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DEVELOPMENT OF A SIX-DIRECTIONAL PLASMA PROPULSION MODULE FOR SMALL SATELLITES

Abstract

Nowadays the development of low Earth orbit (LEO) (up to 2000 km) small spacecraft (SSC) is of particular interest. Such devices are planned to be used for effective telecommunication systems, advanced Earth research and dual-use systems. When developing space missions of such LEO SSC, designers and operators encounter a number of the following technical problems: inability to use one propulsion system for all flight operations, such as transfer from parking orbit to the target one, maneuvers between orbits, altitude control, orbit maintenance, attitude control, de-orbiting; limited lifetime of conventional (Hall and Ion type) Electric Propulsion Systems (EP); high energy consumption of existing EP systems; - unloading of SSC attitude control systems; de-orbiting of the spacecraft from the target orbit at the end of the active life of the SSC to reduce contamination of LEO. To overcome these problems, electrodeless plasma thrusters using magnetic nozzles could be the solution. Such propulsion systems can generate thrust in two directions. Using three bi-directional plasma thrusters in one system it is possible to create a plasma propulsion module with six thrust vectors that allows to perform all the SSC's space mission tasks where propulsion systems are needed while has a long-term lifetime in upper atmosphere (more than 10 years), low energy consumption (from 100 W) and compact size (2U) which allows using this module onboard of the most small satellites. This paper describes the first prototype of the six-directional plasma propulsion module. There have been studying the radio-frequency (RF) two open ends plasma source with magnetic nozzles for plasma acceleration and magnetic lenses for the restriction of the plasma flow. The example of this source demonstrates the possibility of effectively creating two thrust vectors using the single bi-directional RF plasma source.