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COMPARATIVE STUDY OF DIFFERENT PROPELLANTS FOR SOLID-PROPELLANT-FED MAGNETOPLASMADYNAMIC THRUSTER

Abstract

To ensure a larger payload, usually the volume and mass of propulsion system should be as small as possible, which also leads limitations to the energy source. Therefore, much research has been conducted on the configurations and electric acceleration to obtain the better performance under limited energy. While the propellant is not the only motivating factor in performance, but the effect is indeed not negligible. However, relatively little is known about propellant developments. In this work, we present a broad comparison of propellant samples, which are made of the polymer filled with different dopants (including metals, salts, oxides, and nonmetallic element) according to the sample preparation steps, as propellants on a solid-propellant-fed magnetoplasmadynamic thruster with a common design base. The plume, ablation morphology, impulse bit, specific impulse, efficiency, and discharge success rate of the propellant samples were measured and analyzed under the same operation. It is found that: (1) The ablation surfaces of PTFE, POM, HDPE, and PMMA were full of bumps and holes, while that of PVC was smooth without pores or cracks after repeated ablation. So PVC is more suitable for the long-term supply of propellants. (2) The dopants of black matter and metals could greatly increase the plume flow and expansion speed, but metals could reduce the plume splitting. (3) The dopants of metals could improve the impulse bit, while that of salt could promote the stability of the discharge process. And the samples doped with oxide performed dramatic specific impulse and thrust efficiency. (4) A small amount of monoatomic carbon doping could improve the discharge success rate and propulsion performance, but the ablation surface was prone to carbon deposition, which is not conducive to long-term work. and (5) The sample doped with TiO2 in lower doping rate was expected to rank maximal specific impulse and efficiency at most operations, especially under the conditions of low laser energy, long discharge width, and high initial voltage.