

# Surface and volume kinetics of molecules in air depollution processes

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Plasma-catalyst coupling for air depollution has been extensively studied for more than two decades. Studies dealing with the plasma induced heterogeneous reactivity are analysed as well as the possible modifications of the catalyst surface under plasma exposure. Alternatively to the conventional and widely studied plasma catalyst-coupling, a sequential approach has been recently proposed, where pollutants are first adsorbed on the material, then oxidized by switching on the plasma. This allows direct monitoring of surface reactions decoupled from gas phase reactions.

## 1. Plasma-catalyst coupling for Volatile Organic Compounds oxidation

Plasma-catalyst coupling has proven to be very effective for the destruction of diluted pollutants and is therefore suitable for indoor air-treatment [1]. Now commercially available indoor air treatment units can be found on the market. Most of these devices combine dielectric barrier discharge (DBD) or corona discharges with an adsorbent, which may have a catalytic activity. The plasma generates highly oxidizing species at low energetic cost, which oxidize the pollutants. The respective importance of gas phase oxidation versus surface oxidation has long been discussed.

Historically, various high dielectric permittivity materials (BaTiO<sub>3</sub>, TiO<sub>2</sub>, ...) were introduced inside the plasma region, partly to favour plasma ignition and energy transfer [2] as well as high mineralisation (complete oxidation to CO<sub>2</sub>) [3]. The positive effect of a porous material inserted in a discharge was evidenced [4]. Because of the diffusion of the species inside the porous structure of alumina and silica, active species lifetime and Volatile Organic Compounds (VOC) residence time increase favouring higher mineralization.

## 2. Evidencing oxidation at the surface

More recently, a sequential approach has been recently proposed, where pollutants are first adsorbed on the material, then oxidized by switching on the plasma. Monitoring the gas phase composition AND the VOCs adsorbed onto the catalytic surface allows analysing oxidation mechanisms [5].

Different parameters are studied, such as the injected power, the relative humidity, the type of VOC and the type of catalytic materials. In-plasma and post-plasma configuration are studied [5-6]. The

analysis of the chemical composition of the gas phase is performed using an FTIR cell and the in situ surface analysis of adsorbed species and intermediates is followed using a DRIFTS cell

In addition, we will present results obtained using Sorbent-TRACK, a new device, developed to monitor adsorption and surface oxidation of pollutants under direct plasma exposure [7-8]. It is based on direct transmitted Fourier Transformed Infrared (FTIR) spectroscopy. Performances and sensitivity of Sorbent-TRACK are reported. Adsorption and oxidation of acetone leads to production of adsorbed isobutene and acetic acid, where oxidation of isopropanol gives mainly to adsorbed acetone, mesityl oxide and acetate.

## References

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