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LASER-INDUCED IGNITION IN AIR-BREATHING ELECTRIC THRUSTERS

Abstract

One of the most effective means to keep spacecraft in an ultra-low orbit (ULO) is the air-breathing electric thruster (ABET), using the outboard atmospheric gases as a working body. The principal advantage of ABET is that the ULO keeping condition for spacecraft with ABET is a tolerance to the atmosphere density that can vary in an order of value even on a circular orbit.

To expand the range of altitudes where ABET can be used, it is necessary to ensure the stability of the plasma ignition and burning at minimum concentration of the working gas in the ionization chamber. For this purpose, there is considered the possibility of using the basic elements of a plasma-ion thruster (PIT) in ABET. The example of the PIT was developed at TsAGI and passed flight tests back in the 60s of the last century. PIT's advantages, as a part of ABET, include very high efficiency (80-90

In the paper there is investigated the possibility of a qualitative improvement in electron emission and an increase in the cathode lifetime due to the rational choice of the cathode material and the change of thermionic emission means: a miniature infrared laser instead of a direct or alternating current through the cathode wire. We have studied possibilities for discharge ignition at laser impact on refractory (W, Ta, Nb, Hf) plate electrodes in rarefied air corresponding to the conditions in the ABET ionization chamber in ULO. Two ways for that were studied: thermionic emission due to heating with 100 W Yb-doped fiber laser and pulsed (15 ns) laser (1064 nm DPSS) for the same purpose. We evaluated success for different voltages (100 V) applied to the inter-electrode gap (100 mm) by discharge current rise for different impact regimes. It has been shown that such ignition is possible for a row of modern robust and compact lasers. This way suggests the problem of thermionic emitting cathode lifetime in such thrusters could be resolved with laser-irradiated plates.