

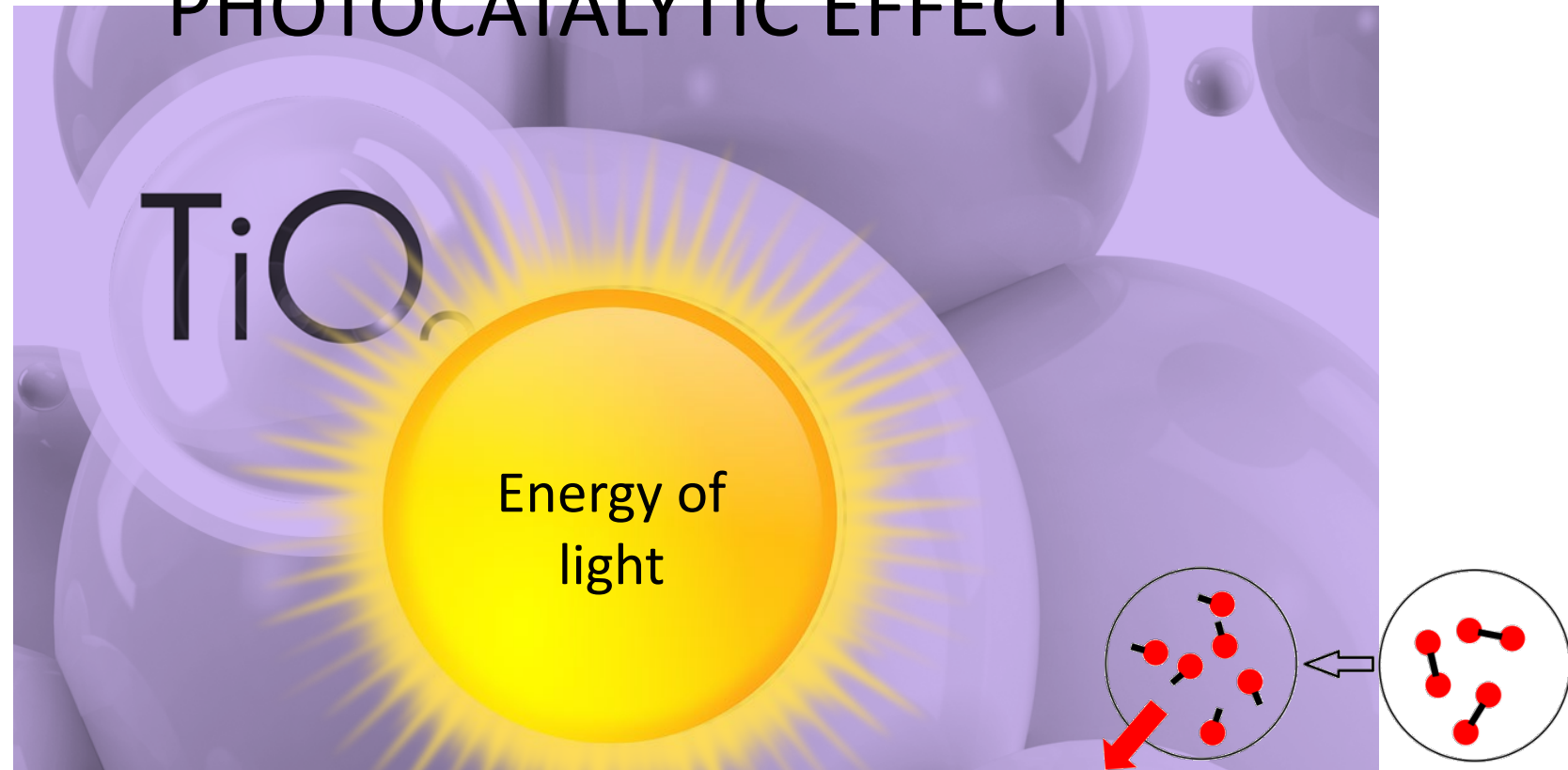


# Photocatalysis in the Czech Republic and Certification Program of the Czech Association of Applied Photocatalysis

Markéta Zukalová, Ph.D., Jan Procházka, Ph.D.

Daylight energy activated photocatalytic surfaces provide enough power to break down molecules of pollutants

## PHOTOCATALYTIC EFFECT



HISTORICALLY FIRST APPLICATION  
OF PHOTOCATALYSIS THAT  
EVERYONE KNOWS



ROAD SIGNS

SELF CLEANING SURFACE



# Smart Cities

start with



clean water



clean air



clean look



clean environment



energy savings



# Vision for 2050 to reduce air (and water and soil) pollution to levels no longer considered harmful to health and natural ecosystems/ toxic-free environment



Proposal for a Directive of the European Parliament and of the Council on ambient air quality and cleaner air for Europe



Zero Pollution EC Action Plan

## 2030 targets:

- Reduce the health impacts of air pollution (premature deaths) by more than 55%
- Stricter air quality standards

Ongoing since 2021

# Theories are nice, but reality kicks back

Nearly entire global population breathing polluted air: WHO

<https://www.msn.com/en-xl/health/medical/nearly-entire-global-population-breathing-polluted-air-who/ar-AAVQ9BS?ocid=mailsignout&li=BBJDXDP>



© PHILIPPE DESMAZES Fresh data from WHO showed that every corner of the globe is dealing with air pollution

A full 99 percent of people on Earth breathe air containing too many pollutants, the World Health Organization said Monday, blaming poor air quality for **millions of deaths** each year.

Fresh data from the UN health agency showed that every corner of the globe is dealing with air pollution, although the problem is much worse in poorer countries.

"Almost 100 percent of the global population is still breathing air that exceeds the standards recommended by the World Health Organization," the agency's environment,



Bryant Aardema -bryants wildlife images / Getty Images

You cannot clean the environment without technologies able to do it.

[Air cleaning and depollution of environment require efficient photocatalysis](#)



# Situation in the Czech Republic: High level of pollution (NO<sub>x</sub>, BAP, VOC, O<sub>3</sub>, PM<sub>2.5</sub>, pesticides, etc)

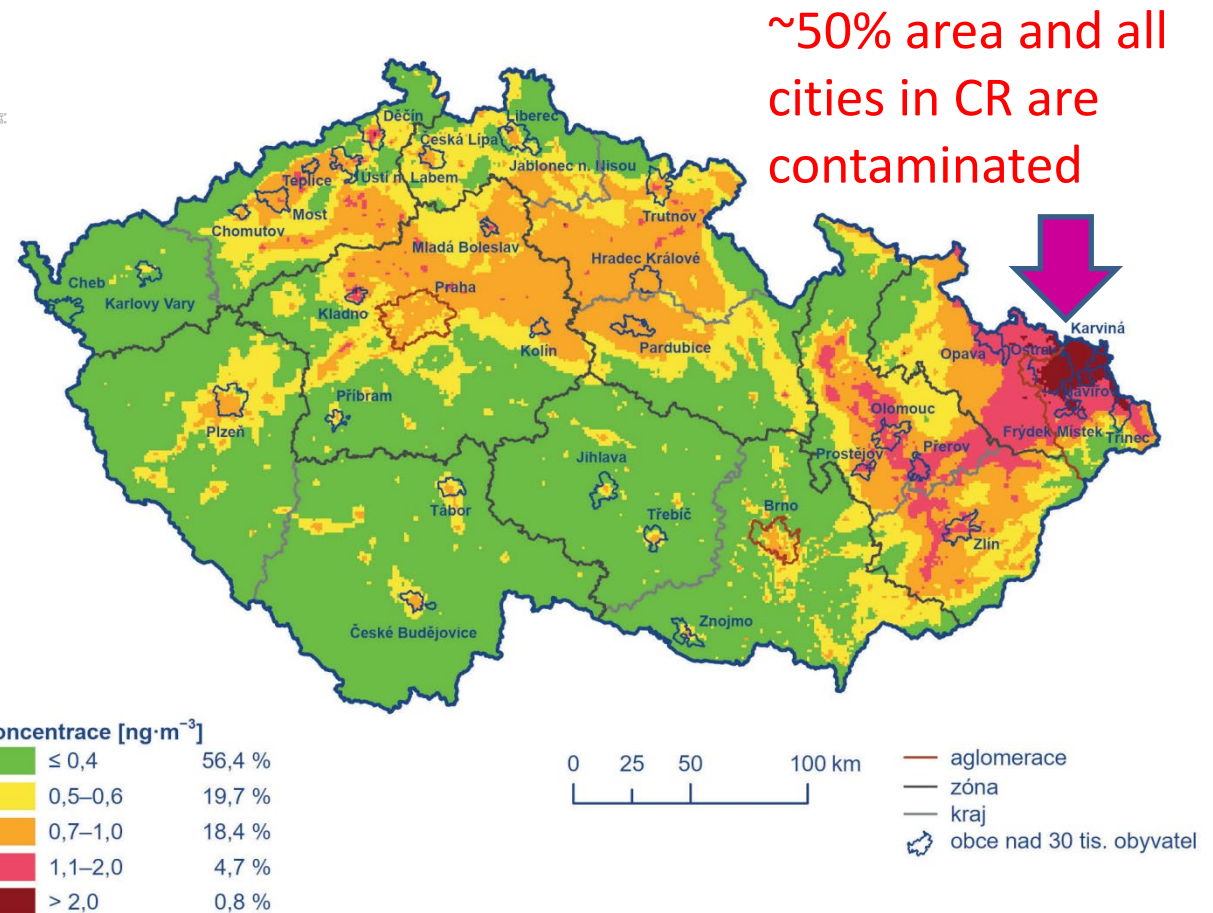
**Academia** - very strong fundamental research in photocatalysis field since early eighties

## Industry

About 1 % of TiO<sub>2</sub> global production 

16 members of CAAP with their own products with verified efficiency

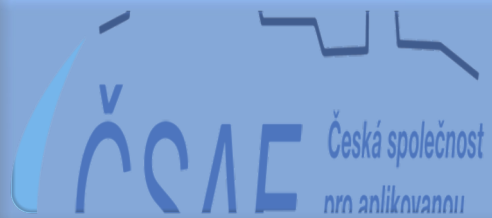
 VŠB-TU Ostrava	 Tomton	 PRAGOTHERM Servis fasád s. r. o.	 NanoFlow s. r. o.
 VŠCHT Praha	 TUL	 Clean and Health s. r. o.	 eNecont s. r. o.
 AlgaClean s. r. o.	 Retap, spol. s. r. o.	 NANO4PEOPLE s. r. o.	 NANO Detox, s. r. o.
 LANIK s. r. o.	 FN NANO s. r. o.	 Barry a laky Teluria s. r. o.	 ADVANCED MATERIALS – JTJ s. r. o.



**CAAP and its certification program were created because the photocatalytic market was a complete jungle, discrediting photocatalysis as such.**

Main problem were **negligible efficiencies** of Asian electrostatic deposition compositions and photocatalytic paint versions of large paint manufacturers

Marketing of many companies can be classified as cheating. Negligible photocatalytic effect and reporting adsorption data instead of photocatalytic elimination is quite common.



**Product efficacy determination**



**Certification program**

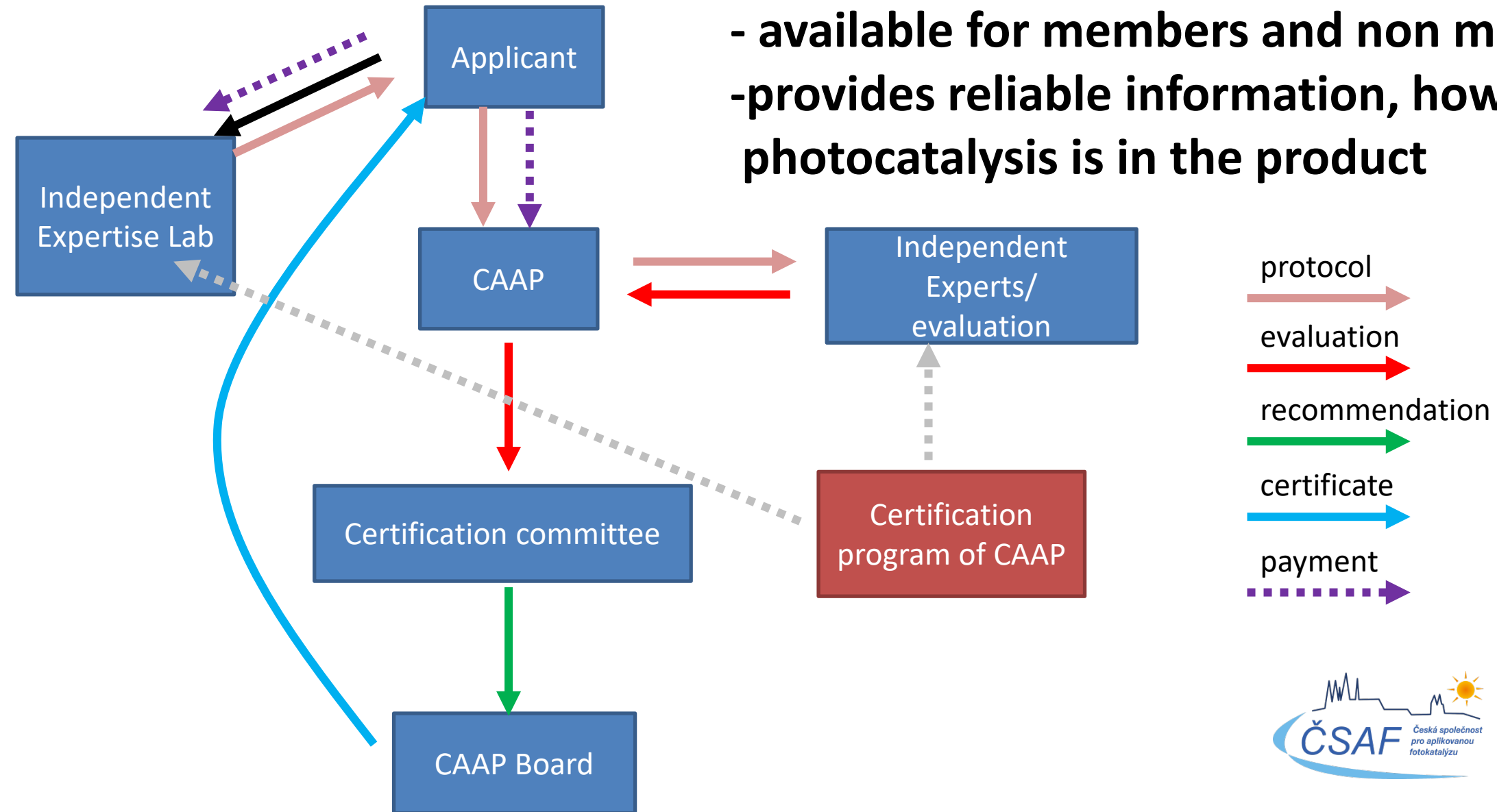


# Certification process of CAAP – objective, independent, transparent

- based on ISO methods

- available for members and non members

- provides reliable information, how much photocatalysis is in the product

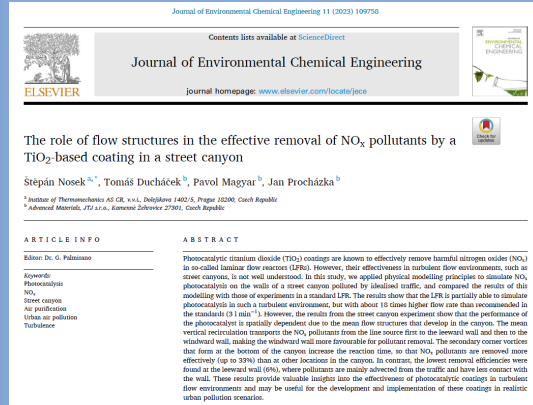


# Certification program can determine efficiency of surfaces made from particular products and the product safety.



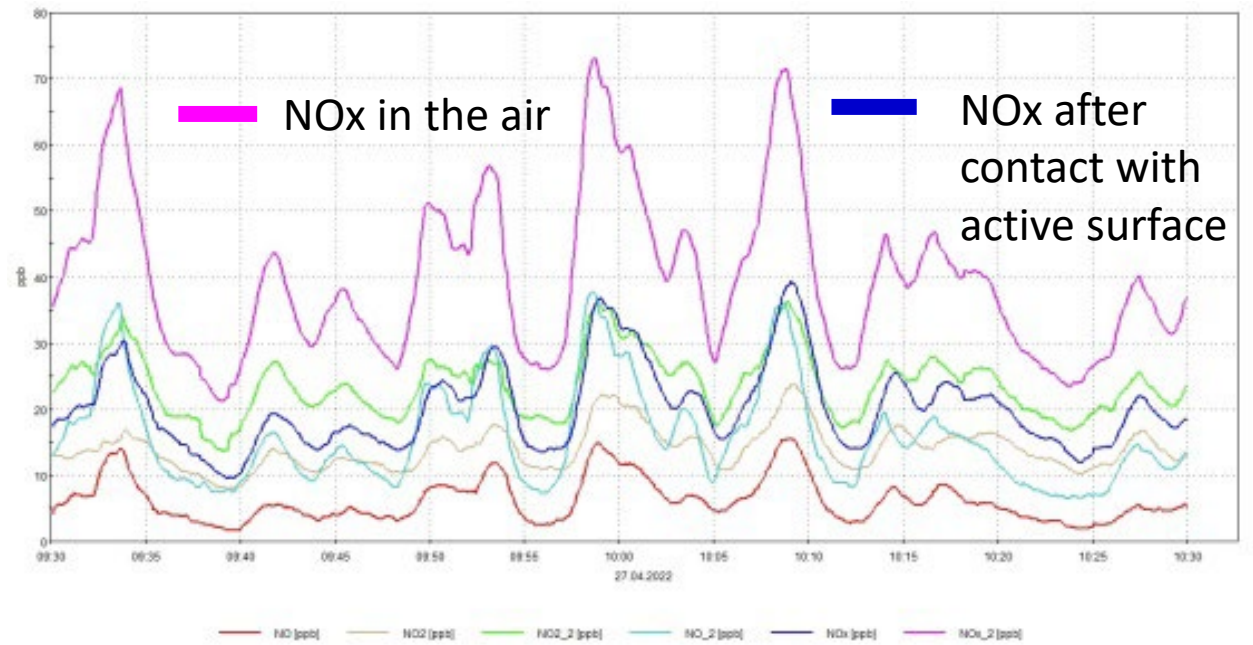
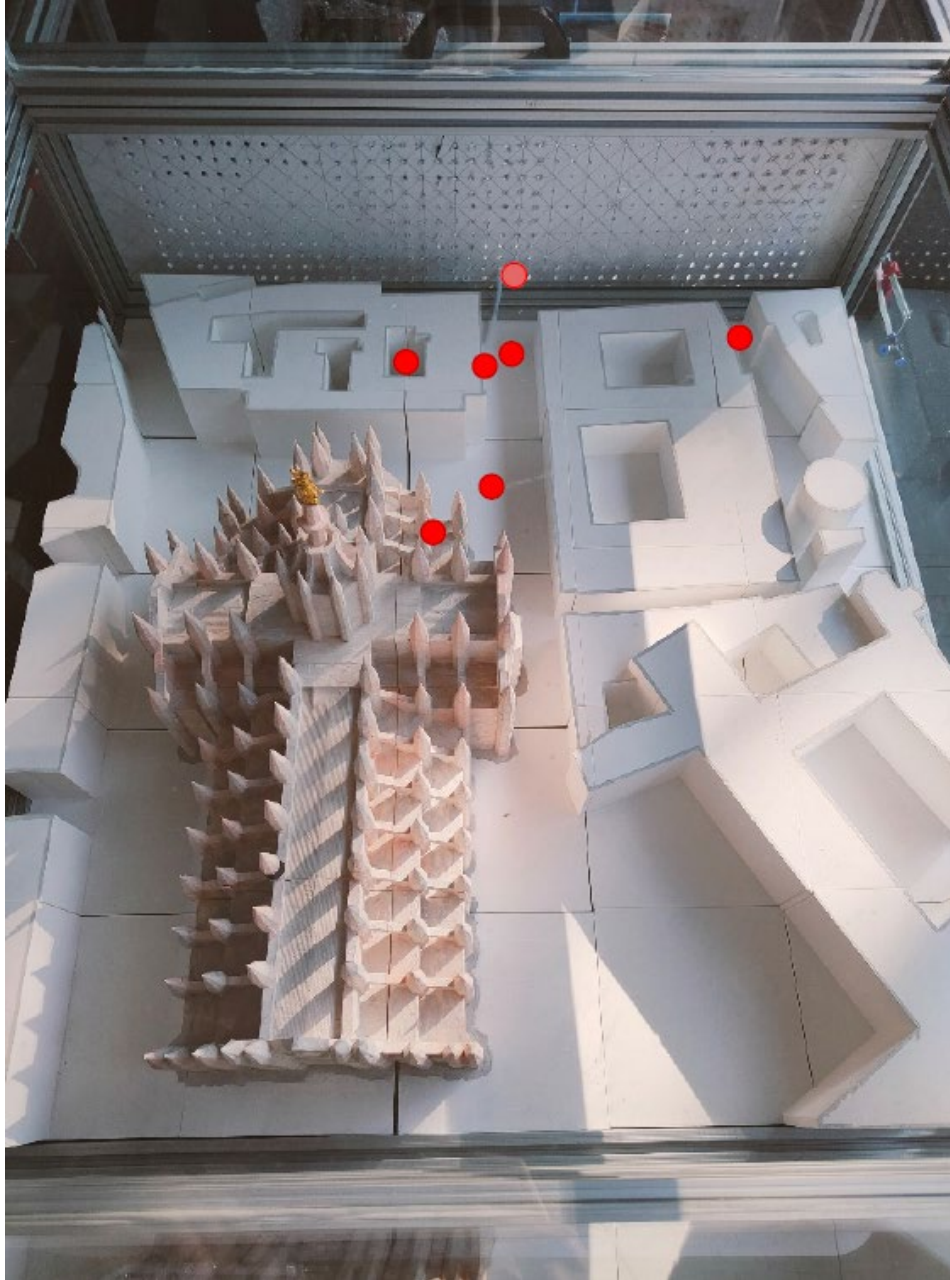
What is still missing?  
Modeling studies in real environment  
simulating objects and urban areas

<https://clearcities.org/>



# Modeling of particular effects of photocatalysis on air quality

DeNO<sub>x</sub> ~ 40% all day average



**Tab. 1:** Comparison of average concentrations of NO<sub>x</sub> in the air in the outdoor environment before entering the reactor and after passing through the photocatalytically active 3D model.

Pollutant	Placement of the tube	$c_{in}$ [ ppbv ]	$c_{out}$ [ ppbv ]	Pollutant removal [%]
NO <sub>x</sub>	Wall with FN NANO <sup>®</sup> 2 (main street)	87.5	45.4	48
NO <sub>x</sub>	The center of the main street	100.7	78.0	23
NO <sub>x</sub>	Above the level of the roofs on the main street	124.8	117.6	6
NO <sub>x</sub>	Inner block	116.0	27.6	76
NO <sub>x</sub>	Wall with FN NANO <sup>®</sup> Transparent	93.7	54.5	42
NO <sub>x</sub>	The center of the square	81.6	63.2	23
NO <sub>x</sub>	Wall with FN NANO <sup>®</sup> 2 (side street)	68.3	30.3	56

\*  $c_{in}$  is the concentration in the outdoor environment;  $c_{out}$  is the concentration after passing the air through the reactor.





Milano  
testing campaign  
with real  
atmosphere at  
the particular  
location



# What is outside is also inside

# DeNOx model in interiors

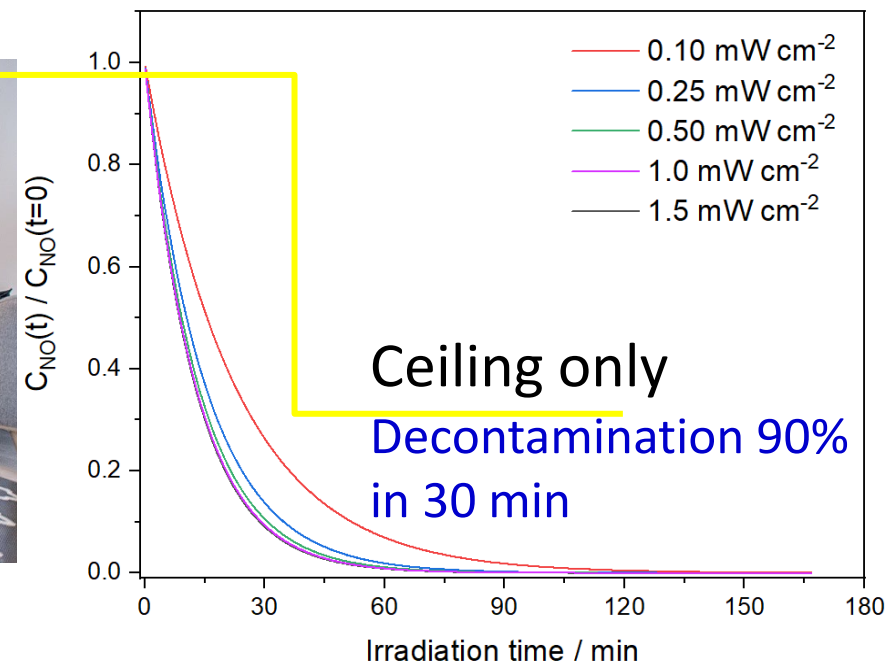
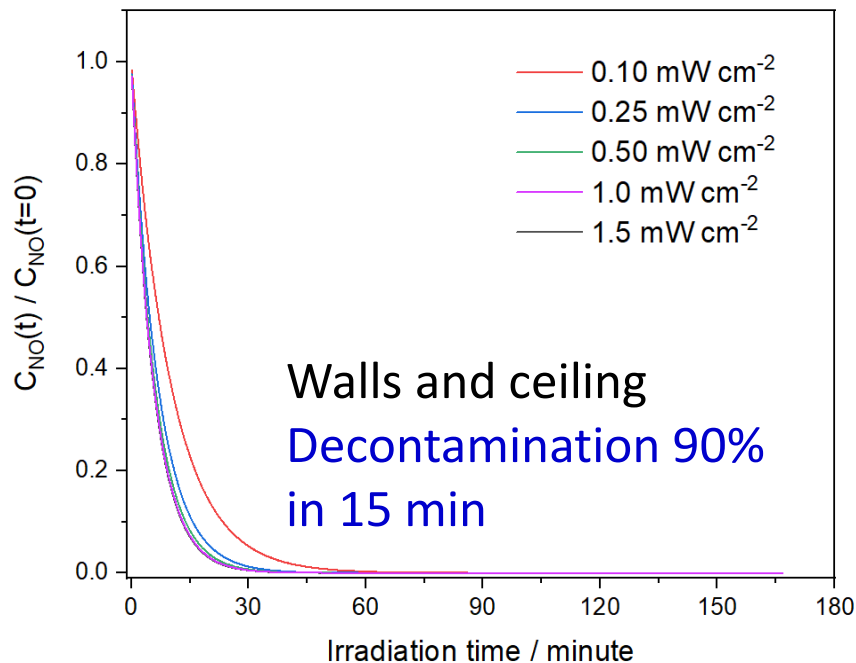
Low intensity of activation light is sufficient to start the effect

$$r = \frac{k K_p C_p}{1 + K_p C_p}$$

Reaction rate  $r$  pro  $NO$  is expressed as Langmuir-Hinshelwood model.  
 $r / \mu\text{mol m}^{-2} \text{h}^{-1}$  - moles of pollutant eliminated from the air in one hour on  $1\text{m}^2$  of photocatalytic surface.

$C_p$  is a concentration of the pollutant,  $k$  is a reaction rate ( $\mu\text{mol m}^{-2} \text{h}^{-1}$ )

$K_p$  is Langmuir adsorption constant ( $\text{m}^3 \mu\text{mol}^{-1}$ )



## **SUMMARY**      **Economy & Health & Ecology**

- Photocatalytic technology can significantly eliminate imissions from the air and maintain the air pollutions in the city in legal limits
- The 2030 goal on reducing the health impacts of air pollution (premature deaths) by more than 55% is already achievable with the application of efficient photocatalytic products in interiors
- Methodology for modern architecture to estimate the environmental effects in specific area/objects is available



Our certification program and methodologies are available to other photocatalytic associations.

Let's make a difference

Thank you for your attention



BREF CWW



JRC SCIENCE FOR POLICY REPORT

Best Available Techniques (BAT)  
Reference Document for Common  
Waste Water and Waste Gas  
Treatment/Management Systems in  
the Chemical Sector

*Industrial Emissions Directive  
2010/75/EU  
(Integrated Pollution  
Prevention and Control)*

Photocatalysis is a part of the EU legislative as an emerging /Best Available Technology in BREF CWW for waste gas and waste water treatment