Seminar

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Institute for Plasma Research

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Title: Study of transition behaviour of plasma fireball in various magnetically constricted anode

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Date: 02nd April 2024 (Tuesday)

Time: 11:00 AM

Venue: Seminar Hall, IPR

Abstract

A Fireball is a spherical shaped anode glow (AG) observed on a small electrode biased more positive to the bulk plasma. The size, shape, and intensity of the glow depend on the anode, pressure, applied voltage, magnetic field, etc. [1]. When the electrode system is highly asymmetric with smaller electrode as anode, an electron-rich double layer is observed with an intense anode glow [2]. The electron-rich sheaths have many interesting and unexplored properties used in electrostatic probes, current collectors, virtual cathode oscillators, fireballs etc. Although the literature on AGs is extensive, the physical processes involved in its appearance are still not well understood. However, many experimental results have shown that the anode glow is the product of a self-organization process [3].

Recently, a droplet shaped fireball is observed in a magnetically constricted disc shaped anode [4, 5]. The device consists of a stainless steel vacuum chamber acting as cathode and a copper disc electrode mounted with permanent magnets acting as anode. The anode glow is found to switch from centre to periphery of the anode disc under particular threshold value of pressure and voltage. How the double layers form at the edge of the anode glow expands and leads to peripheral transition is not clearly understood.

This work reports the effect of magnetic field on the formation of droplet shaped anode glow and its transition from centre to periphery of the anode disc. The experiments have been carried out in three magnetic field configurations. In first configuration, 1 magnet is placed at centre and 16 small identical magnets are placed symmetrically at the periphery of the anode. In configuration second and third, 8 and 4 magnets are placed, respectively along with the central magnet. This study includes the characterisation of droplet shaped fireball and the discharge mechanism behind this phenomenon. A Langmuir probe [dia. = 0.5 mm, length = 3 mm] with axial and radial variation has been used to characterise the discharge. The typical plasma density and temperature inside the fireball are found to vary from $\approx 5 \times 10^{9}$ to $\approx 5 \times 10^{10}$ cm^{-3} and ≈ 2 to 8 eV, respectively for the pressure range 3×10^{-2} to $\approx 2 \times 10^{-1}$ mbar and the discharge current between 1 to 10 mA. The details of the work carried out and the future work will be discussed.

References:

1. S. D. Baalrud, B. Longmier, and N. Hershkowitz Plasma Sources Sci. Technol. 18 (2009) 035002.

2. P. K. Barnwal, A. Ganguli, R. Narayanan, and R. D. Tarey, Phys. Plasmas 29 (2022) 072102.

3. M. Sanduloviciu, V. Melnig, and C. Borcia, Phys. Lett. A 229 (1997) 354.

4. S. Chauhan, M. Ranjan, M. Bandyopadhyay, and S. Mukherjee Phys. plasmas 23 (2016) 013502.

5. S. Chauhan, T. Barman, M. Bhatnagar, M. Ranjan, and S. Mukherjee, Review of Scientific Instrument 88 (2017) 063507.