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POLYMERS THRUST CHARACTERISTICS IN ABLATIVE PULSED PLASMA MICROTHRUSTER

Abstract

Nowadays CubeSat satellites are becoming the most popular technology in space due to their small dimensions, low mass, low manufacturing price and wide range of abilities. The most important application is testing new technologies: when companies test their new equipment in space. Another applications, such as Earth observing, communication and television are also taking place.

In order to expand CubeSats abilities, a propulsion system is needed onboard for extending satellite lifetime, changing orientation, orbit altitude and solving space debris problem by utilizing satellite in lower atmosphere.

Due to CubeSat size, weight and power consumption restrictions, a very small amount of propulsion systems fits the requirements. In this regard, electric propulsion systems (EPS) are considered as the best option for CubeSats. But not all EPS can be used for these satellites. For example, it is a challenge to fit a gridded ion thruster or a hall thruster in CubeSat one unit (1U), as they have complicated power processing unit and needs a propellant tank. Furthermore, these thrusters have unstable work mode at low powers and are also difficult to manufacture in such size. However, there are several researches in this area.

Another option of the EPS for CubeSats is ablative pulsed plasma thruster (APPT). This is small, light-weight thruster, which can consume low powers (from 1...10 W) and generate micro-newton range thrusts. APPT consists of cathode, anode, initiation system, propellant bar and power processing unit. One of the greatest APPT advantages is its propellant – usually a solid dielectric bar. This simplifies propellant storage system and make the whole propulsion system cheaper. In most cases polytetrafluoroethylene (PTFE) is used as propellant material.

However, one of the most significant APPT weakness is PTFE face carbonization, because a conductive carbon film short-circuits the electrodes and thruster fails.

In order to find solution to this problem, it was decided to test different polymers in order to pick a new propellant material. Series of the experiments were made with polyacetal, polyurethane and polycarbonate. Discharge and thrust characteristics were measured. Voltage was varied from 1 kV to 2 kV and capacity was 5 μF, propellant face area - 1,26 cm^2. Obtained results in comparison with PTFE are discussed.

The presented results have been obtained at large-scale research facilities “Beam-M” of Bauman Moscow State Technical University.