Paper ID: 27923
oral

SPACE PROPULSION SYMPOSIUM (C4)
Interactive Presentations (IP)

Author: Dr. Lei Yang
China Academy of Launch Vehicle Technology(CALT), China

Prof. haibin tang
China
Prof. Yuping Huang
China

RESEARCH ON DISCHARGE PLASMA CHARACTERISTICS OF AN ABLATIVE PULSED PLASMA THRUSTER VIA EMISSION SPECTROMETRY

Abstract

Pulsed Plasma Thruster (PPT) is a well-developed thruster used on micro-satellites by virtue of its low average electric power, high specific impulse, simple structure. However, PPT has extremely low efficiency, which is related to the ablation and ionization of its solid polymer propellant. To better understand its working mechanism, this paper carried out the emission spectroscopy diagnostics of a 20J PPT prototype discharge chamber, and revealed the components and temporal and spatial distribution characteristics of plasma generated by PTFE ablation process under the excitation of microsecond pulse currents. In the assumption of local thermodynamic equilibrium (LTE), the paper further used Boltzmann distribution relationships and Stark broadening method to obtain characteristic parameters of discharge plasma, such as plasma electron temperature and electron number density. The results showed that discharge plasma mostly existed in the form of first-order ionization, with most C and F species highly ionized (divalent or trivalent) in the first half cycle of the discharge, and the composition of the plasma was not uniform and symmetric at the cross section. Besides, higher temperature and density were detected around electrodes, which confirmed the observations of higher emission intensity. Electron number densities were in the order of magnitude ranging from 10^{16} to 10^{17} cm^{-3}, which conforms to previously known statistical data of PPT plasma. As the plasma accelerated downstream, the temperature at cross section of the discharge chamber slightly fluctuated at about 2.2eV. Combined with low ion current density at this area, emission loss and Ohmic heating can be negligible during the acceleration process. In addition, the paper also developed testing methods for plasma movement under different PPT working conditions, obtained the velocity of multiple plasma components in different spatial locations, and finally found that plasma flow showed an "acceleration-decline" trend. In conclusion, this paper is of great reference in the studies of further optimization and controlling of PPT ablation characteristics and ultimate improvement of thruster performance.