Atomic nitrogen absolute density measurements by means of Two photon Absorption Laser Induced Fluorescence in a Micro-Hollow Cathode Discharge

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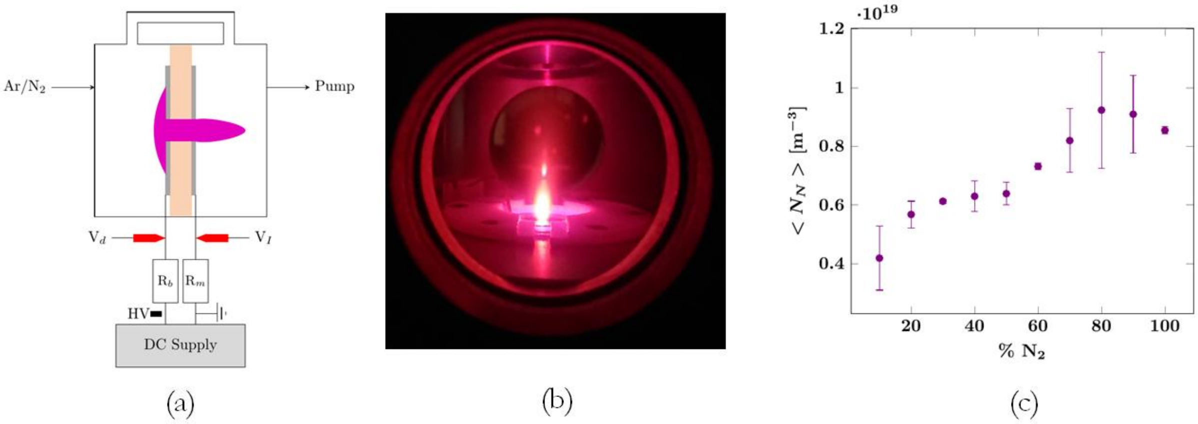
A MHCD (Micro-Hollow Cathode Discharge), used in a hexagonal boron nitride (h-BN) deposition process, is studied by means of nanosecond Two photon Absorption Laser Induced Fluorescence (TALIF). h-BN is a highly attractive material for applications in electronics and photonics, thanks to its large band gap and compatibility with graphene. The N atoms necessary for its deposition are a challenge to obtain because of the high bonding energy of the N_2 molecule (~ 10 eV). The MHCD, providing high electronic density (up to 10^{15} cm^{-3}) at low injected power (1W) lets us expect high dissociation degree of molecular nitrogen, that has to be proven experimentally. The feasibility of the deposition of h-BN using this source has been shown in [1] but further study the plasma source is needed to optimize the process.

The MHCD is placed in a reactor with two chambers (represented in figure 1 (a)), communicating only through the hole of the MHCD. It is ignited in an Ar/N_2 gas mixture, using a DC power supply. A pressure differential between the two chambers, with tens of millibars in the high pressure chamber and 1 mbar in the low pressure chamber, creates a plasma jet towards the low pressure side as shown in the photo in figure 1 (b).



(a) (b) (c)

Figure 1 : (a) Schema of the reactor, (b) Photograph of the plasma jet in the low pressure chamber and (c) Density of N atoms, 4mm from the hole, along the hole axis, measured as a function of the percentage of N_2 in the gas mixture.

The absolute density of N atoms is measured, scanning the low pressure chamber to understand the spatial repartition of N atoms in the chamber where the h-BN deposition occurs, using the method developed in our lab and described in [2]. The influence of other parameters is studied such as the pressure in the high pressure chamber, the percentage of N_2 in the Ar/N_2 gas mixture (see figure 1(c)), the gas flux and discharge current. These results will be compared to those obtained previously using Vacuum Ultra Violet Fourier Transform Absorption spectroscopy, a very sensitive technique, but not spatially resolved.

Références

[1] H. Kabbara et al., Appl. Phys. Lett. **116**, 171902 (2020)
[2] E. Bisceglia et al., Plasma Sources Sci. Technol. (2021)

Statut : Doctorante