Measure of the $Ar(1s_y)$ state densities by OES in Ar-N_2 discharges

L. M. Isola[(*)1], M. M. Lopez[1], J. M. Cruceño[1], B. J. A. Gómez[1]

[1] *Instituto de Física Rosario (CONICET-UNR), S2000EZP Rosario, Argentina*

[(*)] isola@ifir-conicet.gov.ar

In this work, we compared results from two methods for the determination of $Ar(1s_y)$ densities in an Ar-N_2 discharge. Both methods involve measurements of Optical Emission Spectroscopy (OES). The first method (bands method), uses the bands corresponding to Second Positive System (SPS) of N_2, while the second method (line intensities ratio method), uses the line intensities corresponding to transitions $Ar(2p_x \rightarrow 1s_y)$. These techniques were tested in the negative glow and the results show good agreement.

Plasmas generated in Ar-N_2 mixtures have been widely studied for different conditions of pressure, concentration, type and discharge zone [1, 2]. These plasmas arouse interest because it is the atmosphere present in numerous treatment techniques and generation of thin films and multilayer systems [3, 4].

OES is a non-intrusive and relatively easy-to-use procedure, which makes it widely applied to characterize these plasmas, although the spectra interpretation is not straightforward.

In the Ar-N_2 plasma, the high excitation transfer to N_2 from $Ar(1s_y)$ atoms produces a characteristic vibrational and rotational distribution in the $N_2(C)$ level. This makes it interesting to study the SPS bands. In particular, the overpopulation produced in the high rotational levels allows to separate its contribution from that produced by collision with electrons. This separation is performed through a fit function of the bands, wich takes into account the different characteristics of the excitation processes [5].

The knowledge of the $N_2(C)$ density populated by excitation transfer allows to calculate the relative variation of $Ar(1s_y)$ with changing discharge conditions.

On the other hand, the study of the line intensities ratio generated from a same $Ar(2p_x)$ level allows to calculate the densities of $Ar(1s_y)$ metastable and resonant atoms, using the phenomenon of absorption that occurs [6, 7].

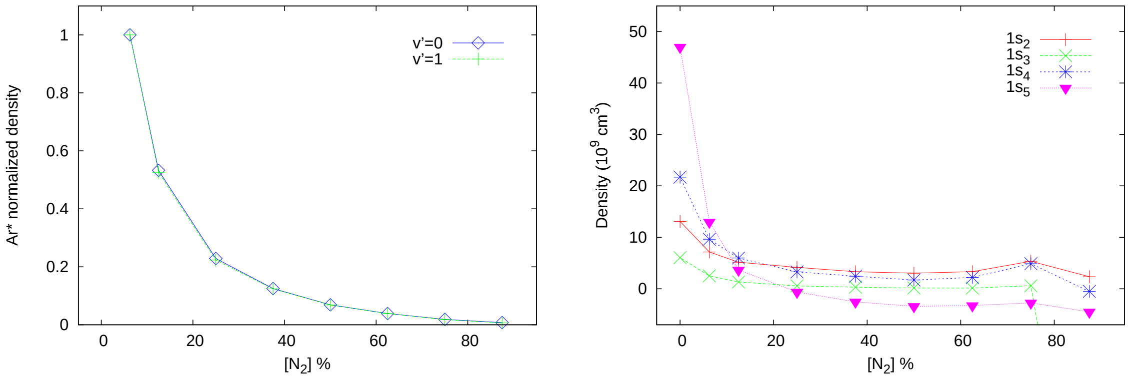
These techniques were tested in the Ar-N_2 negative glow discharge for different concentrations of mixture.

The behavior of the $Ar(1s_y)$ density (normalized with the density measured in a discharge 6 % of N_2), determined from the bands $I_{CB}(0-2)$ and $I_{CB}(1-3)$, is shown in Figure 1(a).

On the other hand, the determination of the $Ar(1s_y)$ densities for different concentrations, but now calculated from the Ar intensities ratio, is shown in Figure 1(b).

Both techniques show a strong decrease in the $Ar(1s_y)$ densities at about 25% N_2 concentration. At higher N_2 concentrations, the decrease is less pronounced.

The line intensities ratio method allows calculate absolute densities for metastable and resonant $Ar(1s_y)$ states. However the band method is useful, because of its grater accuracy, especially for low Ar concentrations.



(a) (b)

Fig. 1: (a) Ar^* normalized density from different vibrational levels vs. concentration of N_2. (b) $Ar(1s_y)$ density vs. concentration of N_2.

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