

Optical Plasma Diagnostics In Gridded Ion Thrusters

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While optical access to plasma parameters appears is attractive for diagnostics on all kinds of plasma devices due to its non-invasive character it is of particular interest for plasmas with small dimensions where the introduction of a probe would cause significant perturbations.

Therefore in order to probe plasma parameters in gridded Radiofrequency Ion Thrusters (RITs) with dimensions of only few centimeters a light-collection set-up together with a theoretical model for the extraction of important parameters such as electron temperature or metastable densities was developed.

In a first approach the 3-grid ion extraction system of a RIT4 thruster operated with either Xenon or Argon was replaced by only one grid with a small number of holes and an optical collimator and fiber for light collection which was directly attached to the grid and protected from deposition by a small window of quartz-glass.

For the extraction of the plasma parameters optical emissions from the Argon and Xenon $2p_i \rightarrow 1s_j$ transition array in the visible and near-infrared was used. Due to the similar atomic properties of Argon and Xenon it was possible to evaluate emissions of both gases with only little changes in the model framework.

For extraction of the electron temperature an extended corona model was employed taking into account electron impact excitation from the ground state as well as from prominent $1s_j$ states with high number densities.

As next steps it is planned to verify the developed model for extraction of the $1s_j$ state densities by absorption spectroscopy. Projected measurements in the much bigger RIT35 thrusters may offer also the possibility to compare the calculated electron temperature from the model with those measured with Langmuir probes.

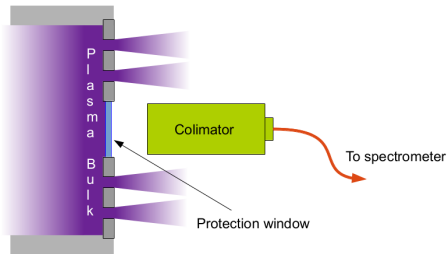


Figure 1: Schematic Set-Up

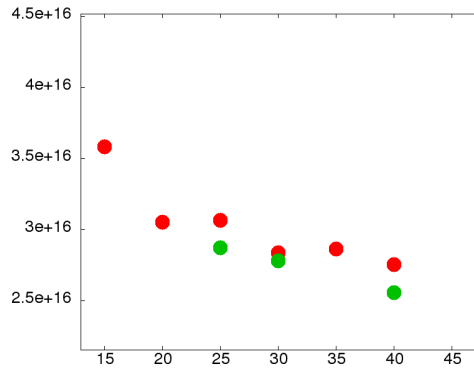


Figure 2: Estimated Xenon metastable number densities at different powers [W]

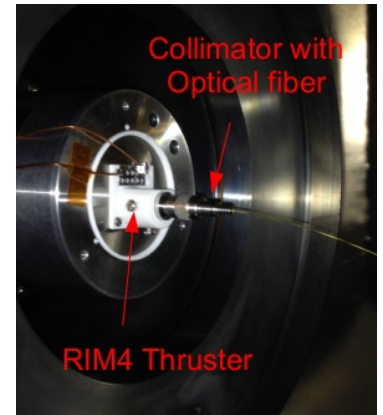


Figure 3: Experimental Set-Up