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Seminar

Institute for Plasma Research

Title : Non-Neutral Sheath region around surfaces In Low Temperature Plasma containing Negative ions

Speaker: Mr. Avnish Kumar Pandey
Institute for Plasma Research, Gandhinagar

Date : 07th December 2021 (Tuesday)

Time : 10.30 AM

Venue : Online - Join the talk:

https://meet.ipr.res.in/Thesis_Defense

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<https://meet.google.com/kzf-gbyf-bwy>

Abstract :

The present thesis devotes to fundamental study on sheath and its application towards electrostatic probe diagnostic in presence of negative ions. In particular, the characteristics of sheath in presence of a negative ion emitting electrode has been analytically studied and its impact on the quasi-neutral pre-sheath is investigated. It is found that the emission has remarkable impact on the transport of negative ion across the sheath, as a consequence of which the Bohm speed for positive ions, sheath thickness and the pre-sheath potential structure are greatly influenced. The negative ion emission from a plasma facing electrode has important application in plasma based negative ion sources for producing MeV range of neutral beam and in magnetron sputtering discharges during oxide coating of optical instruments. In conjunction to the above, the sheath models for a non-emitting cylindrical wire have been developed to estimate the negative ion parameters in electronegative plasma by means of electrical probes. Two new techniques have been developed for the first time. These are; (a) Using floating potential of a cylindrical Langmuir probe to determine negative ion temperature and; (b) a unique DC biased hairpin resonance probe to infer plasma parameters namely plasma potential, sheath width, electron temperature and negative ion concentration in an argon/oxygen discharge. Determining negative ion parameters is important in etching/deposition process using electronegative plasma, where the heat flux provided by the positive ions on the substrate is greatly influenced due to presence of negative ions. Moreover, the dc bias hairpin in particular, is a unique device for validating various sheath models, which are otherwise difficult to measure due to sheath dimensions being extremely small. In summary, the thesis provides some innovative solution to electric probe diagnostics of negative ions by cementing some of the gap areas in research of non-neutral sheath region around surfaces emitting negative ions; it also provide an insight in to the possibility for perfecting the underlying technologies for commercial application.

List of Publications:

1. Pandey, A. K., & Karkari, S. K. (2017). "Characteristics of floating potential of a probe in electronegative plasma". *Physics of Plasmas*, 24(1), 013507.
 2. Pandey, Avnish Kumar, Jay K. Joshi, and Shantanu Kumar Karkari. "Inferring plasma parameters from the sheath characteristics of a dc biased hairpin probe." *Plasma Sources Science and Technology* 29 (1) (2019): 015009.
 3. Pandey AK, Karkari SK. "Positive ion speed at the plasma-sheath boundary of a negative ion-emitting electrode". *Contributions to Plasma Physics*, DOI: 10.1002/ctpp.201900116.
 4. Pandey AK, Karkari SK, "Floating sheath characteristic of a negative ion emitting electrode in electronegative plasma". (Under preparation)
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