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Author: Mr. Alexey Arkhipov
RIAME, Russian Federation

Prof. Vladimir Kim
RIAME, Russian Federation
Mr. Evgeniy Sidorenko
RIAME, Russian Federation

INVESTIGATION OF STATIONARY PLASMA THRUSTER (SPT) PLUME CHARACTERISTICS UNDER INCREASED DISCHARGE VOLTAGES

Abstract

Some results of plume characteristics studies of the stationary plasma thruster SPT laboratory models of various sizes and designs are presented in this paper. These characteristics are used for estimation of thruster plume interaction with the spacecraft structural elements and systems. Studies were conducted with various mass flow rates of the working gas through the SPT accelerating channel at various discharge voltages (up to 800-900 Volts). Retarding potential analyzer (RPA) developed in RIAME was used for the diagnostics of plume plasma. RPA was moved inside a vacuum chamber along a circle with a radius of 70 cm and centered in the point of the thruster axis intersection with the exit plane of the accelerating channel. Distribution of the accelerated ion current density in off-axis angle and "retarding curves" (dependence of the ion current to the probe collector on analyzing grid potential) were obtained for different modes of the thruster model operation. Differentiation of the mentioned curves allowed obtaining of the ion energy distribution function for different off-axis angles. Obtained data allowed determination of such parameters of the SPT plume as the total current of the accelerated ions, their mean energy, ions mean velocity and the mean axial component of the ions velocity. These data also gave an opportunity to estimate the factors characterizing "efficiency" of the applied discharge voltage usage for the ions acceleration, working gas mass utilization within thruster accelerating channel, factors, characterizing thrust efficiency reduction due to plume divergence and ions velocity dispersion. With some assumptions it was possible also to estimate the doubly charged ions fraction. Given paper also provides a comparison of the plume divergence behavior with the variation of the maximum electrons temperature within the SPT accelerating channel.