Space and time resolved characterization of *in-air* Pulsed Atmospheric Plasma Streams for biomedical applications

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Non-Thermal Atmospheric Pressure Plasma Jets (NT-APPJ) are powerful tools of great interest for the growing Plasma Medicine field. The Plasma Gun, developed in GREMI, producing Pulsed Atmospheric pressure Plasma Streams (PAPS) is used for *in vitro* and *in vivo* studies of the antitumor effect of plasmas. Besides numerous *in-capillary* studies concerning PAPS velocity, morphology and splitting-merging behaviour [1], recent achievements about *in vivo* antitumor activity of the Plasma Gun, led to focalize on plasma chemo-physical properties of the *in-air* expending jet.
PAPS generated with the Plasma Gun, under short time excitation (µs) from 100Hz to kHz in Helium at low flow rate (100 to 1000 ml per min) have unique features such as high ionization front velocity (108 cm.s-1) and long propagation in flexible dielectric capillaries (~m) prior to *in-air* expending jet. In this work, they have been studied in terms of their reactive species (RS) production.
Emission intensity as well as spatial distribution evolution of RS versus parameters such as gas flow, repetition rate and applied voltage amplitude, were under the scope of this work. To achieve optimization of the plasma delivery *in vitro* and *in vivo*, parametric studies had been performed using space and time resolved spectroscopy (OES) to follow the relative evolutions of reactive oxygen species such as OH*, NO* and nitrogen molecular species (N2* and N2 +*) considering their highly probable involvement in biological processes. Filtered imaging had been achieved focusing on species radiation in UV and Visible domains on those species and He*.
Fast imaging reveals spatial distribution of RS within the PAPS. NO* emission intensity per pulse was shown to increase with the repetition rate which was not the case for other species. We have shown that distance between dielectric capillary exit and targets, target coupling with the ground as well as gas flow rate clearly change RS production and spatial distribution opening ways to control RS delivery on the target.
This work gives an overview of the dynamics taking place during PAPS propagation in the *inair* expending jet resulting in the ability to optimize experimental parameters to suit desire treatment conditions.

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References

[1] E.Robert *et al.* Characterization of pulsed atmospheric-pressure plasma streams (PAPS) generated by a high repetition rate plasma gun in press [PSST/411873/SPE/25845]