing to lower the preheating power of the micro-thruster, optimizing component configurations such as the decomposition chamber and the inner nozzle, as well as conducting integrated propulsion system tests.