IAF SPACE PROPULSION SYMPOSIUM (C4)
Electric Propulsion (1) (5)

Author: Mr. Evgenii Chebykin
Bauman Moscow State Technical University, Russian Federation, evgeny.chebykin@mail.ru

Mr. Aleksei Pavlov
Bauman Moscow State Technical University, Russian Federation, alekseipavlov@bmstu.ru
Dr. Yury Yu. Protasov
Bauman Moscow State Technical University, Russian Federation, protasov@power.bmstu.ru
Dr. Tadeush Shchepanuk
Bauman Moscow State Technical University, Russian Federation, tadeush56@mail.ru
Dr. Victor Telekh
Bauman Moscow State Technical University, Russian Federation, telekh@bmstu.ru

COMPARATIVE EXPERIMENTAL ANALYSIS OF PERSPECTIVE MPPT PROPELLANTS EVAPORATION BY UV-VUV RADIATION

Abstract

A serious increase in the number of CubeSat satellites launches is noticed over the last five years. Satellites simple manufacturing and low price of launch provide solutions to various problems. Many publications on micro propulsion systems shows the relevance of this topic. A review of these publications shows that electric propulsion (EP) is suitable for CubeSat. Ablative pulsed plasma thruster (PPT) stands out among EP due to its simple design and low manufacturing price.

PPT are performed with polymer propellant. The pulsed discharge vaporizes part of the polymer, and thrust is created by ionization and acceleration of the vapor by Lorentz force. Heating and vaporization of the propellant occurs due to absorption of radiation energy (UV and visible range) from the plasma formation.

Investigation of the interaction of broadband high-brightness radiation on the polymer is necessary to optimize the characteristics and the processes in operation of the microPPT. There is no complete and acknowledged model of the ablation process despite the fact that polymers light erosion research has been going on for more than fifty years. In this regard, the experimental study of polymers evaporation under the action of broadband radiation becomes even more topical.

This work presents the experimental research results of light erosion (including the vacuum UV range) and determination of plasma parameters of microPPT's promising propellants: PTFE, polyamide-6, acrylic glass, polyurethane, polyoxymethylene, polycarbonate and etc.

The source of radiation was an erosive type discharge of the magnetoplasma compressor (MPC), which is similar to the PPT discharge. Usage of different gases with MPC discharge makes it possible to control the spectral composition of the radiation. So does the distance from the sample to the emitter for the radiation energy coming to the sample. The discharge radiation heats, evaporates and ionizes the sample vapor. It expands and realizes the "plasma piston" model, compressing the layer of background gas above the sample surface.

Diagnostics of evaporation processes was performed by schlieren photography and the method of double-beam laser holographic interferometry. Interferograms and schlieren photographs processing made it possible to determine the studied materials dynamics of evaporation and ionization. It is a necessary step for choosing the optimal propellant for microPPT. The obtained results are discussed.

The presented results have been obtained at largescale research facilities “Beam-M” of Bauman Moscow State Technical University. The reported study was funded by RFBR and ROSATOM (No.20-21-00087).