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Antimicrobial NO_x generated by transient spark in atmospheric dry air and air with water electrospray

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Nitrogen oxides (NO_x) are typical by-products of atmospheric pressure air plasmas and 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, DC-driven repetitive self-pulsing discharge initiated by a streamer transforming to a ~20-50 ns short spark current pulse with the pulse repetition frequency 1-10 kHz [1]. It has been successfully applied for several environmental and bio-medical applications [2-3]. The TS can induce electrospray of the treated water, which enhances the mass transfer of plasma generated species towards bacteria or cells suspended in water solutions. Generation of nitrogen oxides in the gas phase was studied in dry air, and in the air humidified by water electrosprayed through the discharge zone. Nitrites, nitrates, hydrogen peroxide and peroxynitrites were measured in the treated water using UV-VIS absorption/fluorescence spectroscopic methods [2].

The dominant stable gas phase products were nitrogen oxides, while only traces of ozone were detected (<10 ppm). 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 was around 7×10^{16} molecules/J. Due to the transfer to the liquid, the NO_x densities were lower in the air humidified by the electrospray. 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 a crucial role as antimicrobial agents in the water treated by the TS, while the role of dissolved O_3 was found negligible [2].

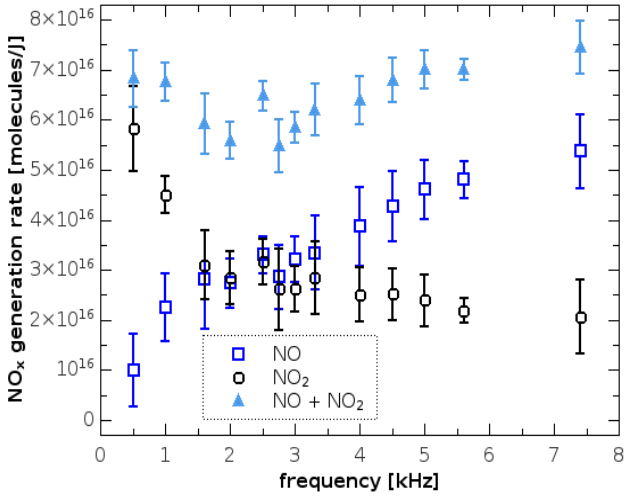

Fig. 1 NO, NO_2, and total NO_x production rate in TS in dry air.

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