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EXPERIMENTAL APPROACHES FOR MICRO-CATHODE ARC THRUSTER DIAGNOSTICS

Abstract

Micro-Cathode Arc Thruster (μCAT) is a low-mass (< 200 g), low-volume (200 cm^{-3}) propulsion system, intended to provide attitude control and station-keeping duties for micro and nanosatellites. In this work various diagnostic techniques allowing thorough characterization of the μCAT parameters including specific impulse, plasma parameters in the exhaust plume, back flux, propellant consumption rate, etc. will be presented.

Motion of the cathode spot along the cathode surface was characterized using set of electrostatic single Langmuir probes facing specific portion of cathode. This approach allows tracing the cathode spot motion and determination of its motion speed. Magnetic field led to increase of cathode spot motion speed up to 100 m/s at 0.3 T that ensured uniformity of cathode propellant consumption.

Velocity of the exhaust plasma jet was measured by exciting denser plasma bunches on the plasma mainstream which propagation was detected using time-of-flight (TOF) approach by means of double probe detectors. Utilization of the double probes decouples ion bunches' detection circuit from the main discharge circuit and eliminates noise that seriously complicates the measurements in the case single probes are used. In addition, special design of double probe collectors ensuring minimal level of plasma flow perturbation was used. Plasma jet velocities were measured to be around 20 km/s without a magnetic field and acceleration to about 35 km/s at distance of about 100–200 mm from the cathode was observed for the magnetic field of about B=0.3 T.

Spatial distribution and temporal evolution of ion current was measured using set of single Langmuir probes. This approach allows simple way to visualize the exhaust plasma jet, characterize back flux to the satellite and determine distribution of plasma parameters in the jet as well as overall exhaust characteristics.