Validation of PIC/MCC simulation coupled with CRM for capacitively-coupled Ar plasma by OES measurements

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One-dimensional (1D) Particle-in-Cell/Monte Carlo Collision (PIC/MCC) simulations [1] coupled with a Collisional Radiative Model (CRM) [2] for capacitively-coupled Ar plasmas were performed and the predicted OES spectra were compared to those obtained from symmetric discharge experiments. The CRM for the first 14 levels of argon used in this study can incorporate an arbitrary electron energy distribution function. The predicted OES intensities based on the electron density and electron energy distributions obtained from PIC/MCC simulations may offer a relatively easy means to validate the PIC/MCC simulation, in the absence of more elaborate diagnostics such as probe measurements or active optical measurements such as Thomson scattering. The experiments were performed in a plasma source with symmetric parallel-plate metal electrodes having a gap distance of 4 cm and enclosed inside a cylindrical quartz chamber wall. The electrode radius was 7.1 cm. The applied peak-to-peak radio-frequency (RF) voltage between the electrodes and the gas pressure were in the ranges of 200 – 500 V and 5 - 120 Pa respectively. The RF frequency was 13.56 MHz. The OES in the experiment was acquired from the central (~1cm-wide) bulk region of the plasma. The measured current was also compared with the PIC/MCC simulation results. Figure 1 shows a comparison between the line intensity ratios (normalized at the Ar 794.8 nm line) predicted by the simulation (marked as "PIC/MCC-CRM") and measured from experimental observations (marked as "OES") for an Ar discharge at an applied peak-to-peak voltage of 300V and at a pressure of 10 Pa. The results are found to be in good agreement.

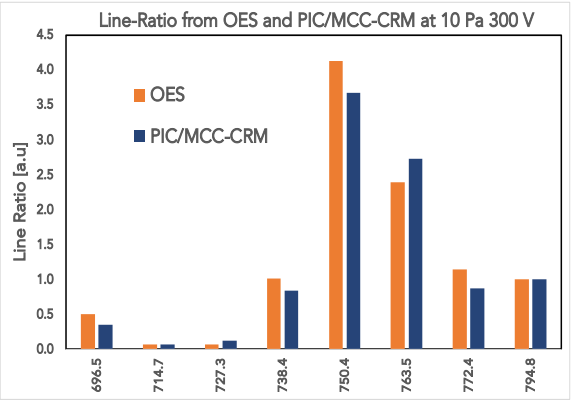

Figure 1. Line-ratio results from OES and PIC/MCC-CRM of argon plasma at 10 Pa 300 V.

References:

[1] Z. Donko, *Plasma Sources Sci. Technol.* 20 (2011) 024001

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