Investigation of discharge dynamic and chemical kinetics in the microdischarges generated in a multipin-to-plane pulsed N2/O2 corona system working in the nanosecond regime

M. Redolfi, C. Klett, S. Touchard, A. Vega, X. Duten, K. Hassouni

LIMHP - CNRS UPR 1311, UNIVERSITE PARIS 13 - 99 AV JB CLEMENT VILLETANEUSE, IDF 93430, FRANCE

Abstract:

Atmospheric non-thermal discharges have received renewed interest during the last two decades due to their high application potential in many fields such as flue gas treatment, biological processing, thin film deposition, surface treatment processes, and more recently plasma assisted combustion and aerodynamic drag reduction. These discharges may be generated in a number of ways and using different configurations.

In this work, we are more specifically interested in corona discharge generated using strongly asymmetric electrode system. We consider those corona discharges obtained using fast voltage choc with a characteristic rise time in the nanosecond regime. Such systems present a significant interest since they allow working with significant over-voltage, which is likely to enhance the chemistry induced by the discharge, without transitioning to the spark regime.

Streamer micro-discharges have been produced in a 300 pin-to-plane pulsed corona device and were investigated through modeling and experimental measurements. The streamer propagation phase of the micro-discharge was investigated by solving the coupled set of charged species transport equations and Poisson's equation for the electric field in condition where the propagation takes place under a significant background electric field. Some of these experimental information's were used as input parameters for a modeling investigation of the energy deposition and the thermochemistry in a single micro-discharge.

The detailed chemistry induced by the streamer propagation was analysed with the help of a quasi-homogeneous thermo-chemical model. Both the discharge dynamic and the thermo-chemical models were qualitatively validated. Results showed that the streamer propagation dynamics and the resulting O-atom production kinetics are very sensitive to the rise time of the voltage choc that generates the corona discharge.

Experimental and modelling results are presented and discussed.