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Towards an understanding of plasma-bio interactions: tracking reactive species from the plasma source to the biological target

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Non-equilibrium atmospheric pressure plasmas interacting with biological matter offer a unique source of highly reactive chemistry at close to ambient temperatures beneficial for many applications including food decontamination, wound healing and cancer treatment, each in their own right major societal challenges. Each application requires selective treatments. For example, the inactivation of bacteria on healthy tissue or food substrates needs to occur with minimized off target effects, similarly, treatments of tumors should be selective to cancer cells with minimum impact on the surrounding healthy cells and tissue. Developing controlled and selective plasma treatments for biomedical applications would highly benefit from a detailed understanding of the key plasma-produced reactive species enabling the plasma-induced effects.

With this motivation, my group, in collaboration with colleagues working in the field of biology and medicine, has performed detailed studies of the interactions of plasma with virus, bacteria and mammalian cells [1-3]. This work was complemented with detailed measurements of plasma-produced reactive species in the gas and liquid phase. Our research shows that controlling the gas phase plasma chemistry can lead to significant different biological responses of the living organisms. We will show examples of how such studies enable tracking reactive species from the plasma source to the biological target. The outcomes of these studies allow unraveling chemical pathways responsible for plasma-bio interactions.

As in several other studies, we found the importance of long-lived species such as H_2O_2 and OCl^-. However, many of our studies indicate the direct or indirect importance of short-lived species. We will discuss these results in detail illustrating the unique character of the plasma treatment and the importance of transport limitations leading to a sensitivity of plasma-bio interactions on treatment modalities.

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References

[1] G. Nayak, A. Andrews, I. Marabella, H. Aboubakr, S. M. Goyal, B. Olson, M. Torremorell and P. J. Bruggeman, Plasma Processes and Polymers (accepted) (2020)
[2] V.S.S.K. Kondeti, C. Phan, K. Wende, H. Jablonowski, U. Gangal, J. Granick, R.C. Hunter and P.J. Bruggeman, Free Radical Biology and Medicine 124, 275–287 (2018)
[3] H.A. Aboubakr, S.K. Mor, A. Armien, LA. Higgins, M.M. Youssef, P.J. Bruggeman and S.M. Goyal, PLOS one, 13(3): e0194618 (2018)