TRANSIENT SPARK DRIVING CIRCUIT OPTIMIZATION FOR ENHANCED GENERATION OF NITROGEN OXIDES

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Abstract. Nitrogen fixation in atmospheric air plasma discharges becomes an emerging application due to great potential in agriculture. We are testing N-fixation by Transient Spark (TS): a dc-driven self-pulsing discharge with a repetition frequency of 1-10 kHz. Generated sparks (Figure 1) are of very short duration (∼10 ns) and the energy delivered to plasma is limited to ∼1 mJ per pulse, because the spark is formed only by discharging of the internal circuit capacitance (20-30 pF). This makes TS an efficient plasma source for nitrogen oxides (NOx) generation (Janda et al. 2016). The density of NOx increases with increasing repetition rate, but the increase of frequency also leads to the transition to less efficient high pressure glow discharge (GD) regime (Figure 1).

Large ballast resistor (R = 5-10 MΩ) is used to eliminate TS to GD transition. However, this approach causes decreasing energy efficiency of TS at higher frequency due to the growing losses on R. For this reason, we tested various driving circuit modifications using additional coils and capacitors to keep discharge in spark regime even with R below 5 MΩ. We were able to maintain the discharge in spark regime with R = 2.3 MΩ using additional capacitance C = 70 pF. Moreover, we succeeded to increase the NOx generation efficiency approximately by factor 2. There was no benefit from using even higher external capacitance (tested up to C = 500 pF). The sparks during the active discharge phase were more intense, but the charging of C during the relaxation phase (see Figure 1) was much longer, i.e. the repetition frequency of current pulses decreased.

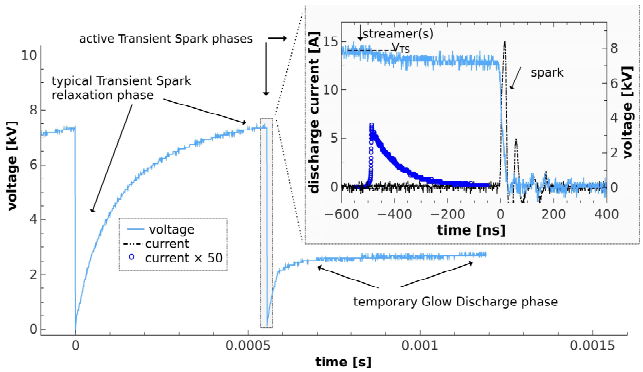

Figure 1: TS current and voltage waveforms.

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References

Janda, M., et al. : 2016, *Plasma Chem. Plasma Proc.*, **36**, 767.