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Author: Mr. Senior Shimhanda
Kyushu Institute of Technology, Japan, shimhanda.senior536@mail.kyutech.jp

Mr. Kotaro Hiraka
Laboratory of Spacecraft Environment Interaction Engineering, Kyushu Institute of Technology, Japan, p108094k@mail.kyutech.jp
Mr. Taro Inoue
Kyushu Institute of Technology, Japan, p108008t@mail.kyutech.jp
Prof. Kazuhiro Toyoda
Kyushu Institute of Technology, Japan, toyoda@ele.kyutech.ac.jp
Prof. MENGU CHO
Kyushu Institute of Technology, Japan, cho@ele.kyutech.ac.jp

SULFUR-FUELED SURFACE ARC THRUSTER FOR PROPELLING NANOSATELLITES

Abstract

Pulsed electrothermal thrusters use kiloampere discharge currents for polytetrafluoroethylene (PTFE) ablation and sublimation. However, higher arc currents cause higher electromagnetic interference (EMI). A 10 J surface arc thruster (SAT), which adopts current regulating diodes (CRD), was developed that enables significant reduction in EMI. A CRD limits the discharge currents to 5 A in spite of the applied voltage. A low-melting-point sulfur propellant has been used that enables low discharge currents to efficiently ablate it and accelerate it electrothermally. In this paper, the near-term potential for elemental sulfur propellant in SAT is investigated. The advantages of sulfur with respect to PTFE are presented. First, we measured the pulse width of the main discharge. Then sulfur propellant proved superior to PTFE propellant in discharge duration. The mean pulse widths of PTFE and sulfur are 3.38 ms and 22.1 ms, respectively. Secondly, we measured the pressure rise in the vacuum chamber after each discharge. The mean pressure rises of PTFE, sulfur powder and sulfur solid are 0.43 mPa, 0.94 mPa and 1.9 mPa, respectively. Sulfur powder experienced the least intensity of discoloration in comparison with other propellants. The discharge initiator misfired frequently during PTFE ablation, but it ignited successively during sulfur ablation. Experimental results indicate sulfur is a suitable propellant for surface discharge propulsion, and for low arc currents is superior to PTFE.