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NUMERICAL STUDY ON WORKING PROCESSES OF A NOVEL LASER ABLATION THRUSTER WITH ELECTROMAGNETIC ACCELERATION

Abstract

The working processes of a novel laser ablation thruster with electromagnetic acceleration were studied and simulated using multi-physical simulation codes. Mechanisms of laser-ablation and electric discharge existing in working processes of the thruster were investigated numerically and analyzed. Firstly, the pulsed laser ablation processes of solid propellants and expansion processes of plasma plume were modeled and simulated. Based on the continuum assumption, the Navier-Stokes equations were applied to simulate the expansion of weak laser-ablation plasma plume. Secondly, the electric discharge was induced by the weak ionized gas entering into the inter space between a pair of electrodes. The laser-ablation plasma plume was further ionized. Besides, the plasma plume could be accelerated by electromagnetic field because of the deposition of discharge energy. The models of electric discharge induced by weak plasma were developed, and the effects of several key parameters were simulated to investigate the ionization enhancement and electromagnetic acceleration. It was indicated that the electric and structural parameters were all important for achieving an optimal design of thruster. The calculation results of impulse bit were in consistent with the experimental results. In addition, it was proven theoretically that high thrust performance and good ablation characteristics could be obtained by the novel thruster.