Investigation of Discharge Characteristics of Three Different Hollow Cathodes

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Abatract. *The hollow cathodes are the main source of electrons for plasma generation and beam neutralization in ion thrusters. Three different hollow cathodes have been experimentally studied to better understand the hollow cathode discharge modes and its plasma parameters. Discharge modes of operation were analyzed. Plasma parameters were measured using an electrostatic probe while varying the operating conditions with both Argon and Xenon. Profiles of plasma parameters for different axial locations of the probe were obtained. Test results revealed that discharge modes and plasma parameters are in agreement with those reported in the literature and are considered typical results for hollow cathodes.*

Keywords: Ion Thruster; Hollow Cathode; Plasma Plume; Discharge modes.

1. Introduction

Hollow cathodes are devices mechanically simple, with a reliable re-ignition and great repeatability after long periods turned off. The hollow cathodes can be tested on ground and can operate with low (100 mA) and high (100 A) discharge currents for long periods. More than 28,000 hours of operation has been theoretically and experimentally demonstrated [Domokos 1999]. Even though hollow cathodes have been investigated for over 40 years there are no definitive models for plasma parameters capable of describing all configurations and discharge conditions [Goebel et al. 2005]. The existing investigations are limited to theoretical studies [Siegfried and Wilburt 1984] and tests with the variation of geometric parameters [Martin 2009] while observing the influence of these parameters on the lifetime and the performance of hollow cathodes.

This paper presents an excerpt of data from a recent research effort at the Associated Plasma Laboratory (LAP) of The Brazilian National Institute for Space Research (INPE) on discharge characteristics and plasma properties of three different hollow cathodes for different mass flow rates of Xenon and Argon. Two of the hollow cathodes tested were equipped with rolled tantalum foil inserts covered with oxides and built with a technology entirely developed at LAP/INPE.

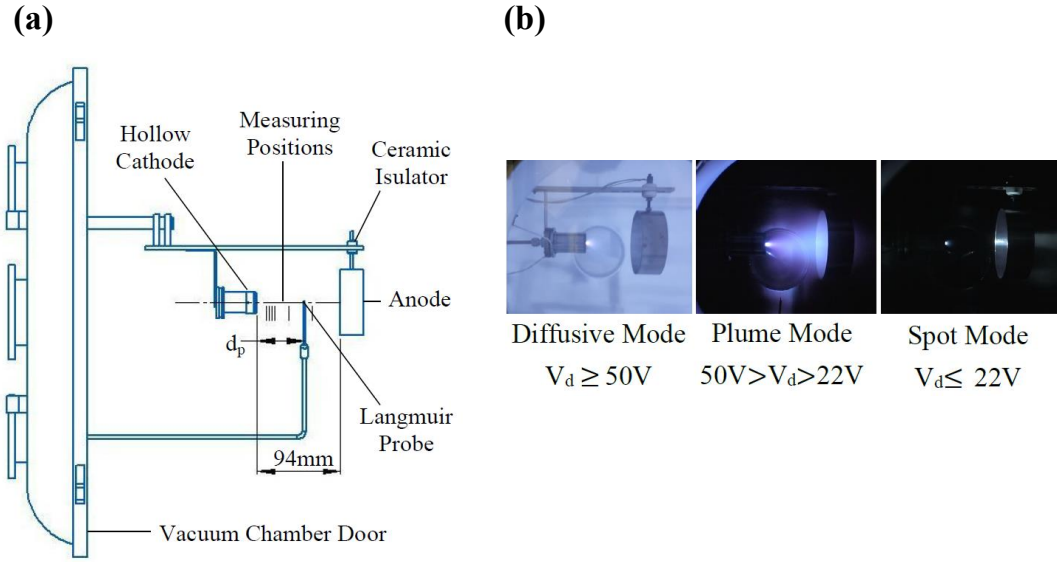

Figure 1. Experimental setup (a) and discharge modes of hollow cathodes (b).

2. Test procedures

The experimental setup consisted of a hollow cathode, a cylindrical anode and an electrostatic probe. The probe could be moved along the cathode axis to measure plume plasma parameters at different distances (d_p) from the keeper. The components were mounted on the experiments support assembly on the vacuum chamber door, this is illustrated in Figure 1a. The experimental study comprised the steps of heating, ignition, variation of operating parameters and electrostatic probe tests. The discharge modes observed were diffusive mode, plume mode and spot mode, as shown in Figure 1b.

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