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INVESTIGATION ON THE IONIZATION PROBABILITY OF COATED INTAKES USED FOR A NOVEL PASSIVELY IONIZING AIR-BREATHING ELECTRIC PROPULSION CONCEPT FOR VERY LOW EARTH ORBITS

Abstract

I. Purpose

To gain access to very low Earth orbits for low latency communications or more detailed Earth observation, air-breathing electric propulsion (ABEP) represents an interesting key technology. Current designs of ABEP thrusters have an active ionization stage that requires some additional electrical power for particle ionization.

The main objective of the AIRLIFT project is to design and validate a new approach to air-breathing electric thrusters, in which the relative speed of particles in orbit and their collision with special coatings is being used to ionize them via surface ionization. This could eliminate the need for an active ionization stage and dramatically reduce the power requirements of the satellite.

II. Methodology

To test this electric propulsion concept, a neutral particle source was developed to simulate the space environment at orbits between 100 km and 250 km. The neutral beam source includes a plasma source in combination with a neutralization grid to overcome the challenge of accelerating neutral beams of highly corrosive gases such as atomic oxygen to orbital velocity. The resulting neutral particle beam is characterized by measuring thrust, temperature, and catalytic reaction on a diagnostic target held in the neutral particle beam.

The ionization probability of the coatings must be determined to evaluate whether this ABEP design can overcome the drag force generated by the residual atmosphere. The coated intake is placed within the neutral beam. Incoming neutral particles are expected to be ionized to some extent at the target surface, producing oxygen and nitrogen ions, respectively. In the proposed air-breathing thruster concept, these ions would then be used to generate thrust. To estimate the ionization probability of given coatings, the

ion current at the target substrate is measured.

III. Results and Conclusion

The test setup is currently capable of producing a stable argon or nitrogen beam. Current and anticipated challenges include generating a high velocity atomic oxygen beam, increasing the particle flux to match in-orbit parameters between 100 km and 250 km, and accurately characterizing the neutral particle beam for all different species.

The developed source will help to assess the feasibility of developing a novel ABEP system without an active ionization stage using special surface coatings. In addition, the neutral beam source can also be used for rapid corrosion testing and space environment simulation.