

# Plasma-generated reactive oxygen species for biomedical applications

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Reactive oxygen species (ROS) are well known to play an important role in several biological systems. However, the production of ROS exceeding the ability of the organism to mount an antioxidant defense results in oxidative stress. If the amount of oxidative damage overcomes the repair capacity of a cell, this can ultimately lead to cell death, which is very important to be taken into account for biomedical applications of plasmas. To get a better insight into the effects of ROS on cellular components, fundamental studies are essential to determine firstly the nature and concentration of plasma-generated ROS, secondly the chemistry induced in biological liquids by those ROS, and finally the ability of this "cocktail" of reactive species (plasma-generated ROS and the others created within the liquid by those ROS) to damage biomolecules. In this context, we have measured the absolute density of two of the main ROS created in three different atmospheric pressure plasma sources: two geometrically distinct radio-frequency-driven microplasma jets ( $\mu$ -APPJ [1] and kinpen [2]), and an array of microcathode sustained discharges [3]. Optical diagnostics of the plasma volumes and the effluent regions have been performed: ultra-violet optical absorption for ozone ( $O_3$ ), and infra-red emission for singlet-delta oxygen ( $O_2(a^1\Delta_g)$ ) [4]. High concentrations of both ROS ( $10^{14}$ – $10^{17}$  cm<sup>-3</sup>) have been efficiently obtained in the gas phase at low gas temperatures ( $\sim 300$  K). The effect of different parameters, such as gas flows and mixtures, and power coupled to the plasmas, on the production of both ROS has been studied. Opposite trends for the different ROS densities within the operational range of each plasma have been observed. Thus, the control of the operating conditions enables to tailor the ROS composition of both plasmas towards different biomedical applications. For plasma medicine, the determination of the reactive species present in plasma-treated liquids is of great importance. In this work, we focused on the measurement of  $NO_2^-$ ,  $NO_3^-$  and  $OH^\bullet$ , generated in physiological solutions like sodium chloride solution, cell culture medium, and phosphate buffered saline. The detection of these reactive species has been done via electron paramagnetic resonance spectroscopy and colorimetric assays. Additionally, the pH value and concentration of  $H_2O_2$  have also been measured by electrochemical detection.

## References

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