HOLLOW CATHODE DESIGN FOR A BRAZILIAN ION THRUSTER

José Américo Neves Gonçalves[1 *], Gilberto Marrega Sandonato[2], Ricardo T. Irita[3]
[1]*Associated Plasma Laboratory, National Institute for Space Research*
[2]*Associated Plasma Laboratory, National Institute for Space Research*
[3]*Associated Plasma Laboratory, National Institute for Space Research*

1. Introduction

The INPE Associated Plasma Laboratory is carrying out the development of ion thrusters to be used in the attitude control of geostacionary satellites. Current research activities includes the performance tests of an electron bombardment ion thruster of a 5mN thrust with employs xenon as propellant. This constraint is posed by the low power capability of the remote sensing sattelite. Two hollow cathodes will be used in the present thruster to generate the plasma and to neutralized ion beam. A great deal of attention has been devoted to the need for a thermal and mechanical design, aimed at minimising the total power input for startint and for steady state operation. At the cathodes, the requiriments is to attain the operation tip temperature rapidly and then to maintain it after discharge initiation. With sufficiently low heat loss from the cathode, the energy dissipated in the cathode discharge is sufficient to maintain the tip temperature, and hence the discharge, without operation of the heater. It is important to ensure that the tip temperature by electron bombardment is not excessive (~ 900 ^{o} C), minimizing loss of barium. A (Ba, Sr, Ca)CO_3 suspension was used for coating of tantalum spiral inserts wich after breakdown thermal process is ready for used in hollow cathodes. We report on the performance of a hollow cathode emission parameters. Measures have been taken of the emission current as function of cathode temperature and anode voltage. Good capability of this cathode has been demonstrated and forthcoming data will be used to stablish life endurance models relevant to ion thrusters applications.

2. Experimental

In the Associated Plasma Laboratory (LAP), ion thrusters started running with tungsten filaments, which were replaced by oxide cathodes, and presently they are equipped with rolled-tantalum-oxide-foil hollow cathodes. All these cathodes were entirely developed and built at LAP. The present hollow cathode consists of a 5-mm diameter by 40-mm long, 0.3-mm-wall thickness tantalum tube, with a cold-pressed 1-mm diameter orifice tungsten tip. The insert consists of a 5-turns rolled tantalum foil painted with a thin layer of mixed carbonates, (Ca, Ba, Sr)CO_3, which are converted to oxides by heating the insert up to 900 ^{o}C. The cathode heater comprises a boron nitride body machined in the shape of a revolver cylinder, in which holes a coiled tungsten filament is passed through. This heater expends 90 W to heat the cathode up the carbonate to oxide conversion temperature. As there are no commercial standard pipe fittings for 5 mm-diameter tubes, both the connector and the ferrules must be developed and machined specially for sealing the cathode body. The present hollow cathode full assembly is shown in Fig.1.

3. Results and Discussions

The preliminary experimental tests have revealed that this hollow cathode can operate at currents in the range of 3 to 10 A for long time periods, and at 18 A for short time periods. This cathode is still under investigation aiming both at its complete performance characterization and performance enhancement.

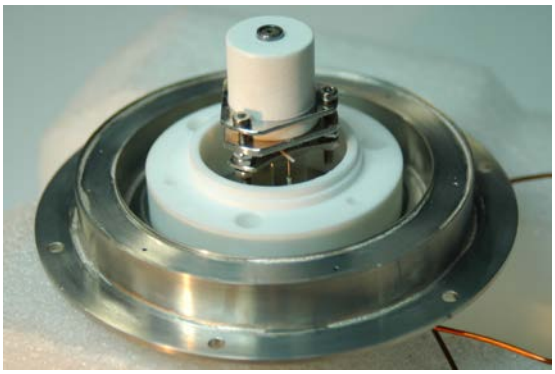

Figure 1. *Rolled-tantalum-oxide-foil hollow cathode: heater cartridge fully assembled.*