

Fundamental study on operating characteristics of a laser-assisted pulsed plasma thruster

by

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Abstract

An assessment of a novel laser-assisted pulsed plasma thruster (PPT) was conducted, in which a laser-induced plasma was induced through laser beam irradiation onto a solid target and accelerated by electrical means instead of direct acceleration using only a laser beam. It was found that the discharge duration at low-voltage cases was as long as that of the laser-induced plasma. While in high-voltage cases, the discharge duration was much longer than that of the laser-induced plasma. In this case, the laser-induced plasma must be leading the main discharge from a capacitor, where some amount of neutral components of vaporized propellant must be ionized through the discharge. At 8.65 J discharge energy, the maximum current reached about 8000 A. With a newly developed torsion-balance-type thrust stand, the thrust performance characteristics of the thruster could be estimated. The impulse bit and specific impulse linearly increased. On the other hand, the coupling coefficient and the thrust efficiency did not increase linearly. The coupling coefficient decreased with energy showing a maximum value (20.8 $\mu\text{Nsec/J}$) at 0 J, or in pure laser ablation cases. The thrust efficiency first decreased with energy from 0 to 1.4 J and then increased linearly with energy from 1.4 J to 8.6 J. At 8.65 J operation, impulse bit of 38.1 μNsec , specific impulse of 3791 sec, thrust efficiency of 8 %, and coupling coefficient of 4.3 $\mu\text{Nsec/J}$ were obtained.

Keywords: Laser propulsion, PPT, Laser-electric hybrid propulsion, ICCD camera observation, torsion-balance thrust measurement

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