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5. Plasma-liquid interaction / plasma chemistry in biological liquids / plasma activated media for cancer applications

FORMATION OF RONS INCLUDING $ONOO^-$ AND $O_2^{\circ-}$ IN PHYSIOLOGICAL BUFFERS EXPOSED TO COLD ATMOSPHERIC PLASMAS

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Plasma-liquid interactions are increasingly studied over the last years, within the framework of biomedical applications of cold atmospheric plasmas (CAPs). Among various energy components of CAPs, reactive oxygen and nitrogen species (RONS) play a key role in the reported biological effects [1]. Stable ones (H_2O_2, NO_2^-, NO_3^-) remain in the liquid during several hours after CAP treatment and can be detected by different methods [2]. A major challenge consists of the detection and quantification of the unstable and very reactive forms of RONS (such as $O_2^{\circ-}$, NO° or $ONOO^-$).

Herein, the generation of RONS by CAPs in a common physiological buffer (PBS, pH 7.4) was investigated. Plasma device consists of the formation of guided ionizing waves with the control of the gaseous environment. Correlations between plasma gaseous compositions and induced-chemistry in PBS have been studied by electrochemistry and UV-Visible absorption spectroscopy. First, the chemically stable RONS (hour time-scale) were determined for various surrounding environments. Secondly, the unstable RONS (< sec. at physiological pH) were analyzed following two innovative and complementary approaches; the first one consists in stabilizing RONS by switching the pH of PBS to alkaline values, while the second one consists in analyzing RONS generation close to the plasma-liquid interface owing to an *in situ* and in real time electrochemical detection with microelectrodes. Following this dual protocol, we demonstrated the presence and quantified the highly reactive peroxynitrite $ONOO^-$, a biologically nitrating and nitrosating species, which ends up in stable NO_2^- and NO_3^- species, as observed after minutes and hours post-treatment ([2], [3]). Moreover, *in situ* electrochemistry gave information about the liquid chemistry occurring in the first minutes of plasma treatment and allowed the detection of superoxide $O_2^{\circ-}$ heavily depending on the gaseous environment of the CAPs.

References

[1] D. B. Graves, *Journal of Physics Applied Physics*, *45* (26), 263001 (2012)

[2] F. Girard, V. Badets, S. Blanc, K. Gazeli, L. Marlin, L. Authier, P. Svarnas, N. Sojic, F. Clément, and S. Arbault, *RSC Advances*, *6* (82), 78457–78467 (2016)

[3] F. Girard, M. Peret, N. Dumont, V. Badets, S. Blanc, K. Gazeli, C. Noël, T. Belmonte, L. Marlin, J-P. Cambus, G. Simon, N. Sojic, B. Held, S. Arbault and F. Clément, *Physical Chemistry Chemical Physics,* 20, 9198-9210 (2018)