Poster Presentation: P-6.06

Emission spectroscopy of a DC discharge with carbon cathode

K. Katsonis[1], C. Dominique[2] , C. Arnas[2], M. Cornille[3] and A. Siskos[1]

[1] LPGP, Orsay, France,
e-mail: konstantinos.katsonis@lpgp.u-psud.fr
[2] LPIIM, Marseille, France,
[3] LUTH, Meudon,France,
e-mail: marguerite.cornille@obspm.fr

Evaluation of the plasma electron density n_e and temperature T_e for plasmas which are outside Local Thermodynamic Equilibrium can be done by using a detailed Collisionnal-Radiative (C-R) model taking into account the main physical processes that condition the plasma state and the dynamics of its main constituents. We have lately developed a C-R model [1] meant to be used for the diagnostics and the modeling of Argon and Xenon plasmas of relatively low temperatures, typically less than 30 eV. This model is under way of validation, which includes comparison of theoretical spectra provided by the model with those obtained for the plasmas of various experimental devices and prototype SPT-50 plasma thrusters [2]. We hereby apply this model in the diagnostics of a direct current discharge device with carbon cathode, available at the LPIIM Laboratory in Marseille. In so doing, using our C-R model we generate a set of theoretical spectra, encompassing a sufficiently wide field of n_e and T_e values. These are compared with the experimental spectra obtained for the DC discharge plasma, for a discharge current of 70 mA and a pressure varying from 0.4 mbar to 0.6 mbar. We obtained by this diagnostic method a plasma T_e of the order of 11000 –12000 °K, varying according to the pressure and discharge current conditions.

The experimental spectra acquired in a sufficiently short time interval cover most of the optical plasma region and contain mainly Ar I lines, with Ar II and Carbon lines already present. The Ar I and II plasmas mostly match the theoretical ones in a satisfactory way, provided the correct n_e and T_e values of the experiment are used in the model. Nevertheless, some discrepancies are still observed, which can be attributed to the insufficient approximation of the atomic data included in the C-R model [3]. The most sensible data for the spectra generation being the transition probabilities A_{ji} and electron collision excitation cross sections σ_{ij}. we are working to obtain an improved set of them.

Intensive spectral lines observed in the visible region are the well known “red” and “blue” Ar I lines coming from the 4s – 4p and 4s – 5p multiplets. Lines corresponding to the 4p – 4d, 5d, 6d and 4p – 6s multiplets of neutral Ar are also clearly visible. Ar II lines of the 4s – 4p and 3d – 4p multiplets are also present. We remind that a gap in the Grotrian diagram of about 10000 cm^{-1} corresponds to the infrared limit of the optical spectrum, say about 950 nm. This explain why the 4p – 3d are mostly excluded from the visible lines of the first Ar spectrum. The relative intensities of the Ar I spectrum versus the Ar II ones increase with pressure, in agreement with our C-R model predictions. Experimental and theoretical spectra belonging to the most prominent multiplets will be shown and commented in the Meeting. Work in progress aims to replace the Ar working gas by Xenon or to add a small admixture of Xe in order to obtain a differential diagnostics of the discharge [4] and to further validate our C-R model for Xe plasmas.

[1] K. Katsonis, K. Dzierzega, S. Pellerin, HTMP **7** (2003) 559.
[2] A. Siskos, “Constantes Atomiques et Modèles C-R pour la Propulsion Ionique”, PhD Thesis, Université de Paris-sud, Orsay, France, April 2005.
[3] K. Katsonis, R.E.H. Clark, M. Cornille, J. Abdallah Jr., XXIV ICPEAC, Rosario, 2005.
[4] Malyshev M V and Donnelly V M, Phys. Rev. E **60** (1999) 6016.