



ENVIROAD 2009 CONFERENCE

RESEARCH DESIGN AND DEVELOPMENT OF A PHOTOCATALYTIC ASPHALT PAVEMENT

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INTRODUCTION

Impresa Bacchi srl was born in 1979 and carries out its activity in general construction sector, particularly in road, railways and airport construction.



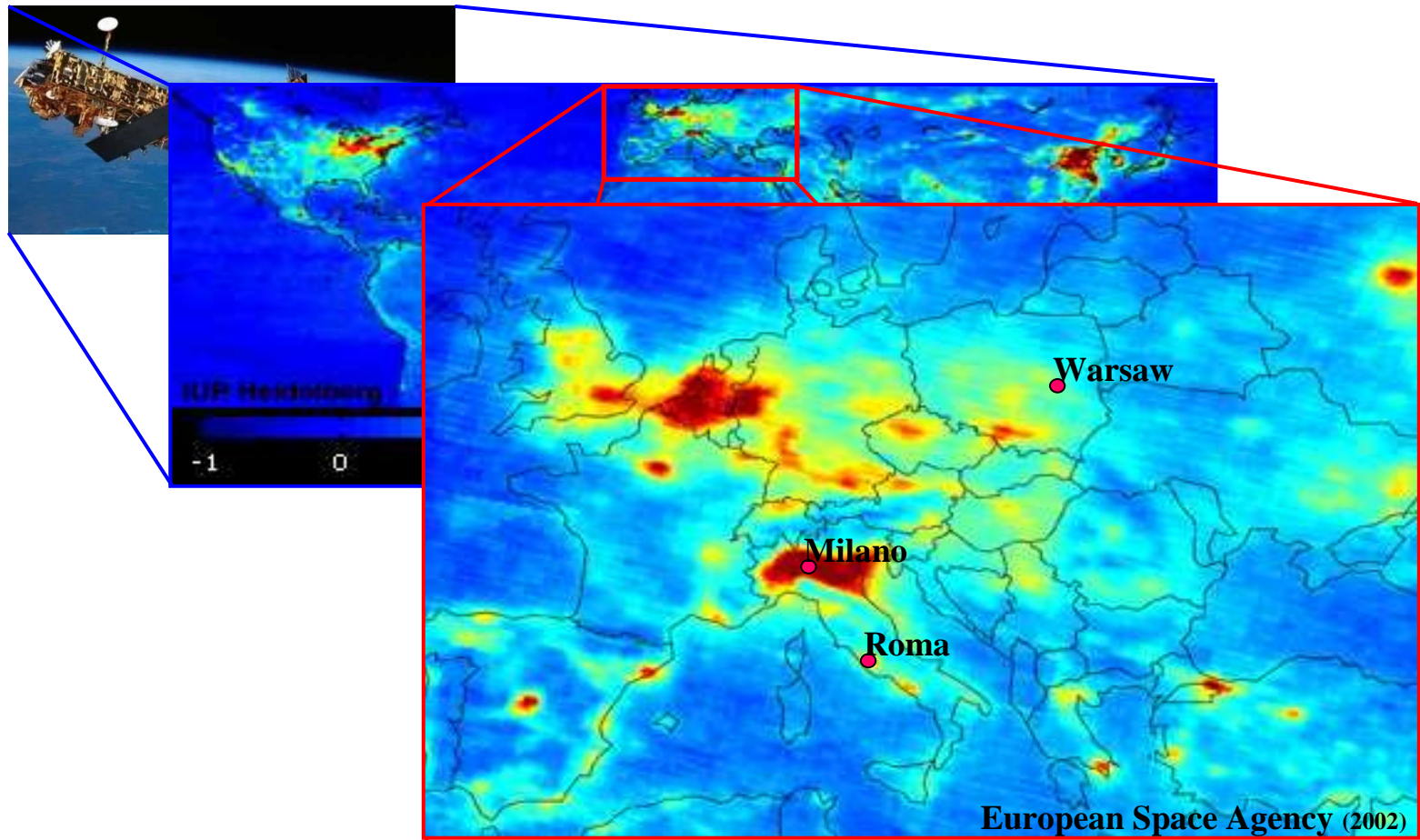
Important business sector is
R&D of technologies for roads

INTRODUCTION

Advanced Laboratory
located inside the
New Productive Pole (2008)



POLLUTANTS



The European standards of pollutants **emissions are almost never respected** and air pollutants have a negative effect on the respiratory and cardiovascular system. World Health Organization (WHO) research underlined that **pollution is responsible for 100.000 deaths each year in the European area.**

POLLUTANTS

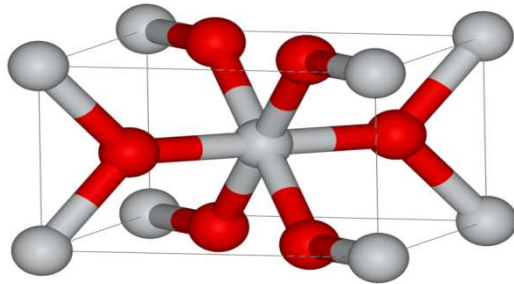
Principal source:

- vehicular traffic (NO; NO₂; CO; CO₂; PM10; H-CHO; NMHC);
- thermoelectric central and heating (SO₂);
- agriculture and breeding (NH₃, CH₄);
- solvents (VOC - volatile organic compounds).

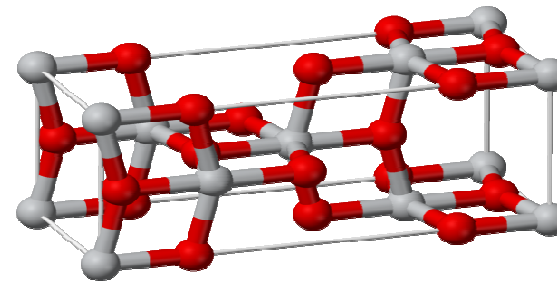


TITANIUM DIOXIDE

The main ingredient for a photocatalytic product is the titanium dioxide



Crystalline structure RUTILE



Crystalline structure ANATASE

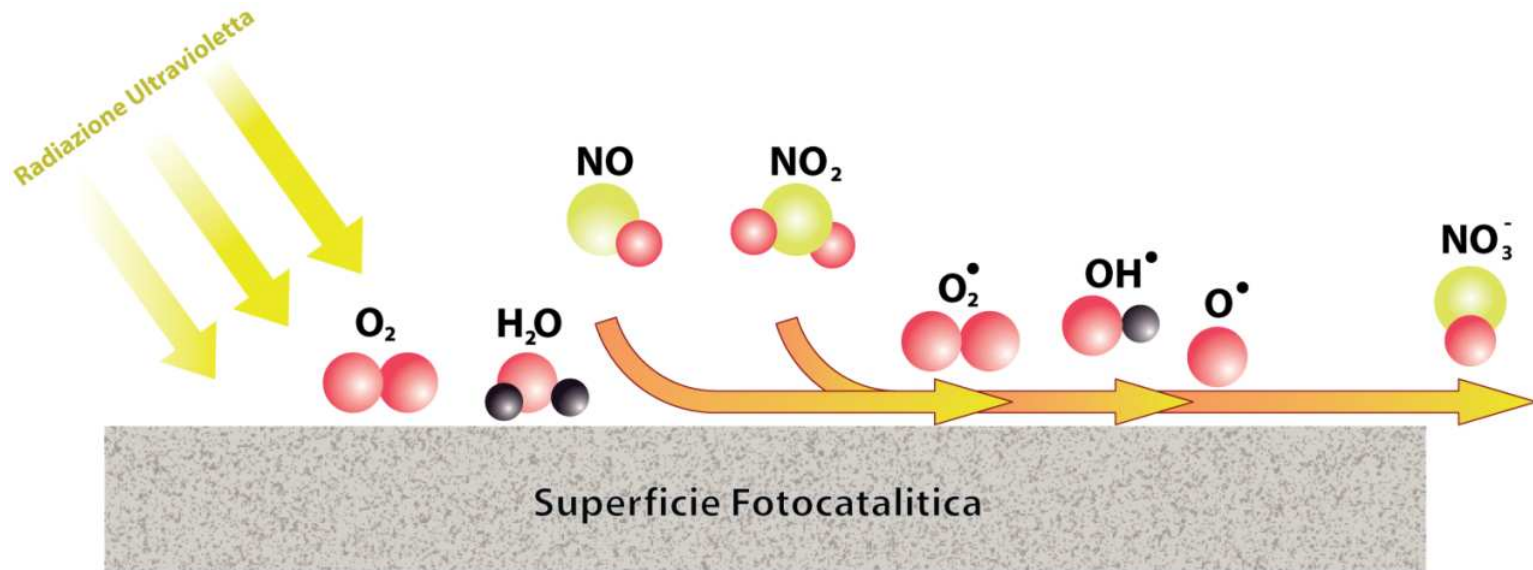
Many variables influence this ability, especially the **grains dimension and the presence of impurities**. TiO_2 normally used has **nanoparticles** with a great specific surface (area to volume ratio) and diameter inferior to 100 nm.

Biologically inert, TiO_2 is used:

- for water and air purification;
- for medical use;
- as pigments in foodstuffs, paints, ceramics, cosmetics or pharmacology;
- as a corrosion resistant **coating**, self-cleaning coatings and anti-foggy;
- in solar cells for the production of hydrogen and electric energy, in electronic devices and as gas sensor.

PHOTOCATALYTIC PROCESS

In presence of sunlight and air, the titanium dioxide produces a significant acceleration of natural chemical reactions turning air pollutants into inert elements.



Soluble substances with a concentration for pavement unit lower than the amount that you can find in a bottle of mineral water.

PHOTOCATALYTIC PRODUCTS ASPHALT TREATMENTS



No direct contact between catalyst (titanium dioxide) and binder (bitumen) because the photocatalyst causes an accelerate oxidation of the bitumen (organic binder).

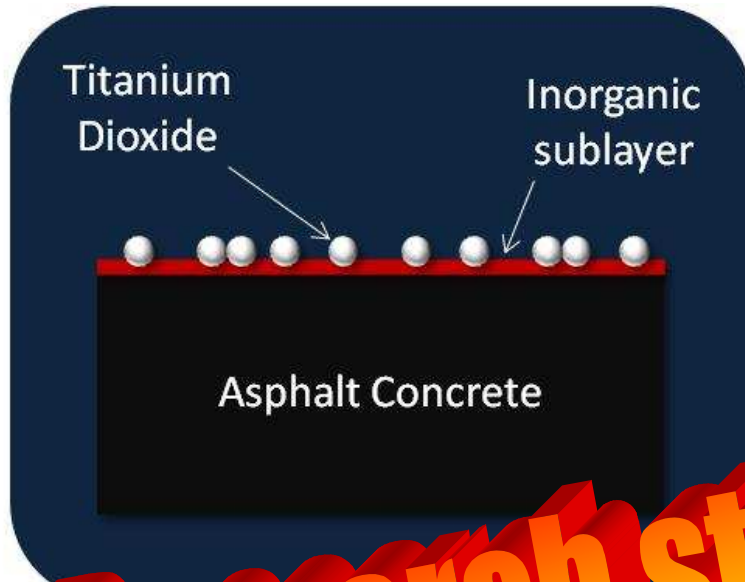
It would be impossible to conserve application under heavy loads and wind.

**How to create it?
Just spreading the
TiO₂ powder on the
pavement surface?**



PHOTOCATALYTIC PRODUCTS ASPHALT TREATMENTS

An inorganic sublayer to which TiO₂ is added and then sprayed onto the surfaces



Research start up: 2006

Collaborations:
Politecnico di Milano
University of Rome "La Sapienza"



LAYING METHOD

The method are two:

Cold-method

on already existing pavements

Hot-method

made directly after the asphalt laying-phase

The two laying methods show:

- equal photocatalytic efficiency;
- different adherence:
 - cold-method: reduction of 6÷8 BPN;
 - hot-method: reduction of 3÷5 BPN.

APPLICATIONS



ANAS Auto-park of Rogoredo in Milan

An area of 4.000mq

Photocatalytic efficiency of the 49%

Efficiency tested with: NOx flow of 1,5 l/min
Irradiance 20 W



APPLICATIONS



**Photocatalytic
efficiency of the 46%**

Efficiency tested with: NOx flow of 1,5 l/min
Irradiance 20 W



The National Road
Forli Cesena

An area of 2.500mq

APPLICATIONS

Center of Monza
and Cantù



Photocatalytic
efficiency of the 48%



Efficiency tested with: NOx flow of 1,5 l/min
Irradiance 20 W

APPLICATIONS



Center of Ferrara:
Viale Bologna

An area of 13.000mq

Photocatalytic
efficiency of the 43%

Efficiency tested with: NOx flow of 1,5 l/min
Irradiance 20 W



APPLICATIONS



Center of Milan:
Tunnel Giardini di
Porta Nuova
An area of 11.000mq

Photocatalytic
efficiency of the 46%

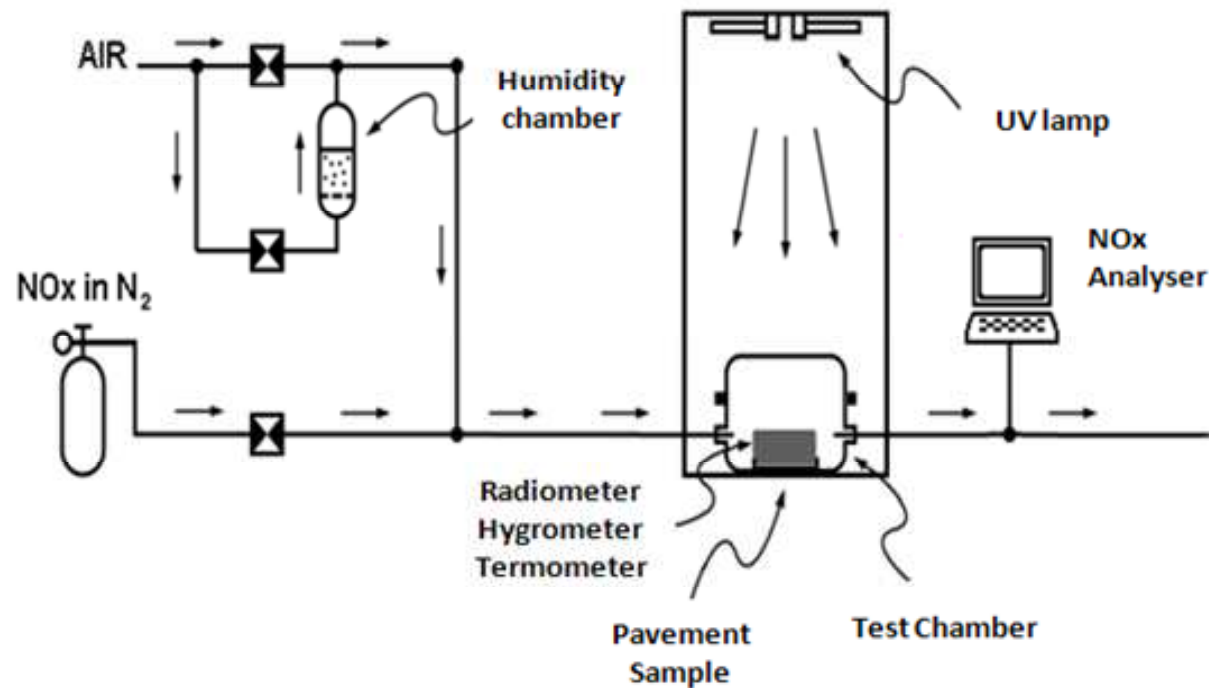


Efficiency tested with: NOx flow of 1,5 l/min
Irradiance 20 W

HOW TO EVALUATE THE EFFICIENCY ?

The TiO_2 efficiency can be verified with different testing methods:

- spectrophotometer (Mogyorosi, 2003);
- mass spectroscopy (Bessergenev, 2005);
- visible effect on a coating or treated mass (Guettai, 2005);
- crystalline structure (Toma, 2008);
- **degradation of nitrogen dioxide (EN UNI 11247).**



Evolution

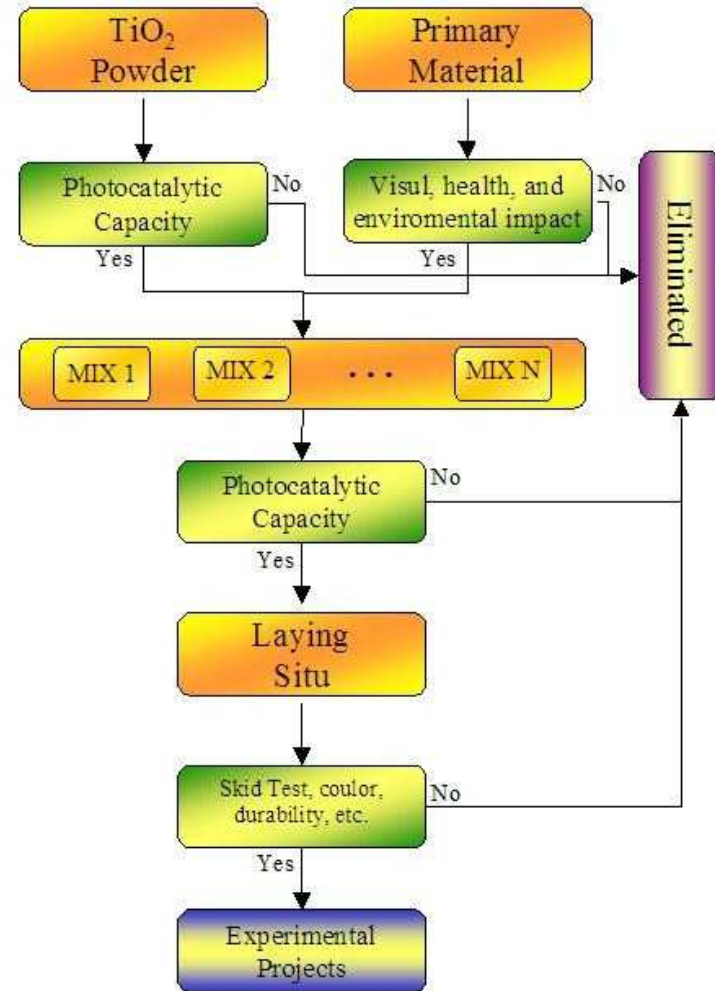


**FINAL
TEST
PROTOCOL
2008**

TESTING PROTOCOL

The Final test Protocol Procedure follows these steps:

1. pure titanium dioxide is tested in order to verify the photocatalytic ability;
2. primary materials are analysed in order to verify the visual, environmental and health impact;
3. primary materials with titanium dioxide mixture are tested to define the final products (laboratory photocatalytic efficiency of each mixture is evaluated);
4. testing field are realized, both of small dimensions (100cm x 100cm) and large dimensions (entire road branches) for “test fields efficiency”.

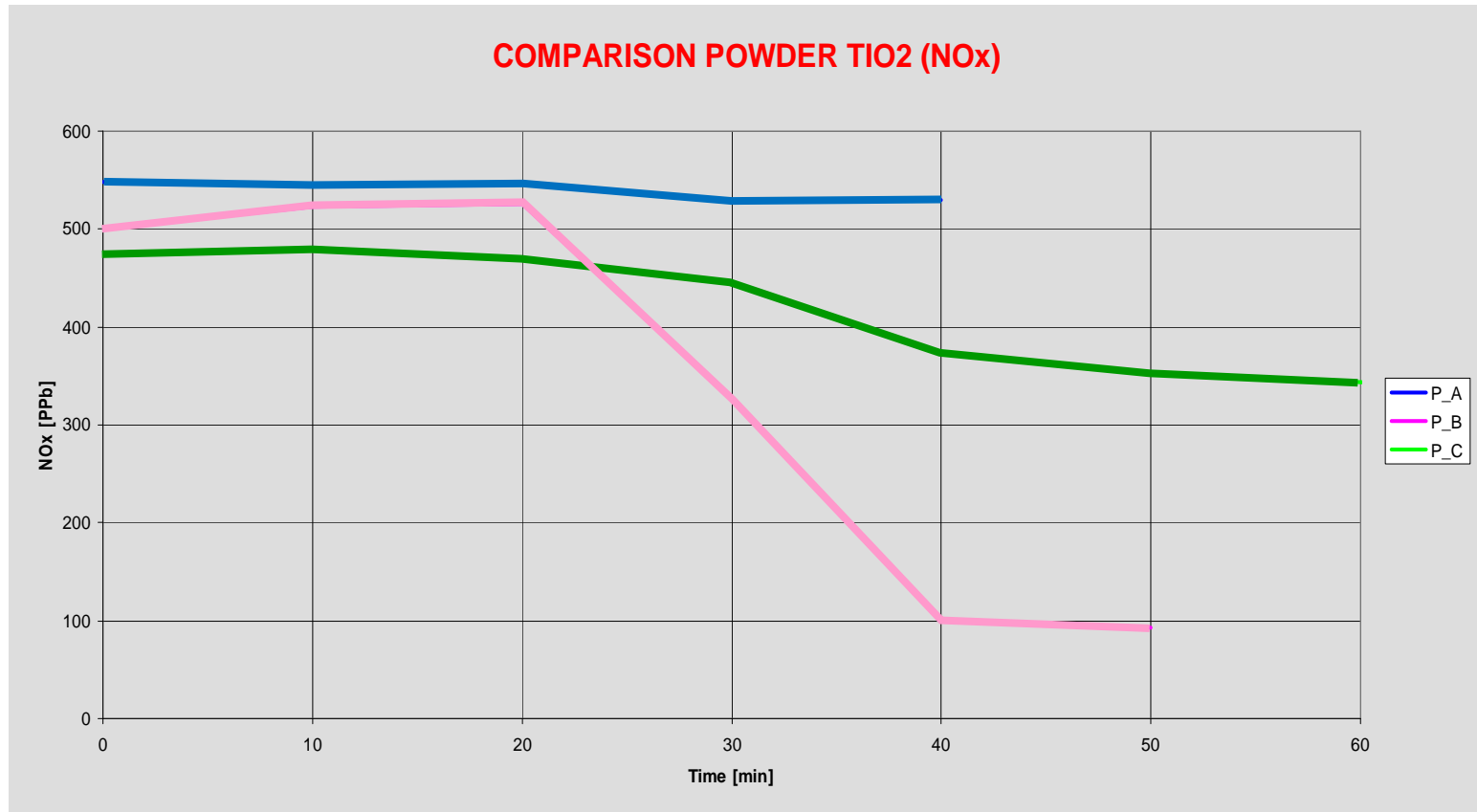


Parameters maintained constant:

Irradiance = 20 ± 1 W/m²; Initial Humidity = 50%

NEED OF TESTING PROTOCOL

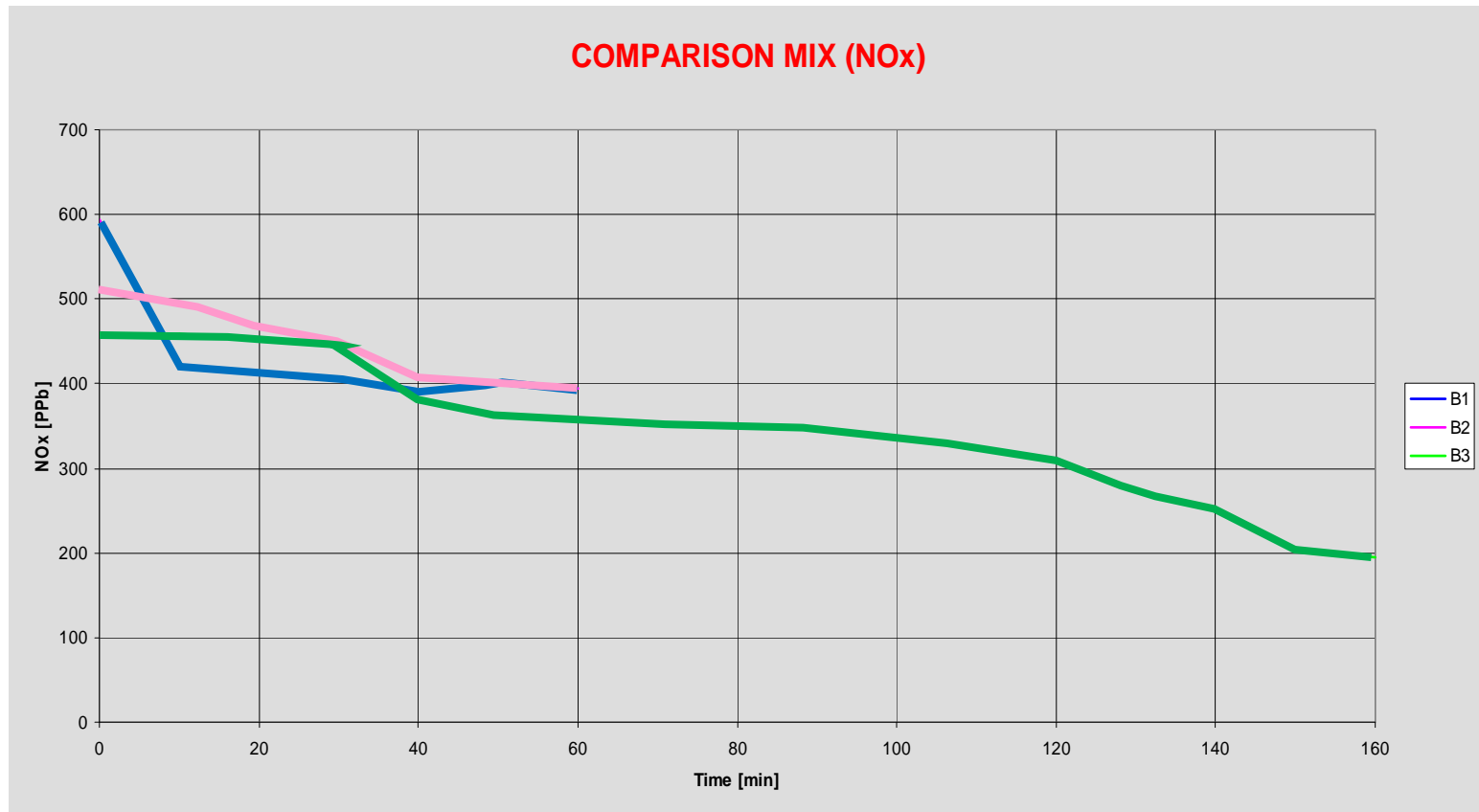
Not all “titanium dioxide” available on the market show a sufficient photocatalytic efficiency, even considering the same crystalline structure.



Efficiency tested with: NOx flow of 1,5 l/min - Irradiance 20 W

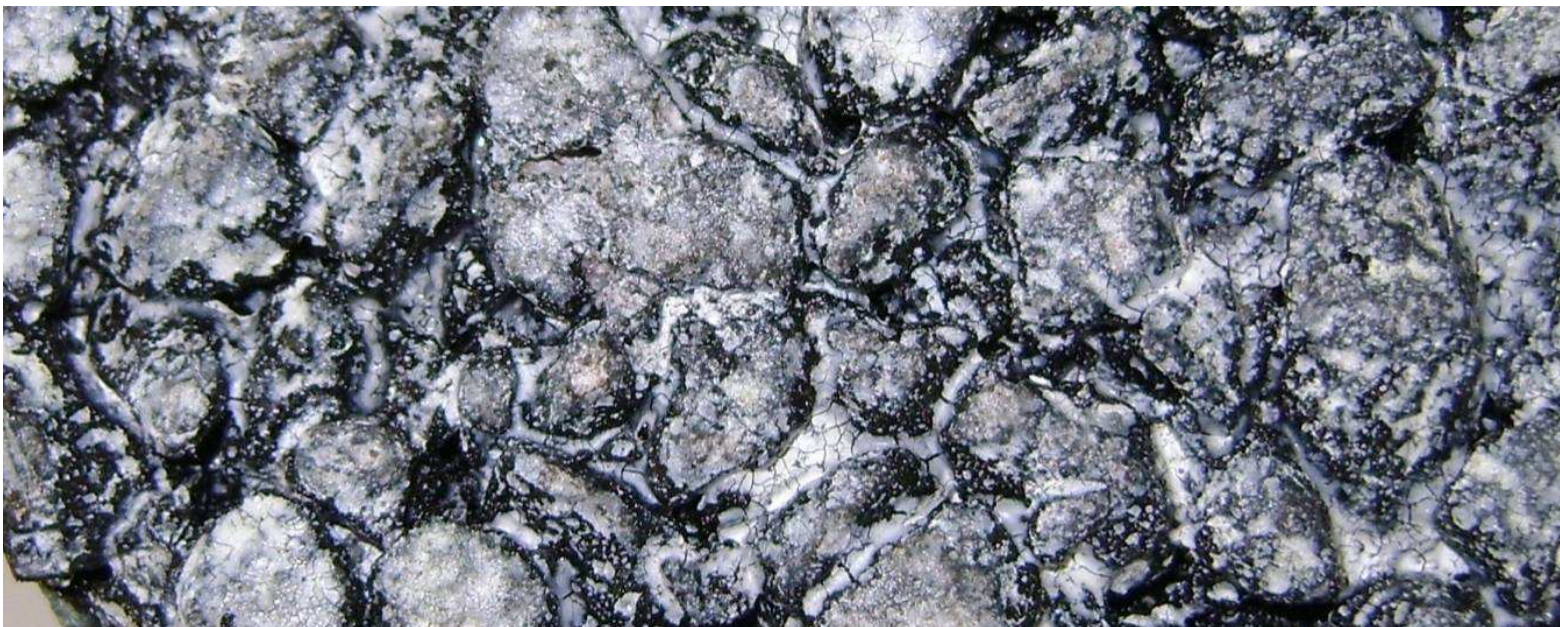
NEED OF TESTING PROTOCOL

Photocatalytic products (Final Mix) even if carried out with active titanium dioxide, not always show sufficient photocatalytic ability because different **primary materials can inhibit the photocatalytic action.**



Efficiency tested with: NO_x flow of 1,5 l/min - Irradiance 20 W

CONCLUSION



1. The photocatalytic treatment represents a big perspective for the environment preservation, the technology is not simple but the application is easy;
2. Pay attention to the type of Titanium Dioxide used and to the Primary inorganic materials that could inhibit the efficiency;
3. Pay attention to the tests execution and in particular to the test parameter used.



L'ambiente si fa strada