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SPACE PROPULSION SYMPOSIUM (C4)
Electric Propulsion (4)

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AN UPPER ATOMOSPHERE SIMULATOR USING ECR DISCHARGE FOR AIR BREATHING ION ENGINES

Abstract

The Air Breathing Ion Engine (ABIE) is a new type of electric propulsion system which can be used to compensate the aerodynamic drag of a satellite orbiting at a super low earth orbit. ABIE enables researchers with respect to aeronomy, accurate gravity and magnetic field mapping, and high-resolution earth surveillance. In the ABIE propulsion system, the low density atmosphere surrounding the satellite is taken in and used as the propellant for the Electron Cyclotron Resonance (ECR) ion engines to reduce the required propellant mass. Therefore ABIE is a promising propulsion system in aerodynamic drag free missions of more than two years. Generally, the pressure of a discharge camber is lower than the propellant tank pressure in electric propulsion, and the propellant flows from the tank to the discharge chamber. In the case of ABIE, the static pressure of the atmosphere which represents the tank pressure is lower than the discharge chamber pressure. The major components of the atmosphere at the super low earth orbit are atomic oxygen, molecular nitrogen, and molecular oxygen. Hence the environment surrounding ABIE is subjected to hypothermal atomic oxygen flux with energies equivalent to velocities of about 8 km/s (about 5 electron volts (eV) for atomic oxygen). This flux varies with altitude up to about 1E16 atom/cm2/s. Feasibility and performance of the ABIE are subject to the compression ratio and the air intake efficiency. One of the most important study about ABIE is the design of air intake which allows the incoming flow to enter the discharge chamber. A mechanism intaking this hypothermal flux is necessary to pressurize the atmosphere into the discharge chamber and its design is a major challenge to realize the ABIE system. Furthermore, a wind simulator which imitates the environment of super low earth orbit is an inevitable equipment to study ABIE on ground. First, we try to simulate the environment in super low earth orbit by using a 6 cm ECR plasma source. The neutral beam with 5 eV is realized by reflecting plasma on the metal surface. We use both oxygen gas and nitrogen gas individually, and generate an atomic oxygen beam or a molecular nitrogen beam respectively. We will report the results of the environment simulated by the 6cm ECR plasma source. The fluxes are less than 5E12 atom/cm2/s which corresponds to the environment at 400km altitude for the initial stage of the experiment of ABIE.