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Conference Paper · September 2021

DOI: 10.1109/ICOPS36761.2021.9588569

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N_2 OXIDATION PATHWAYS IN A ns-PULSED DISCHARGE ABOVE WATER: O ATOMS, NO, AND OH RADICALS KINETICS

Mikhail Gromov[1,2], Kseniia Leonova[2], Nikolay Britun[3], Rony Snyders[2,4], Nathalie De Geyter[1], Rino Morent[1], and Anton Nikiforov[1]

[1]Ghent University, Department of Applied Physics, Gent, 9000, Belgium
[2]Mons University, Chimie des Interactions Plasma-Surface (ChIPS), Mons, 7000, Belgium
[3]Nagoya University, Center for Low-temperature Plasma Sciences, Nagoya, Japan
[4]Materia Nova Research Center, 3 Avenue Nicolas Copernic, 7000 Mons, Belgium.

Nitrogen fixation (NF) is a process of converting molecular nitrogen into valuable chemicals, such as NH_3 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, "N_2 Fixation by Plasma-Activated Processes", Joule, 2020, 16p.
2. M. Gromov et al., "N_2 oxidation kinetics in a ns-pulsed discharge above a liquid electrode", Plasma Sources Sci. Technol, 2021, 14p.

* Work supported by the Excellence of Science FWO-FNRS project NITROPLASM (EOS ID 30505023)