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(G*) Influence of pulsed gas injections on the stability of Townsend dielectric barrier discharges in nitrogen at atmospheric pressure

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Nanocomposite (NC) thin-films are widely studied due to the multifunctional properties they can develop (optical, electrical, mechanical). A lot of methods are under development with a real attraction for processes at atmospheric pressure, such as dielectric barrier discharge (DBD).
Recently, a new process of nanoparticles injection in plasmas has been developed [1]. This method consists in synthesizing the nanoparticles prior to their injection in the plasma in a low frequency pulsed injection regime. However, the impacts of the gas pulsed injection on the DBD physics are still opening questions.
This work investigates the effects of pulsed gas injections on the physics driving Townsend dielectric barrier discharges in high-purity nitrogen at atmospheric pressure in laminar gas flows (residence time ˜50 ms). For single-pulse injections of N2 with gas opening times lower than the gas residence time, current-voltage characteristics reveal that the discharge remains homogeneous with a single current peak per half-cycle of the applied voltage. However, a transition from homogeneous to filamentary discharge combined with a decrease of the discharge power at fixed amplitude of the applied voltage is observed for higher gas opening times due to an accumulative effect. This is further confirmed by multiple pulsed injections with repetition frequencies between 0.1 and 10 Hz. In such multi-pulse conditions, time-resolved optical emission spectroscopy measurements reveal longer time scale variations of the N2(A) and O(3P) populations compared to the expected residence time in a laminar gas flow. This suggests that recirculation of impurities due to the pulsed injections play an important role in the destabilization of Townsend discharges. The system's conductance, calculated from pressure rise measurements over a wide range of operating conditions, confirms the instantaneous transition from laminar to turbulent gas flow due to the pulsed gas injections.

1. Kahn, M., Champouret, Y., Clergereaux, R., Vahlas, C. & Mingotaud, A.-F. Process for the preparation of nanoparticles. (2016).

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