Recent developments in ionic liquid field emission electric propulsion

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The study here reported was aimed at the characterization of the plume of a ionic liquid fed, linear slit FEEP thruster, in terms of composition and velocity of the constituents. Ionic liquid propellants are actively investigated as promising alternatives to alkali metals in field emission thrusters, in order to reduce system cost and ground operation complexity. To this end, a large number of tests was carried out using the EMI-BF4 ionic liquid as a propellant. The thruster was fired in positive polarity and negative polarity to check the capability to extract anions and cations alone. Most of the testing was then carried out in alternate polarity mode, in order to avoid electrochemical poisoning of the propellant due to the unbalanced extraction of charged particles[1]. Such operating mode is believed to be the most promising candidate for flight operation, as it would allow to get rid of an external neutralizer to maintain electrical neutrality of the spacecraft.

Ion beam composition was investigated by means of a time-of-flight mass spectrometry technique. The measurements show that the emitted beam is mostly composed of monomers (BF4)-, dimers (C6H11BF4N2) (BF4)- and polimers $(C6H11BF4N2)_n$ (BF4)- (with n a function of applied extraction voltage). Propellant consumption was evaluated indirectly by means of time integration of the emitted current, under the assumption of a certain beam composition, and independently verified by means of direct observation of the depletion of the propellant reservoir. The resulting estimated specific impulse is around 1400 s. The thruster behavior resulted quite variable, especially when operated at high voltage levels in continuous polarity mode. Better performance was registered in alternate polarity operation with an alternation period of several tens seconds at extracted current of just a few µA.

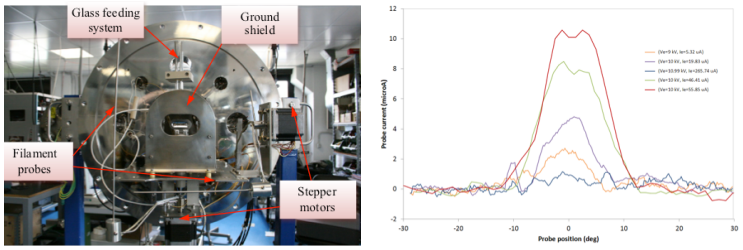

Figure 1. Left: experimental setup; right: exhaust beam profile recorded with an electrostatic probe.

References

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