SPACE PROPULSION SYMPOSIUM (C4)
Electric Propulsion (4)

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ESTIMATION OF THE ION THRUSTER LIFETIME ON A SHORTENED TIME BASE

Abstract

Requirements to the lifetime of electric thrusters mounted on board the spacecraft designed for various purposes are growing. For example, ion thruster T5 produced by QinetiQ operated for more than 36000 hours in the orbit on board the GOCE satellite. Long operational life, reaching tens of thousands of hours, is one of the main advantages of ion thrusters comparing to other types of electric propulsions. From the ion thruster lifetime point of view, the accelerating electrode of its ion-extraction system is the most critical element, because of its sputtering by the charge-exchange ions. Durable endurance test of ion thrusters requires a lot of time and heavy financial expenditures. Therefore it is extremely important to reduce duration of endurance tests and to develop procedure allowing estimation for the ion thruster life on a shortened time base. The paper presents estimation results for the erosion rate of accelerating electrode of the low-power radio-frequency ion thruster developed at RIAME MAI. They are based on the determination of sputtering rate and shape of erosion wear for a combined multilayer coating, consisting of the optically contrast metals - aluminum and copper, that was preapplied to the surface of interest. In preparation for the test, layers of aluminum and copper were sputtered alternately onto the accelerating

electrode surface facing the ion beam by a magnetron. During the experiment the recesses were formed on the accelerating electrode surface between the holes under the influence of ion bombardment. The layers of copper and aluminum came gradually into sight, and the pattern of alternating dark and light stripes was formed as a result. It is possible to estimate accurately the rate of erosion of the multilayer coating by counting the number of sputtered layers and then interpolate this value for the material of which it is planned to produce the accelerating electrode. The paper presents test results obtained with the model of low-power radio-frequency ion thruster having a two-electrode ion-extraction system. Test results were compared with the accelerating electrode erosion rate, calculated using the software package IOS-3D developed by the Keldysh Research Center, as well as with the experimental results obtained while testing the thrusters XIPS and NSTAR. The procedure of accelerated life tests of ion thrusters can be developed in future on the basis of the fulfilled works.