# Seminar

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# Institute for Plasma Research

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**Title:** Floating-Electrode Based Microwave Plasma Jet Source: Study from Plasma Characterization to Societal and Fusion Material Applications

**Speaker:** Dr. Navin Sharma
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**Date:** 27th January 2026 (Tuesday)

**Time:** 02:30 PM

**Venue:** Seminar Hall, IPR

## Abstract

In this talk, the development of a floating-electrode based microwave plasma jet source is presented along with its comprehensive characterization. This source has been successfully tested for the generation of stable plasma in pure $N_2$ and $N_2$–$CO_2$ gas admixtures. This testing was carried out at atmospheric pressure with varying gas flow rates (5-10 LPM of $N_2$) and microwave excitation powers (400-800W).

The characterization of this plasma jet was carried out using the time resolved imaging and optical emission spectroscopy. The time-resolved fast imaging helped in investigating the temporal evolution of the plasma plume, and it was observed that $N_2$ flow rates affect the elongation of the plasma plume with the formation of swirling structures within the discharge. It was also seen that the initial breakdown occurs at the tip of the tungsten floating electrode, which is followed by plume propagation in the gas flow direction. Further, the Optical emission spectroscopy (OES) analysis was performed to identify key molecular bands and atomic spectral lines. This spectral analysis showed the presence of strong emission at wavelengths around 391 nm, 408 nm, 430 nm, and 505 nm, which correspond to nitrogen molecular bands and tungsten atomic lines. The tungsten spectral line shows the sputtering of tungsten from the electrode tip that highlights plasma–electrode interactions. The thermal imaging of this plasma discharge is also being carried out. The phenomena of this microwave plasma discharge were simulated using COMSOL Multiphysics to understand the electric field distribution, electron density, electron temperature, and gas temperature. The validation of these simulation results with the experimental observations is in process.

Based on the sputtering results observed in OES, the coating of tungsten was experimented on the commercial graphite rod (14mm dia), and the results were analysed using Raman spectroscopy. The Raman spectra exhibited the presence of tungsten peaks on the graphite surface, indicating tungsten deposition, which needs to be further studied systematically. The other characterization techniques, such as XRD, SEM, and AFM under various operating conditions, are also required to fully understand the coating uniformity, thickness, and surface morphology, as such deposition is one of the key research elements for plasma-facing materials in fusion devices.

The literature shows that the atmospheric-pressure plasma is recognized as an eco-friendly approach for urea synthesis in aqueous media. In this context, the generation of $N_2$–$CO_2$ plasma using the developed microwave plasma jet is being further investigated for efficient urea production in water. A detailed and systematic study of urea formation using this source will be carried out.