WG: 2

Generation of antimicrobial NO_x by transient spark discharge in atmospheric dry air, and with water electrospray through the discharge zone

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Nitrogen oxides are typical by-products of atmospheric pressure air plasmas that are important antimicrobial (NO_2) and physiological (NO) agents. We studied the synthesis of NO, NO_2 and their precursors (O and N radicals) by the transient spark (TS) discharge in air, using optical emission spectroscopy (OES) combined with the post-discharge gas composition analysis. The TS is a DC-driven self-pulsing discharge initiated by a streamer transforming to a short spark current pulse, with the pulse repetition frequency 1-10 kHz. The TS current pulses are sufficiently short (~10-100 ns) to avoid the plasma thermalization. The non-equilibrium plasma generated during the spark phase of the TS is highly reactive, since the electron density as high as 10^{17} cm^{-3} can be achieved.

The TS has already been successfully tested for several environmental and bio-medical applications, for example for bio-decontamination of water [1-3]. From this point of view, the TS represents a promising alternative of water disinfection techniques, as it can operate in direct contact with the treated water. With water being supplied via a hollow anode [4], the TS can induce electrospray of the treated water and the gas-liquid interaction surface area enhancement to facilitate the mass transfer towards bacteria or cells suspended in water solutions. Generation of nitrogen oxides in gas phase was studied in dry air, and compared with humid air with water sprayed through the discharge zone. Water collected after the discharge treatment was analysed. Resulting concentrations of nitrites, nitrates and OH radicals were measured using several UV-VIS absorption and fluorescence spectroscopic techniques [2].

The dominant stable gas phase products were nitrogen oxides. The sum of NO and NO_2 concentration more than 600 ppm was achieved with power input below 6 W. The highest NO_x ($NO + NO_2$) generation rate achieved is around 7×10^{16} molecules/J. However, we assume that we can still improve NO_x generation efficiency our system by varying parameters of the electric circuit generating the TS discharge (external resistor, internal capacitance, distance of electrodes). On the other hand, only traces of ozone were detected (<10 ppm). The negligible amount of O_3 in the gas phase supports our previous findings that nitrites and nitrates generated in the aqueous phase from dissolved NO/NO_2, combined with H_2O_2 forming from OH radicals and acidic pH play crucial role as antimicrobials agents in the water treated by the TS, while the role of dissolved O_3 was found negligible [2].

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