

Action P2: Tests under controlled atmospheric conditions:

Main Objectives:

This action aims at testing the real effect of the selected materials on the air depollution under realistic and controlled conditions through a series of tests conducted in different laboratories using complementary analytical tools and equipment.

Beneficiary responsible for implementation:

CNRS- ICARE – Dr. A. Mellouki

Contributors:

Paris12-LISA

Investigation Tools

Simulation chambers are probably the most direct way for investigating the effectiveness of photocatalytic material on de-pollution, the potential feedback from surface chemistry to air composition and to draw mechanisms for modelling purpose. Various chambers with different characteristics have been deployed to conduct the Photopaq tests:

ICARE : Two different complementary chambers made of Teflon were used

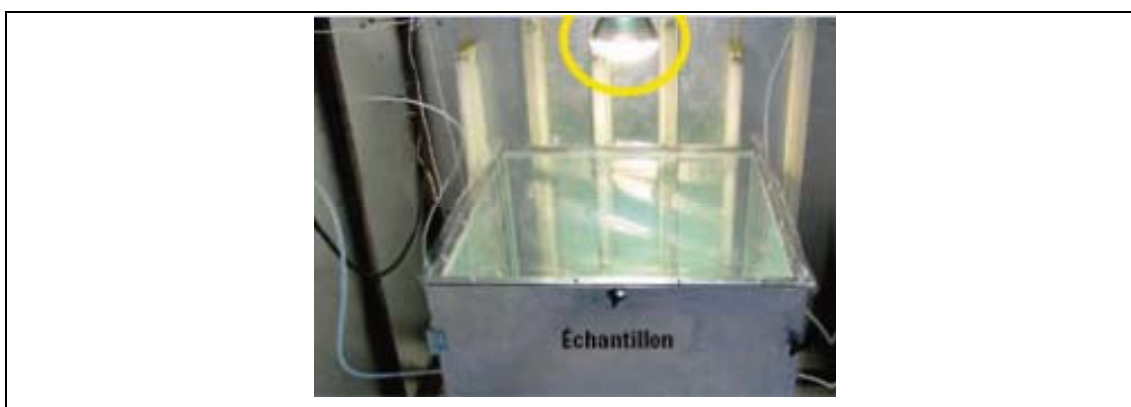


Figure 1a: ICARE, small indoor chamber (Volume = 250 L)

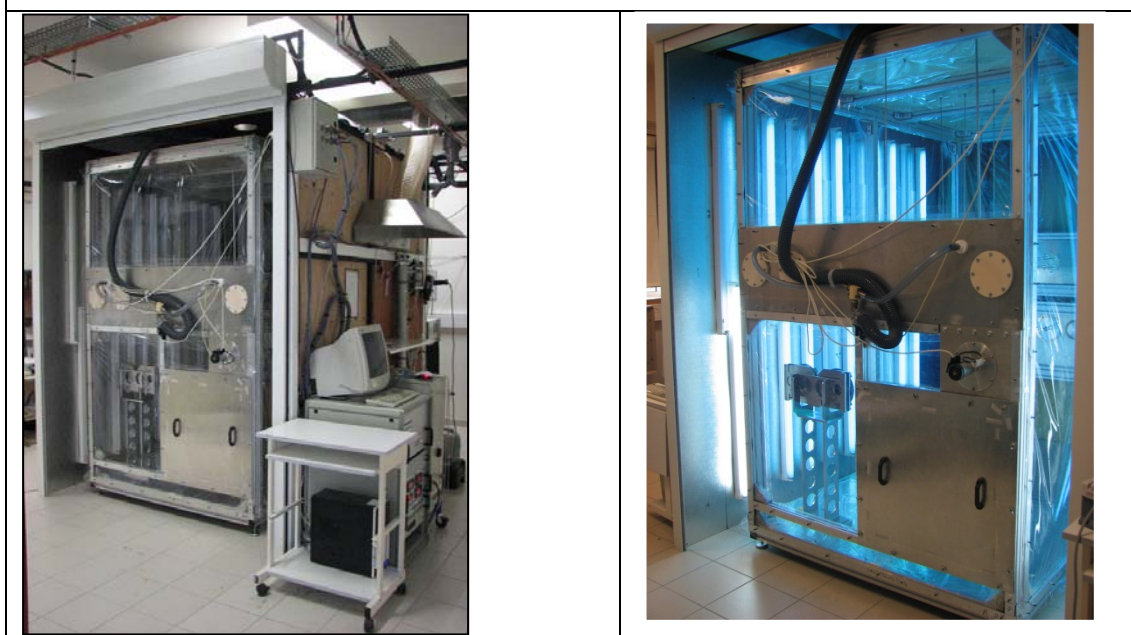


Figure 1b: ICARE, Large indoor chamber (Volume = 7300 L)

<http://www.era-orleans.org/ERA-TOOLS/>

LISA : A large chamber made of stainless Steel

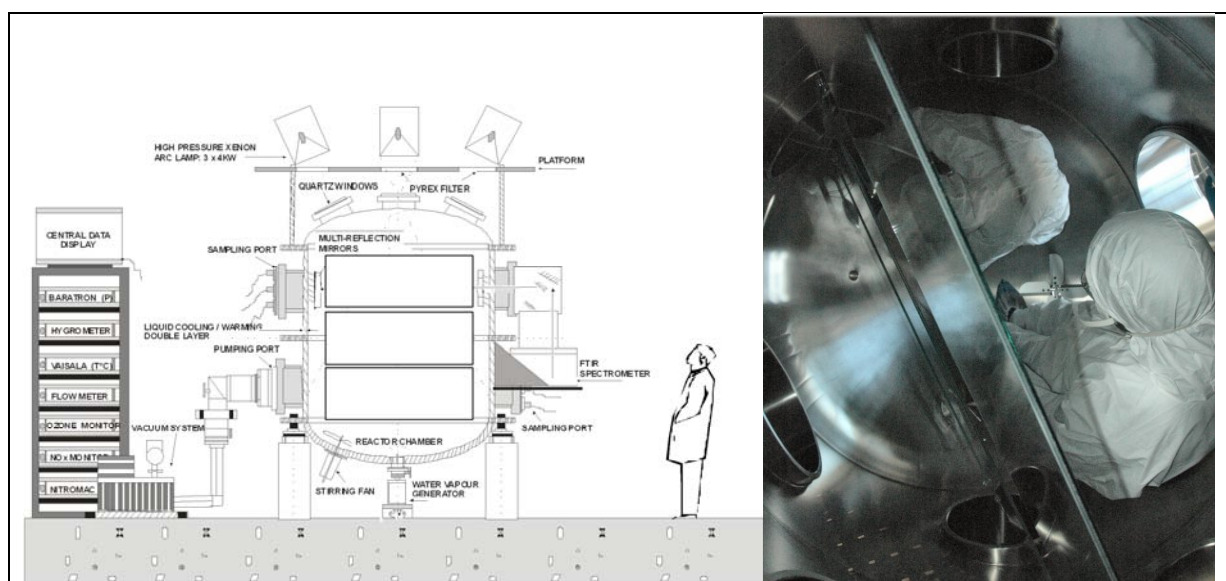


Figure 2: Scheme of the CESAM reactor (Volume = 4200 L). The three rectangles in bold represent the 6 plates of material set back to back in the chamber.

<http://www.lisa.u-pec.fr>

- Description of the work

Tests on different surfaces provided by CRG have been made using different facilities to check the behaviour of a number of pollutants on these surfaces. In addition, other types of materials, such as photocatalytic glass, were also investigated,

In addition to the samples provided by CTG, a number of tests were conducted on samples taken directly from the Tunnel in Brussels (see I2 action).

In each facility, in order to determine the effectiveness of the tested materials, several runs were performed in the presence of non treated surfaces and with TiO₂ treated surfaces inside the chamber. Low concentrations of the studied pollutants have been introduced in the chambers in the presence and absence of the sample plates and the gas phase composition was continuously analysed.

The results obtained in all facilities showed a decrease of NO_x in the presence of the treated surfaces, which may indicate an effect of TiO₂ on the atmosphere containing this pollutant.

Installation of the surfaces to be tested in the ICARE chamber:

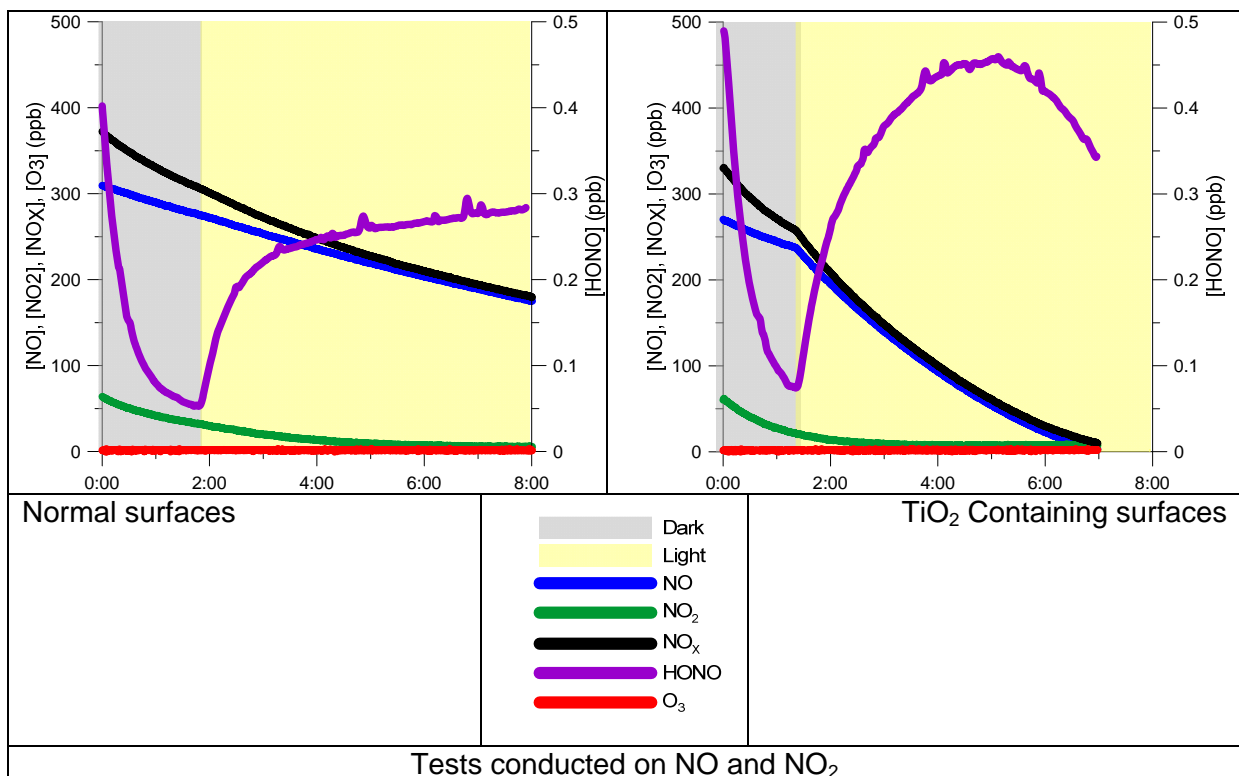




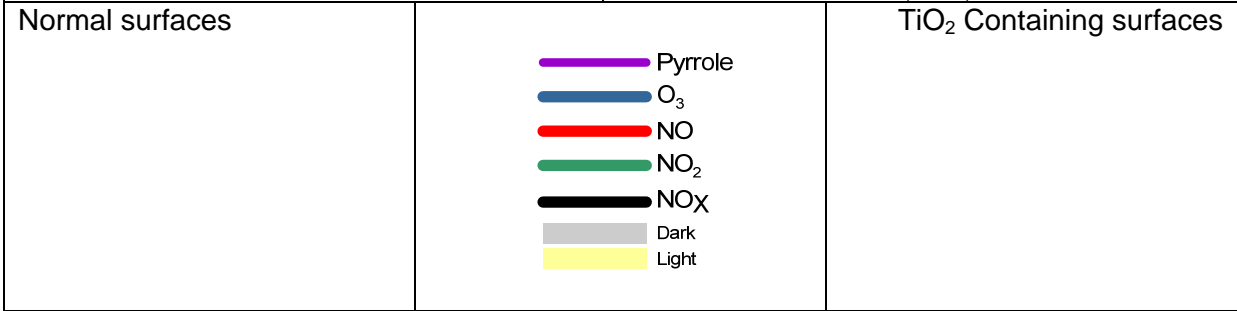
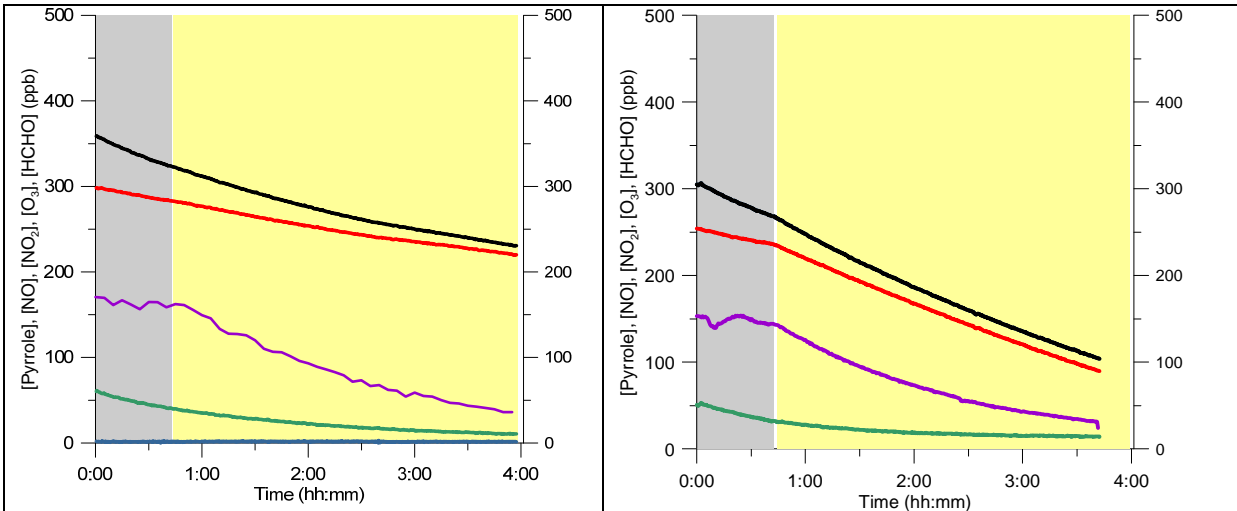
Example of Results

Several tests were conducted with the empty chamber, with non-treated surfaces inside the chamber and in the presence of surfaces treated with TiO_2 . The results obtained in different conditions were compared to each other to derive the effectiveness of the use the TiO_2 containing samples is the transformations of the tested pollutants (NO , NO_2 , O_3 and a series of volatile organic compounds (VOCs)).

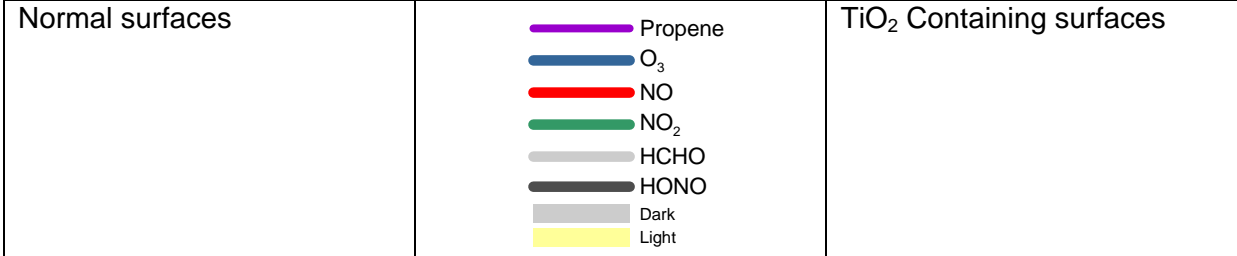
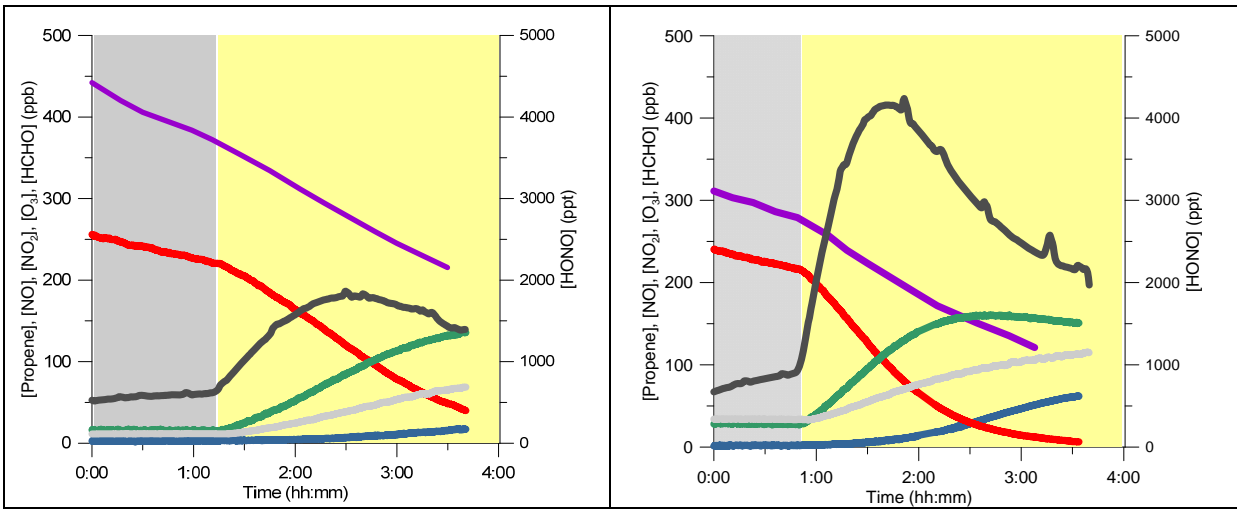
The following figures show examples of the tests. The concentration-time profiles of the gas phase species investigated in the presence and absence of doped materials.



Tests conducted on NO and NO_2

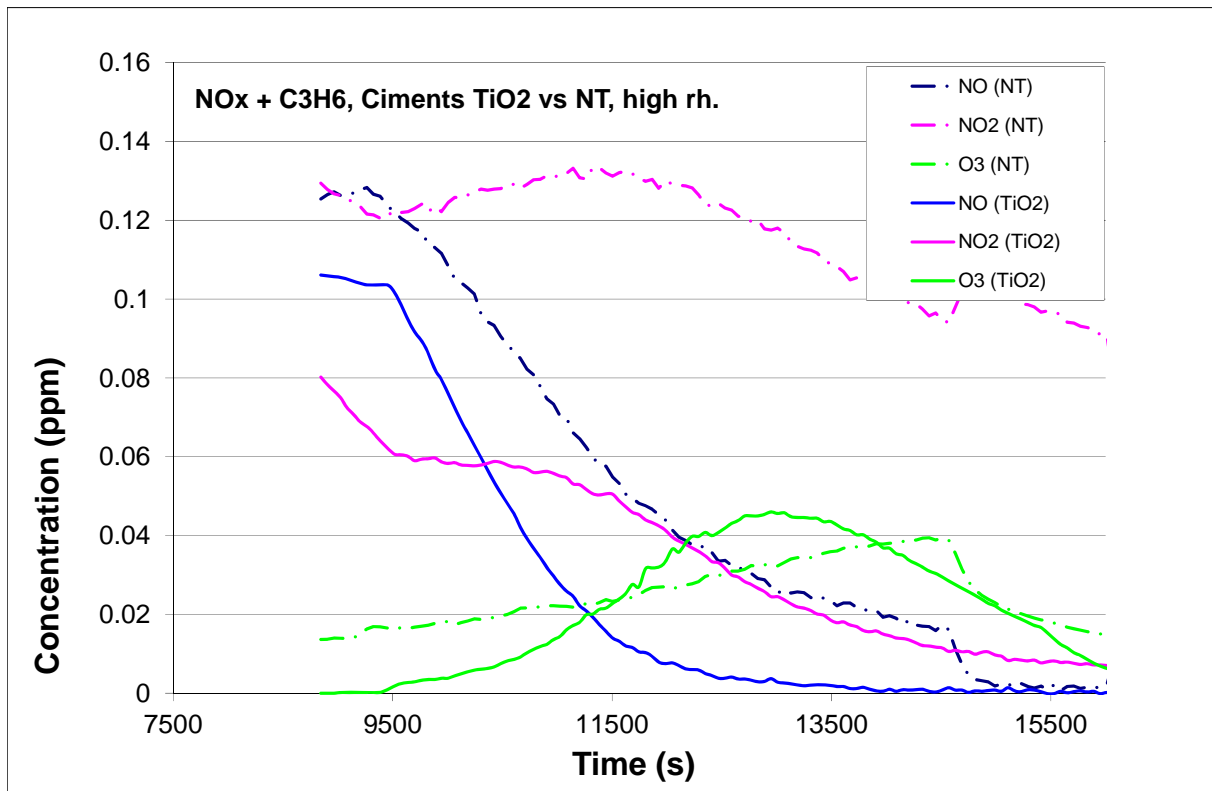


Tests conducted on a gas mixture containing Pyrrole + NO + NO₂



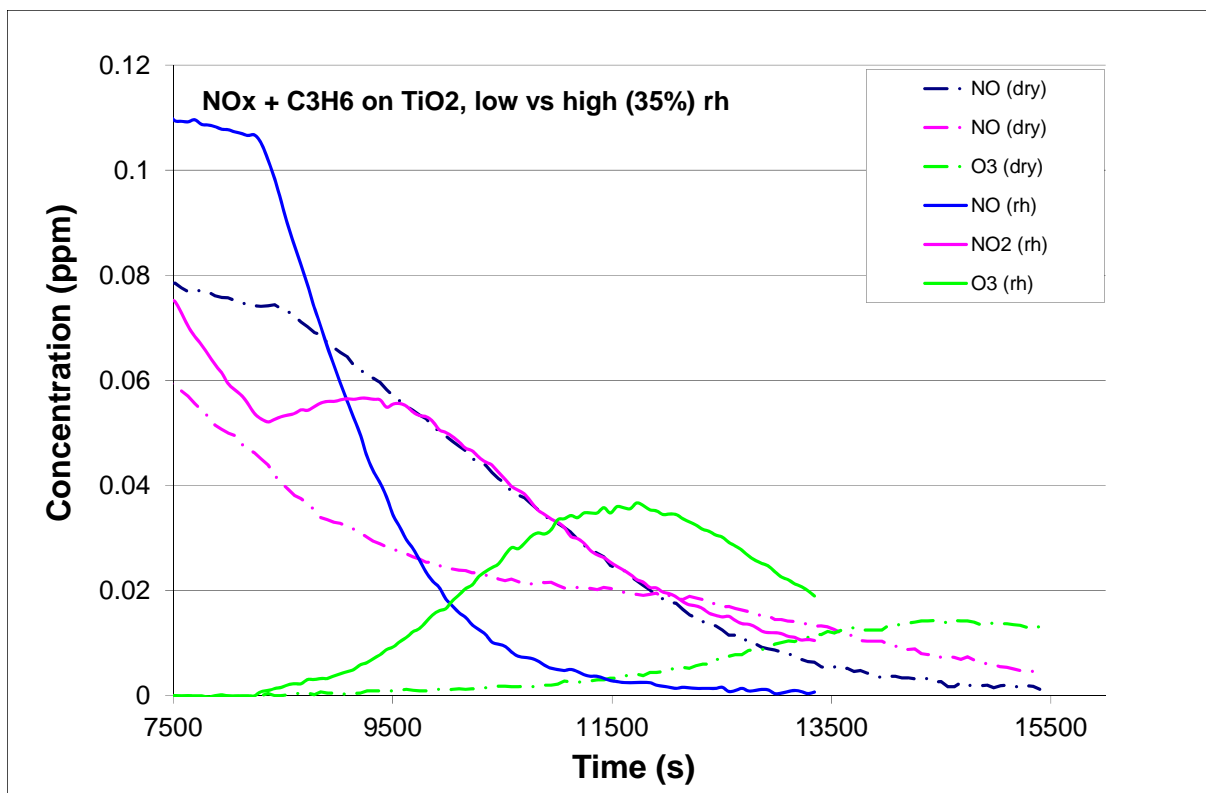
Tests conducted on a gas mixture containing Propene + NO + NO₂

Several experiments were also carried out in the CESAM chamber (www.lisa.u-pec.fr/CESAM) to test the efficiency of photocatalytic material with respect to classic mortar but also to test the effect of relative humidity :



Effect of TxActive Mortar (TiO₂) with comparison to reference mortar (NT: non-treated) on the NO_x and ozone concentration in the light/NO_x/propene (200ppb) system at 35% RH (CESAM/LISA experiment)

The tests show that the TiO₂ containing mortar induces an acceleration of the NO_x consumption that leads in the condition of the chamber to a larger ozone formation. They also show that humidity in the range from 0% to 35% increase the efficiency of this mortar



Effect of relative humidity (0% RH vs 35%) on the efficiency of TxActive Mortar (TiO₂): the NO_x and ozone concentration in the light/NO_x/propene (200ppb) system (CESAM/LISA tests)



Installation of the mortar covered plates in the CESAM chamber.

Conclusions:

The tests conducted by LISA-PARIS12 and CNRS-ICARE using complementary simulation chambers on the doped and not doped materials with TiO₂, provided by Itacimenti, have shown:

- An effective loss of NO_x and some effects on the chemistry of propene/NO_x/light system.
- No effect on Pyrrole (taken as example for VOCs and possible tracer in the field studies).
- An extensive dataset which will lead to a set of rate constant to be implemented in kinetic models