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Spontaneous Formation of OH Radicals in the Air-Water Interface of Water Droplets

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Water covers about 71 percent of the Earth's surface and it is crucial for all the biological systems. Although bulk water is inert, water microdroplets provide a favourable environment for chemical processes. In the air-water interface the presence of a strong electric field can lead to the acceleration of chemical reactions and initiate spontaneous reduction of organic compounds. Our study is focusing on the spontaneous H_2O_2 production at the interface of water droplets, which occurs via the recombination of the hydroxyl radicals that are formed via the dissociation of hydroxyl ions, while other pathways cannot be excluded. H_2O_2 may play a key role in the oxidation of atmospheric aerosols and therefore, it may alter the oxidation capacity by increasing the production of radicals.

Within this framework, a thorough laboratory study, using state-of-the-art instrumentation has been carried out. Two different types of experiments were performed, where the H_2O_2 and thus the OH production was measured either directly or indirectly by using sensitive water-soluble fluorescent probes. Aqueous microdroplets, in a range of diameter 0.1 to 10 μm were generated by nebulizing salted solutions inside a glass reactor. These particles were then collected and the liquid phase H_2O_2 was measured by using an H_2O_2 analyser. During our experiments, an Optical Particle Counter was connected in order to monitor the size distribution and the number of the particles. To extend our understanding in the processes that occur at the interface, different types of salts were selected, in order to investigate the way that different ions affect the H_2O_2 production. In order to verify the OH production, salted solutions containing terephalic acid (TA) were also nebulised and the collected droplets were analysed via fluorescent spectroscopy, where the 2-hydroxyterephthalic acid (TAOH), product of the reaction of TA with OH radicals, was observed.

All the experiments provide evidence that H_2O_2 is produced in the air-water interface of microdroplets at a range of (1–7)$\times 10^{-2}$μM. Results from this study are expected to significantly improve our insight on the processes that occur in atmospheric droplets and to assess the contribution of this OH radical source in total atmospheric budget.