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Nitrogen atoms ps-TALIF in atmospheric pressure nanosecond volume DBD plasma

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1. Introduction

Nanosecond discharges at atmospheric pressure are studied for different applications, where dissociation of molecules often plays a key role. This work presents the results of picosecond TALIF-measurements of N-atoms density (using ps-TALIF in Kr) in atmospheric pressure air.

2. Experimental setup and results

The volume dielectric barrier discharge was ignited in 1 atm room air by a burst of about 10 pulses produced by means of a FPG-12-1NM (FID GmbH) generato. The initial 5 kV amplitude on the high-voltage (HV) electrode decayed from pulse to pulse in the burst, each pulse being 29 ns FWHM, separated by 200 ns. The bursts were repeated with 5 Hz frequency. The schematic of the discharge is given by Fig. 1. The HV electrode is a stainless steel needle. The grounded electrode is Al plate covered with 0.3 mm PVC layer. The interelectrode gap is 1.8 mm. To check the homogeneity of the plasma in the zone of laser focusing, ICCD camera (PI-MAX4 Princeton Instruments) combined with a long distance microscope LDM1 (LaVision) were used. ICCD image of the discharge in the $N = 3$ pulse is shown in Figure 1.

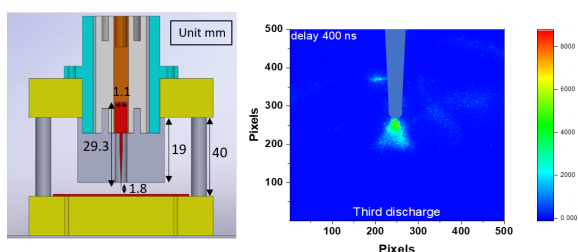


Fig. 1: Schematic of electrode setup and ICCD image of the third discharge.

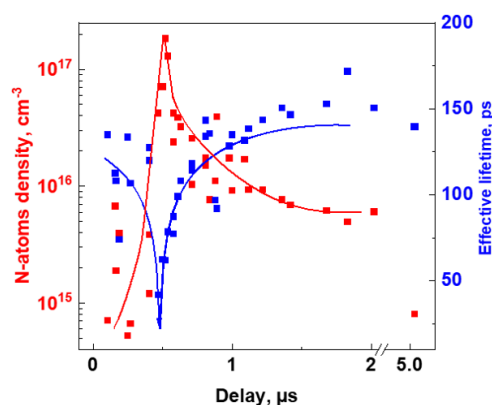


Fig. 2: Fluorescence effective lifetime and N-atoms density.

A picosecond laser system (Ekspla) [1], consisting of a Nd:YLF pump laser (PL3140), a harmonic generator (APL2100), and a solid-state OPG (PG411), provided 10 ps laser pulses at 5 Hz and 206,6 nm that were synchronized with the discharge 11 μ J pulses at 206.6 nm.

A streak-camera (Hamamatsu C10910-05) was used to measure the fluorescence around 744 nm. Shortening of the decay time from 150 ps down to 50 ps during first 400 ns and smooth increase back to 150 ps was observed (Fig. 2, blue curve). Measured N-atoms density (Fig. 2, red curve) exhibits a peak at 400 ns corresponding to the $N = 3$ pulse in the burst. Maximum obtained density is $2 \cdot 10^{17} \text{ cm}^{-3}$, corresponding to $\sim 1\%$ of dissociation of N_2 .

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- [1] L. Invernizzi, C. Y. Duluard, H. Hoeft, K. Hasouni and G. Lombardi, K. Gazeli, S. Prasanna, 2023 *Meas. Sci. Technol.* **34** pp 145-171