Magnetic Field Angle Effects on Sheath Formation Near a Flat Plate Surface with Applications to Hall Thrusters

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Abstract

A sheath is positively charged layer that forms on a negatively biased surface. Building upon previous computational and experimental work,[1,2] an experiment is being designed to analyse sheath thickness due to plasma density, biased potential and magnetic field incidence angles, as seen in Figure 1. The varied angle of the magnetic field is of the greatest interest as it may: improve efficiency, reduce ion losses, affect erosion rates, alter sheath thickness, or even collapse a sheath at large angles. Data collected from this experimentation can hopefully be applied to improve future Hall Thruster designs.

Figure 2 shows a schematic of the current experimental design. Plasma produced from a Boron-Nitrate and steel plated plasma source will be guided through a coiled plasma duct (bent at 90 degrees to separate out cathode debris) to a final destination of a negatively biased flat plate in-between two solenoid magnets. The flat plate will be affixed lengthwise to two supports that will allow for rotation to simulate the 0 to 85 degrees from the previous computational data. Positively biased probes will be placed in series apart from the plates edge to record sheath thickness. As the sheath grows and begins to interacts with the positively charged probe, the probe current becomes close to zero as it collects the the sheath's electrons. Through the probe series, it can then be determined how thick the sheath has become. Sheath thickness can then be altered and studied through various combinations of: the application of various bias voltages to the plate, changing the diameter of the plasma duct to increase or decrease the plasma density, and by altering the plate angle in-between the solenoid magnets.

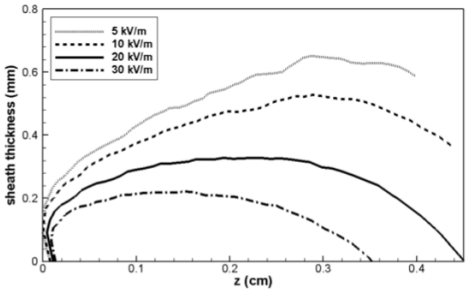

Figure 1: Sheath profile for θ=60° magnetic field as a function of normal electric field [2]

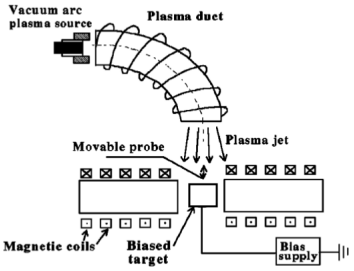

Figure 2: Schematic of the experimental configuration (not to scale) [1]

References

[1] L. Brieda and M. Keidar, *"Plasma-wall interaction in Hall thrusters with magnetic lens configuration"* J. Appl. Phys. 111, 123302 (2012).

[2] M. Keidar, O.R. Monteiro, A. Anders, I.D. Boyd, *"Magnetic field effect on the sheath thickness in plasma immersion ion implantation"* Appl. Phys. Lett. 81, 1183 (2002).