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Plasma-Photocatalyst Interaction for VOC Removal: Origin of the Synergy

ANTOINE ROUSSEAU[1], LPTP, Ecole Polytechnique

It is well known that the coupling of an atmospheric non-thermal plasma with catalytic materials lead to synergetic effects for the abatement of some volatiles organic compounds (VOC). We analyze, here, the mechanisms of such a synergy where the catalyst is a porous semi-conductor (TiO_2). Different porous materials are compared: silica fibers possibly containing SiO2 and/or TiO2 nanoparticles. The respective influence of the porosity versus the chemical type of the catalyst is investigated and the oxidizing species are identified using two complementary approaches. 1) Efficiency of the plasma-catalyst coupling in a dielectric barrier discharge (DBD) at atmospheric pressure, 2) Plasma-catalytic surface interaction in a pulsed low pressure discharge. It is shown that the VOC oxidation scales as a function of the specific injected energy and occurs mainly on the porous surface due to short-life species produced the plasma [1-3]; Time resolved and in-situ measurements using laser absorption spectroscopy and emission spectroscopy in a low-pressure experiment have shown that i) plasma-TiO2 synergy is also evidenced at low pressure[4], ii) O atoms are reversively adsorbed on porous nanoparticles of TiO2; their desorption occur during the first millisecond of a plasma pulse [5], iii) air-plasma pre-treatment of the porous material leads to an enhancement of VOC adsorption on porous TiO2 and has no influence on porous silica.

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[1]In collaboration with O. Guaitella, K. Allegraud, F. Thevenet- Ecole Polytechnique and C. Guillard, U. Lyon 1