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LAB6 HOLLOW CATHODE WITH WIDE RANGE CURRENT OPERATION

Abstract

Introduction

Hall effect thruster (HET) systems provide significant mass and cost-savings advantages compared to other propulsion technologies for missions such as LEO orbit raising, north-south stationkeeping, and GEO orbit topping. A significant component of HET is the hollow cathode, since it emits electrons to ionize neutral atoms in the discharge channel and the created ions move through the exit while electrons are partially trapped in HET due to magnetic field. The second role of the cathode is completely different from the former in a way that equal amount of electrons to exiting ions should be emitted to compensate for the charge effects on thruster and to prevent the spacecraft from charging. One of the most promising emitter materials in hollow cathodes is lanthanum hexaboride (LaB6). Cathode based on LaB6 are stable under ion bombardment conditions, less sensitive to low vacuum and poisoning by oxygen, water vapor, air, CO2, etc. compared to other emitter materials. Hollow cathodes based on LaB6 in HET are capable of working in contact with various working substances.

Discussion

The task was to develop a hollow cathode design for Hall effect thrusters by adapting the cathode to a different range of currents without significant design changes. One of the most critical components of the hollow cathode is a heater. SETS is developed heater based on carbon-carbon composite material to increase lifetime of heater. Such material characterized by low density (due to the porosity of the material), high specific strength and rigidity, persistent indefinitely long in the inert media at temperatures up to 3000 C that can be perfectly implemented as a heater into hollow cathode. In the paper are provided test results and comparison of two types of heaters for hollow cathode: swaged tungsten rhenium and carbon-carbon composite.

Conclusion

Lanthanum hexaboride (LaB6) hollow cathode design was successfully developed and tested for HETs with discharge power ranging from 100 W to 1.5 kW and current from 0.5 A to 5 A. Test campaigns were carried out in both stand-alone and coupled configurations with the different power consumption Hall

thrusters ST-25, ST-40, ST-100 developed by SETS. Future developments will include an improved mechanical design of the cathodes and additional experimental campaigns, to assess the cathode performance and lifetime and to further validate the theoretical model.