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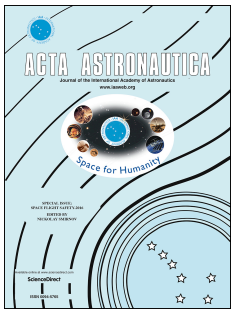

Ignition mechanism in ablative pulsed plasma thrusters with coaxial semiconductor spark plugs

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Ignition mechanism in ablative pulsed plasma thrusters with coaxial semiconductor spark plugs

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Abstract

Ignition process, as the initiation of the entire discharge, plays an important role in ablative pulsed plasma thrusters. While spark plug exactly how initiate discharge is achieved is still under review. This study did some experiments with two kinds of propellant surfaces (normal or inclined) and without propellant to explain the ignition process. The experimental results showed: when the thruster discharge without propellant, it is essentially a surface flashover process on ceramics; when the propellant was loaded, the main discharge occurs after the initial conductive path composed of electrons emitted by spark plug forming. This study provides a reference for the high performance pulsed plasma thrusters.

Keywords: ablative pulsed plasma thrusters; ignition process; propellant surface

1. Introduction

Ablative pulsed plasma thrusters (APPTs), use polytetrafluoroethylene (PTFE) as the propellant, are spacecraft propulsion devices that utilize plasma accelerated by electromagnetic field created by pulsed electrical discharge [1, 2]. APPTs are reliable, relatively simple to design, inexpensive, and provide a high specific impulse. In addition, they require low power (<10 W) and are used for attitude controlling for larger satellites and propulsion for microsatellites [3], that is, they remain an important propulsion device for space missions [4]. Ignition process using spark plug, as the initiation of the entire discharge, plays an important role in ablative pulsed plasma thrusters (APPTs). Some early APPT studies measured the ignited characteristics [5, 6] and investigated the physics via experiments [7, 8] and numerical simulations [9]. However, spark plug exactly how initiate discharge is achieved is still under review.

Nowadays, two possible theories have been proposed: the first [7, 8] is that the spark plug begins to ignite and provides the initial plasma for the multiplication process of secondary electrons, when the number and distribution of charged particles (ions, electrons) meet the circuit requirements, a plasma channel forms between electrodes and the main capacitor starts to discharge. The second involves field emission [10]. In the presence of strong electric fields, a potential barrier forms at the surface of the solid (such as electrodes), as shown in **Fig. 1**. If the electric field is strong enough and the potential barrier suitably thin, the electrons would tunnel quantum mechanically through the barrier and escape into the vacuum (the discharge channel). That is, the electrons would be emitted, the augment the electric field creating a conductive path, the main discharge then occurs.

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