Optical and probe diagnostics of a 2.45 GHz ECR coaxial plasma source

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1. Introduction

ECR coaxial plasma sources distributed in a two or three dimensional network were proposed as far back as in 2002 [1] in order to achieve high density and uniform plasmas. Another variant of an ECR coaxial source called *Aura*™ source (SAIREM S.A.) is studied here for future use in multisources configuration. Two magnets were used instead of one in the coaxial structure in order to obtain larger ECR surface, thus achieving uniform plasmas more easily. The performance of this source will be studied in single and multi source configuration.

2. Experimental setup

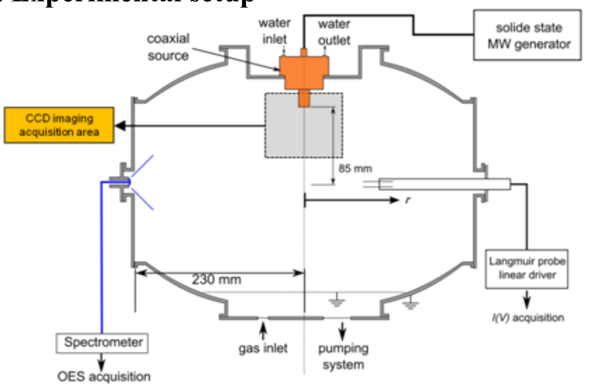

Fig. 1: *Experimental setup*

The experimental setup is shown in Fig. 1. The plasma electrostatic characterization was conducted with a referenced Langmuir probe placed at 85 mm in height from the ECR plasma source extremity, the probe was linearly driven with a step-motor, resulting in radial resolution of the plasma parameters. The Langmuir probe is made of two cylindrical tungsten tips (*Ø230* µm in diameter and *12* mm in length): one for current–voltage (*I-V*) acquisition and the other served as a reference electrode for noise reduction and probe circuit impedance compensation. Data acquisition and analysis were carried out with Impedans ALP SYSTEM™. For probe measurement validity in presence of magnetic field, the magnetic field calculated analytically from [2] does not exceed 1 mTesla at 85 mm from the source head. At the worst case scenario where the electronic temperature is as low as 0.5 eV, the Larmor radius is evaluated at $r_L = 2.9$ mm. The probe radius is therefore negligible compared to the Larmor radius ($r_P << r_L$) and the classical probe theory may be used [3].

In order to identify the different species generated during the plasma ignition, the optical emission spectroscopy (OES) measurements were performed in the wavelength range of 200 nm to 1100 nm with a spectrometer (Ocean Optics HR2000+). In parallel, the spatial distribution of the plasma emission was performed with a Princeton Instrument iCCD camera with a spectral sensibility ranging from 200 to 1000 nm.

3. Preliminary results

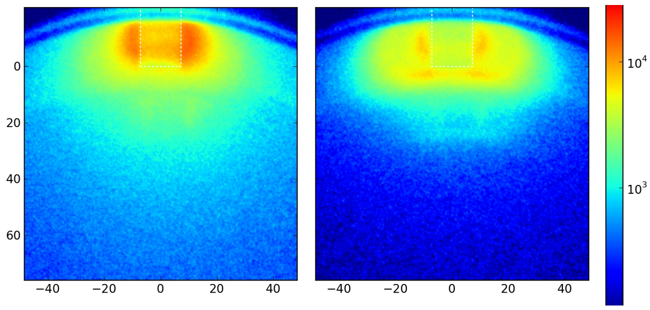

Fig. 2 : *CCD images at 50 W 5 Pa (left) and 1Pa (right)*

The iCCD imaging showed existence of two distinctive discharge modes. This is illustrated in Fig. 2 where the most intense emission was assimilated to area with the highest ionization rate. The area is situated azimuthally around the outer magnet in the first mode, in agreement with the modeling work in a similar case with unipolar source [4]. In the second mode, another ionization zone appeared at the front end of the source head.

In this work, the appearance of these modes will be correlated with results obtained by spectrometer and probe measurements. The impact on the plasma density and temperature radial profile will be presented for different gases (Argon, air, etc.)

References

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