Thrust Measurements of a Meso-Scale Hollow Cathode Discharge

Andrew J. Jamison, Joseph Landon, Joshua A. Cripps
University of Southern California
Department of Aerospace and Mechanical Engineering
Los Angeles, CA 90089-1191

Andrew D. Ketsdever
Air Force Research Laboratory
Propulsion Directorate
Edwards AFB, CA 93524

Joseph Wang
Virginia Polytechnic Institute & State University
Dept. Aerospace and Ocean Engineering
Blacksburg, VA 24061-0203

ABSTRACT

Modeling of small scale discharges is of interest for micropropulsion system development; however, experimental plume and performance data is required for advanced physical models to be validated. The final manuscript will detail performance measurements on the small scale hollow cathode discharge shown schematically in Fig. 1. This discharge is used as a validating testbed due to its simple geometry and straightforward operation. The discharge chamber has a 5 mm radius hemispherical, aluminum anode opposed by a 1 mm diameter cylindrical (hollow) cathode. The discharge is nominally operated on a few hundred volts at tens of milliamperes with argon stagnation pressures of 3 to 10 Torr.

The thrust from the hollow cathode is measured by a torsional thrust stand with the capability of measuring thrusts as low as 100 nano-Newtons. Mass flow measurements will also be taken to assess the specific impulse of the device. The thrust is measured as a function of the device geometry, operating pressure, and discharge voltage and current characteristics. Plume data will also be taken on the device in conjunction with the performance measurements. Both optical and plasma probe diagnostic have been setup for the hollow cathode discharge chamber. The discharge can be positioned in two locations to allow spectroscopic investigation of the light emitted axially and normally to the plume direction. The collected light is collimated and focussed on the entrance slit of a 0.85 m double spectrometer. A Langmuir probe is mounted 2.5 cm downstream from the exit orifice of the discharge chamber with the disk surface normal to the axis of the plume. The diameter of the probe is 5.5 mm, and it is mounted normal to the plume flow direction to operate as a stagnation type Langmuir probe. This data is compared to numerical results to compare the level of physical detail in the model. These results are presented in the final manuscript. A companion paper will describe the model used to

simulate the discharge, and a comparison of the numerical simulation with the experimental data will be given.

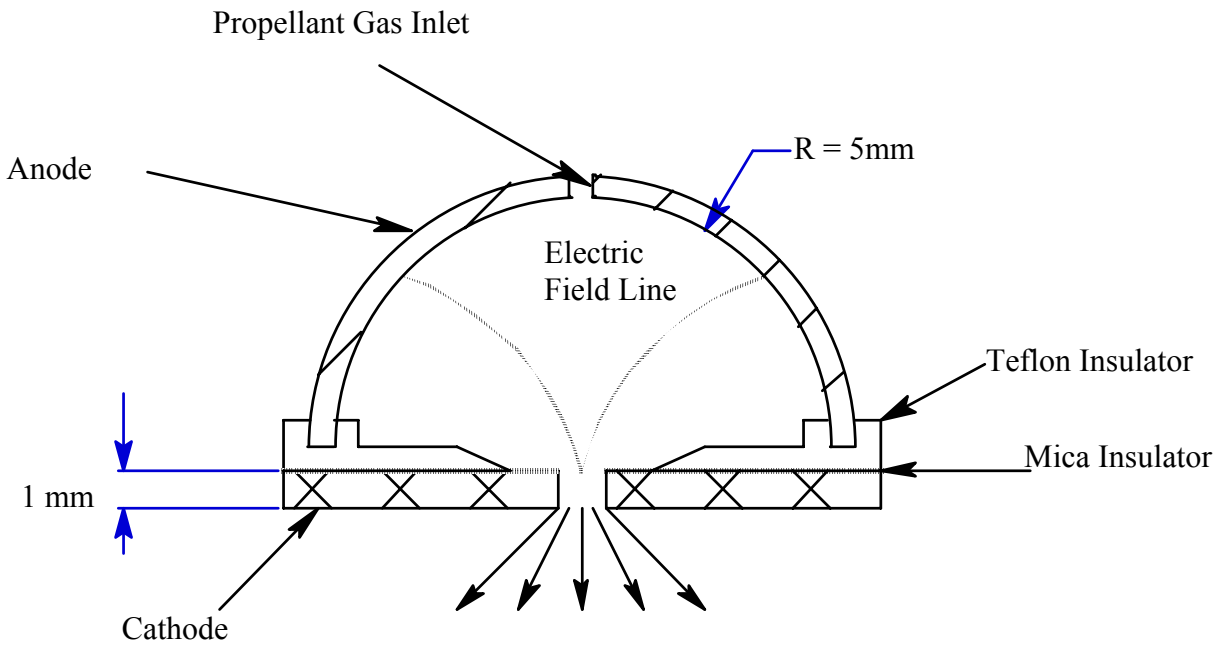

Figure 1: Hollow Cathode Schematic