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N₂ OXIDATION PATHWAYS IN A ns-PULSED DISCHARGE ABOVE WATER: O ATOMS, NO, AND OH RADICALS KINETICS

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Nitrogen fixation (NF) is a process of converting molecular nitrogen into valuable chemicals, such as NH₃ or NO_x. These components are used in many industries, in particular as a feedstock for fertilizers in agriculture. Nowadays, industrial NF is associated with high energy consumption and dramatic environmental impact. Plasma-assisted NF can be a good alternative and, with the support of renewable (green) energy sources, it can bring many benefits and reduce the environmental impact of industry [1].

This research focuses on investigating nitrogen oxidation pathways in the presence of a plasma/liquid interface. The atmospheric pressure plasma was driven by 10 ns long pulses. Temporal-spatial dynamics of the key species were experimentally investigated using laser-induced fluorescence (LIF) and optical emission spectroscopies (OES). The species kinetics were studied varying plasma pulse energy and pulse frequency. A low repetition frequency discharge of 10 Hz in single pulse mode was compared with a high-frequency burst of 100 kHz to examine if a high pulse repetition rate can improve the plasma-assisted NF.

O atoms and NO radicals kinetics revealed that the presence of water creates lingering NO formation up to 10s of microseconds owing to NO formation in reactions with OH radicals [2]. The suggested mechanism is confirmed by the measurement of time-resolved 2D profiles of OH radicals using LIF. Obtained data well agree with previously made suggestions, and together with OES, it gives us a complete picture of the gas-phase chemical dynamics in a ns-pulsed discharge above water. To conclude, this work shows how the presence of water impacts NO formation kinetics, which, in turn, can be used in the optimization of the plasma-assisted NF process.

1. L. R. Winter and J. G. Chen, "N₂ Fixation by Plasma-Activated Processes", *Joule*, 2020, 16p.
2. M. Gromov et al., "N₂ oxidation kinetics in a ns-pulsed discharge above a liquid electrode", *Plasma Sources Sci. Technol.*, 2021, 14p.

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