H atom rel ative density measurements in a He micro tube atmospheric press ure plasma jet using picosecond TALIF and a streak camera

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Résumé

The use of atmospheric pressure plasma jets (APPJ) in novel applications is due to their ability to generate
particularly rich and reactive gas phase chemistry while maintaining a gas temperature close to room
temperature. However , even today, the precise measurement and control of atomic and molecular reactive
species produced in APPJ and brought to different targets are challenging tasks In fact, because of the high
collisional frequency at atmospheric pressure conditions, to determine reactive species kinetics it is necessary to
implement advanced diagnostics that do not disturb the plasma properties. Furthermore, these diagnostics must
exhibit excellent temporal (ps-fs scales) and spatial (mm-μm scales) resolutions, as the density and lifetime of
some critical reactive species is characterized by strong gradients in space and time (1).
Based on the above, the present study focuses on the development of a picosecond Two Photon Absorption
Laser Induced Fluorescence (ps TALIF) diagnostic to measure the relative density of ground state hydrogen
atoms generated in a μs-pulsed He micro-tube APPJ. To achieve it, a picosecond laser (Ekspla® ; pulse width:
10 ps) and a streak camera (C10910 05, Hamamatsu® ; time resolution: few ps) were used. With this setup, we
were also able to measure laser excited H-atom lifetimes of the order of a few hundred ps depending on the

[*]Intervenant

distance from the APPJ's tube and the discharge's operating parameters (peak-to-peak voltage, pulse width, He flow rate). Finally, the streak camera was employed to perform time resolved optical emission spectroscopy as in (2), in order to follow the temporal evolution of the different plasma emissions. Figure 1 depicts an example of a recorded streak image corresponding to the wavelength integrated plasma emission. From Figure 1, two discrete luminous phenomena are distinguished around 10 and 35 μs, corresponding to two discharges generated during the rising and falling fronts of the applied high voltage pulse (25 μs width ; 20 kHz frequency; 2.1-3 .1 kV peak-to-peak voltage). **References**

(1) S. Schröter et al., Plasma Sources Sci. Technol. 29 (2020) 105001

(2) H. Höft et al., J.Phys. D: Appl. Phys. 47 (2014) 465206

Mots-Clés: APPJ, TALIF, picosecond laser, streak camera