

# REMOVAL OF FORMALDEHYDE IN AIR BY HOMOGENEOUS AND FILAMENTARY PULSED DISCHARGES

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**Abstract.** Removal of formaldehyde by pulsed discharges is studied in nitrogen and dry air. Efficiencies of homogeneous and filamentary plasmas are compared. Relative importance of the oxygen atom and of the hydroxyl radical is discussed.

## 1. INTRODUCTION

Formaldehyde (CH<sub>2</sub>O) is one of the most toxic Volatile Organic Compounds (VOCs) emitted by chemical industries. It is also an indoor air pollutant coming from building materials. Moreover, this compound is one of the major by-products (together with CO and CO<sub>2</sub>) obtained from non-thermal plasma treatment of numerous VOCs or hydrocarbons at low deposited electrical energy in the plasma. However, since the first theoretical work by Storch et al. [1], there has been very few experimental studies about removal of CH<sub>2</sub>O by non-thermal plasmas or combination of plasmas with catalysts [2-6]. Moreover, the published works deal with filamentary discharges such as dielectric barrier or corona ones, and non-homogeneous active media constituting packed-bed reactors with pellets. In such conditions a comprehensive kinetic interpretation of measurements is not easy to achieve because it requires a self-consistent modeling of both the discharge physics (electrical energy deposition) and of the strongly reactive chemistry for the gas mixture under consideration. In the present work, a pre-ionized (photo-triggered, PTD) discharge [7] is used to study the conversion of CH<sub>2</sub>O in N<sub>2</sub>/O<sub>2</sub> mixtures. Results are compared to those obtained with a DBD (filamentary plasma) operating in a cylindrical coaxial geometry and energized by a pulsed HV power supply.

## 2. EXPERIMENTAL SET-UP

The PTD cell used in the present work was previously described in [8, 9]. The discharge is ignited between two flat electrodes, 24 cm in length and 2 cm in width, separated by a gap  $d=1.2$  cm. These electrodes are inserted in an acrylic cell which acts as insulator, and are connected to the output of a symmetrical one-stage Fitch generator. The lower electrode is electrically grounded while the upper one, the cathode, is perforated with many 1 mm in diameter holes. An auxiliary corona-like discharge device is located under this electrode in order to uniformly pre-ionize the discharge volume (57.6 cm<sup>3</sup>) by UV-photons. In this way an homogeneous transient plasma is achieved in high pressure N<sub>2</sub>/O<sub>2</sub> mixtures with additives such as hydrocarbons or VOCs. The applied voltage between the electrodes,  $V_0$ , at the time of the pre-ionization must be high enough to insure that the initial reduced electric field (i.e. before the gas breakdown)  $(E/N)_0 = V_0/(N_0.d)$ , is higher than the self-sustaining electric field in the gas mixture used. In the present experiment  $V_0$  has been fixed to 23.5 kV, i.e.  $(E/N)_0=197$  Td.

The DBD reactor was described in [10]. The plasma is created in a Pyrex tube (Inner diameter 15 mm). A stainless steel tape surrounding the dielectric tube is grounded, while a high voltage pulse is applied on a central stainless steel rod (5 mm diameter). The discharge volume is 23 cm<sup>3</sup>.

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