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HOW REACTIVE SPECIES FROM COLD PLASMA ARE TRANSPORTED INTO LIQUID WATER BULK/AEROSOL

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Atmospheric air plasma produces a cocktail of reactive oxygen and nitrogen species (RONS) with multiple functions relevant to applications in biomedicine, agriculture, air and water cleaning, matertial treatment, etc. In plasmas interacting with liquids, the transport of RONS into the liquid through plasma–liquid interface can be significantly enhanced by converting bulk water to aerosol microdroplets [1]. The expected solubility of various RONS with different Henry's law coefficients is very different. We verify the applicability of Henry's law coefficients under strongly nonequilibrium conditions characteristic of plasma–liquid interaction, with water in the form of bulk vs. nebulized or electrosprayed microdroplets. This fundamental understanding can lead to optimized designs of plasma–water interaction systems for multiple applications in biomedicine, environment, and agriculture.
Figure 1 shows the schematic diagram of elementary processes of ionization, excitation and dissociation in air plasma, the formation of radicals and other RONS, as well as their mutual reactions in the gas phase. Then it shows their transport into the liquid water based on their solvation, indicating the Henry's law coefficients. Finally, in the liquid, the plasma-formed, as well as the new ionic RONS, diffuse and undergo further reactions. The RONS transport processes in water are compared in the bulk and in two types of microdroplets: charged ones produced by electrospray (ES), and nebulized non-charged microdroplets. The amount of H_2O_2(aq) and NO_3^-(aq) (mainly from gaseous HNO_3) dissolved in the nebulized microdroplets was ~1 order of magnitude higher compared to that in the ES microdroplets because it was enhanced by their larger plasma–water interface area. On the other hand, the production of NO_2^-(aq) (mainly from HNO_2 [2]) is higher in the charged ES microdroplets, which indicates the importance of the charge effects and ion mobility.

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References
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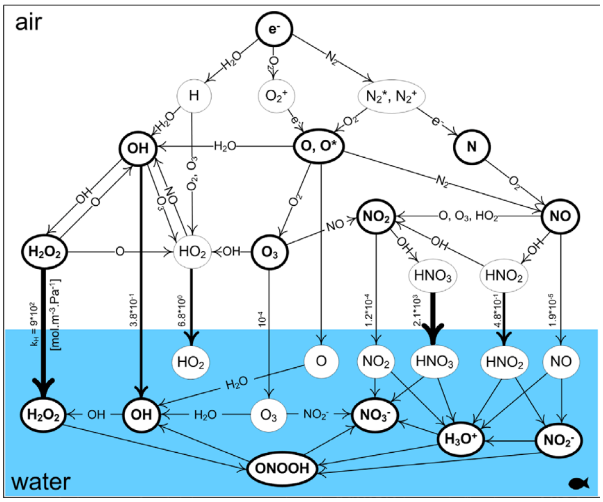

Plasma-liquid chemical and transport processes