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EXPERIMENTAL INVESTIGATIONS AND OPTIMIZATION OF CAMILA HALL THRUSTER WITH STRONG LONGITUDINAL MAGNETIC FIELD

Abstract

CAMILA Hall thruster (Hall thruster with co-axial magneto-isolated longitudinal anode) showed itself as a good choice for Microsatellites. At power of 200W, its anode efficiency is 40–45 percent, and expected lifetime exceeds 4000h (See Kronhaus, I., and et. al, J. of Propulsion and Power, vol.29, pp.938-949, 2013 and references there). There exist two versions of the CAMILA Hall thruster: simplified and full. So far, the simplified version of the CAMILA Hall thruster was predominantly investigated that was due to its relative simpler design and the fact that the performances of both versions of the thruster were close. However, the full CAMILA Hall thruster should potentially possess the higher performance. The aim of the paper was to reveal the reason of anode efficiency shortage in the full CAMILA Hall thruster and optimize its operation.

The carried out investigations included: 1) the experimental studies of dependences of the discharge current and ion current on the potential drop in the anode cavity and longitudinal magnetic field in it in the case of an operation of the thruster without the radial magnetic field in the acceleration area; 2) the experimental research of the azimuthal waves near the exit from the cavity; 3) the experimental investigations of the dependences of the thrust, propellant usage efficiency on the magnitude of the longitudinal magnetic field in the anode cavity; 4) the essential modification of the theoretical model of low-frequency instability, developed before for the near-anode region of a conventional Hall thruster, and the estimation of conditions for the instability in the anode cavity of the CAMILA Hall thruster.

As a result, it was found that the main reason of the deficient effectiveness of ion generation in the anode cavity of the full CAMILA Hall thruster was Bohm's conductivity across the longitudinal magnetic field, due to developing Raleigh-Taylor instability. At the magnetic fields, which were applied before, Bohm's conductivity led to reducing the radial electric field in the cavity or even to change of its sign. Increasing the induction of the longitudinal magnetic field until a maximal admissible on operating temperature of the coils has resulted in growth of the anode efficiency of the thruster by 10 percent. According to conclusion from the theoretical model, in order to suppress the instability in the anode cavity and reduce the requirements to the level of the magnetic field, the longitudinal magnetic field should be non-uniform in the radial direction.