



Berlin, 2 October 2019

# Environmental applications of TiO<sub>2</sub> nano particles

FN NANO<sup>®</sup> photocatalytic coating technology

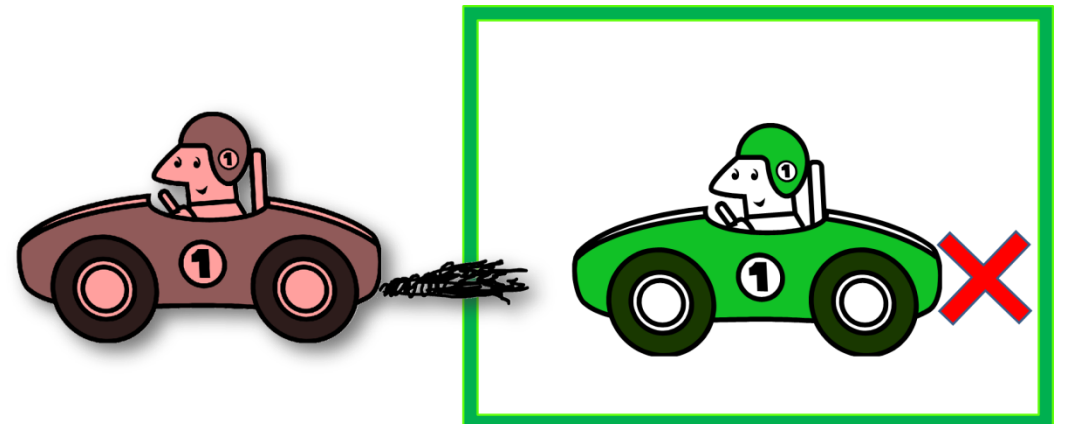
*Jan Prochazka, Ph.D.*

[jan.prochazka@advancedmaterials1.com](mailto:jan.prochazka@advancedmaterials1.com)

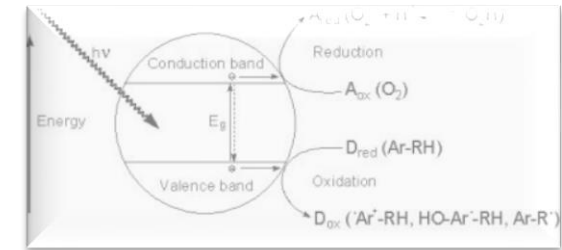
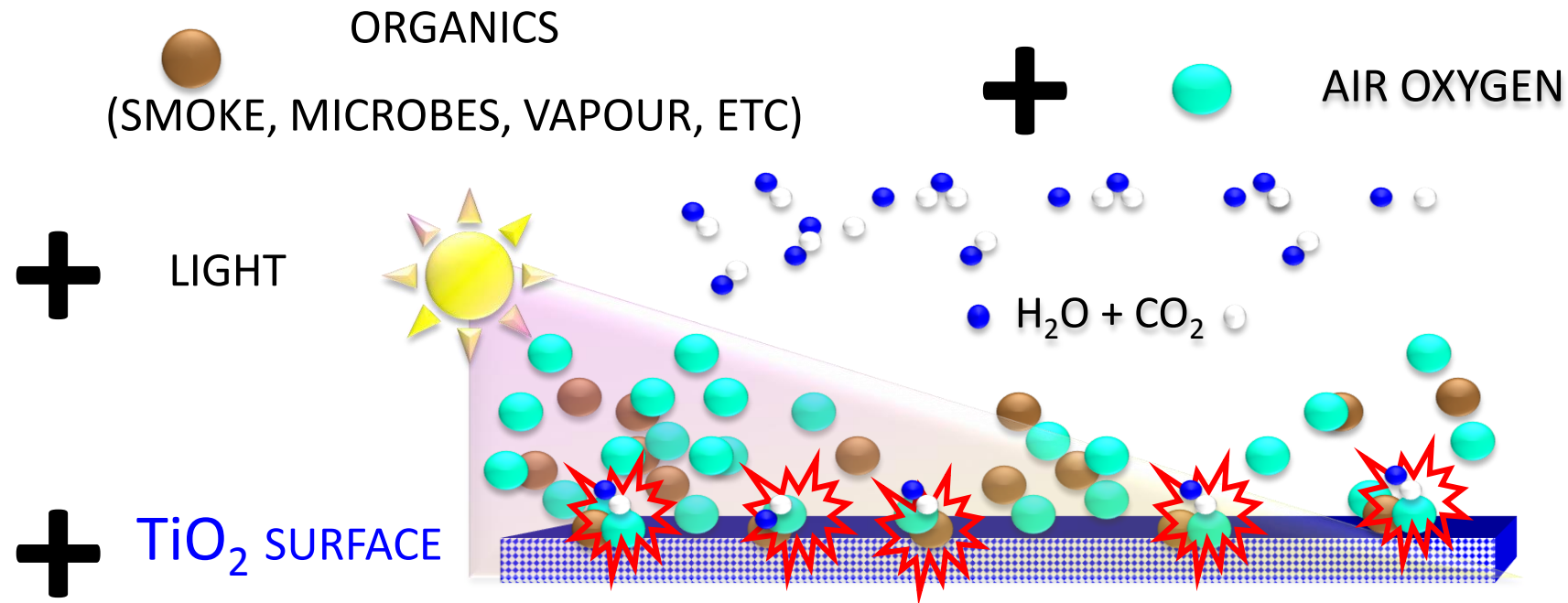


# Environmental applications of TiO<sub>2</sub> nano-particles

- ◆ • Air depollution using photocatalysis of nano TiO<sub>2</sub>
- ◆ • Economy and ecology synergies
- ◆ • New standards
- ◆ • Water post treatment
- ◆ • EU legislative changes and environmental policies



# ❖ Air depollution using photocatalysis of nano TiO<sub>2</sub>



**E<sub>g</sub> ~ 3.2eV (higher oxidation potential than on chlorine)**

**CONVERSION OF LIGHT ENERGY INTO AN OXIDATION POTENTIAL ON TiO<sub>2</sub> SURFACE**

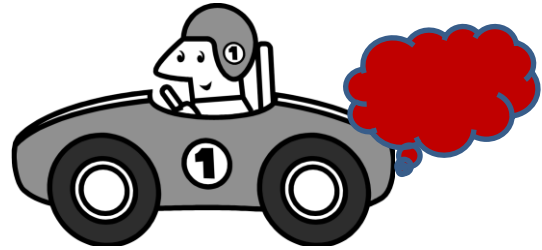


# SMART CITIES AND SMART BUILDINGS START WITH CLEAN AIR

*PHOTOCATALYSIS – the only feasible technology to eliminate pollutants (emissions) of the atmosphere*

**MILLIONS OF SMALL SOURCES OF POLLUTIONS– AUTOMOBILES**  
**MILLIONS OF SMALL AREAS TO CLEAN AIR– PHOTOCATALYTIC SURFACES**

# How emissions form imissions



+

=

Many more



Emissions spread in urban area creating contaminated air-  
imissions

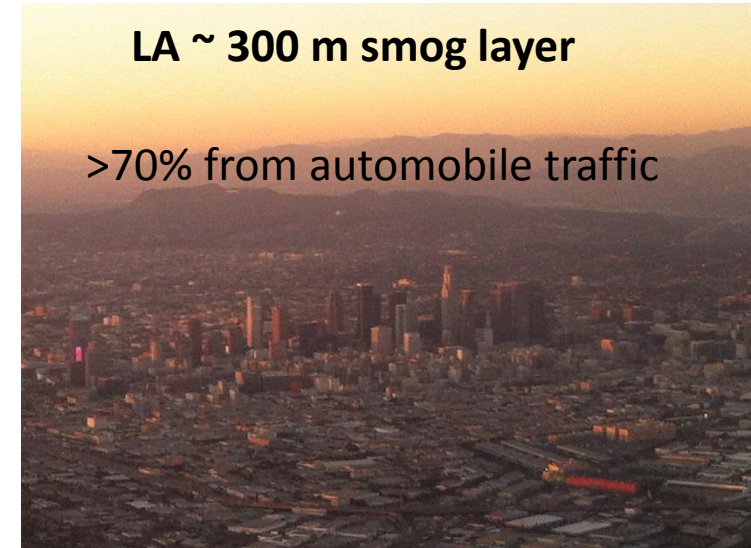
PRAGUE ~ 100 m smog layer

>70% from automobile traffic



LA ~ 300 m smog layer

>70% from automobile traffic



Pollutions form on the ground

> 500 m smog layer



Prague – Czech Republic

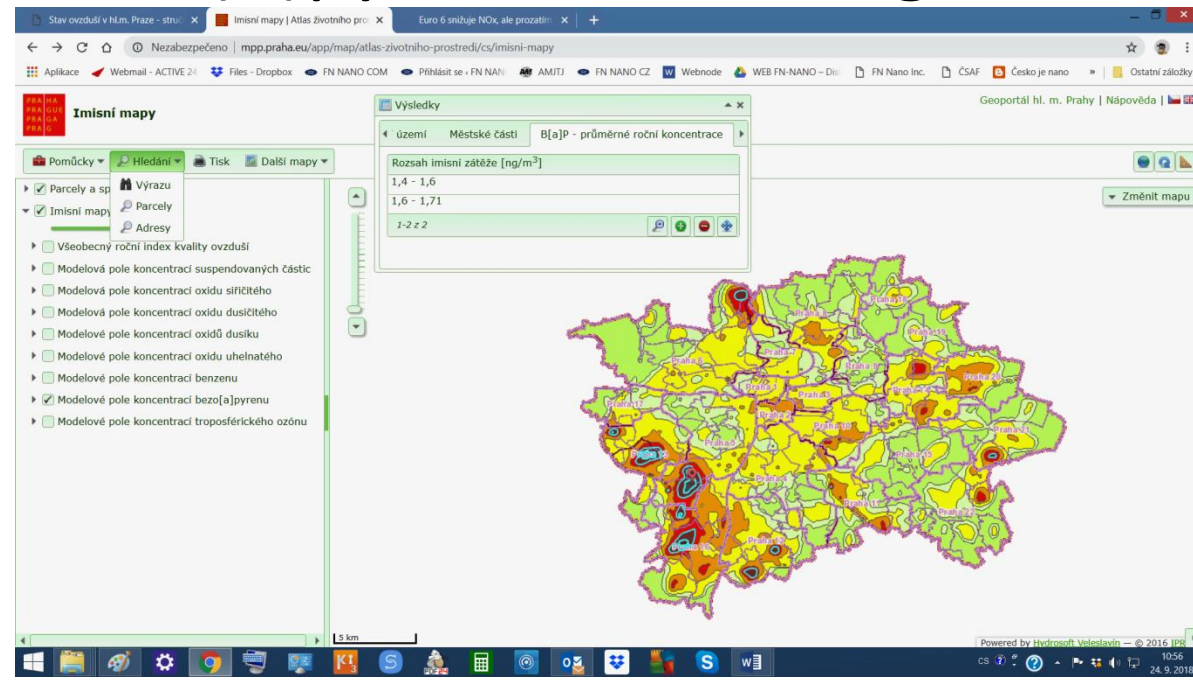
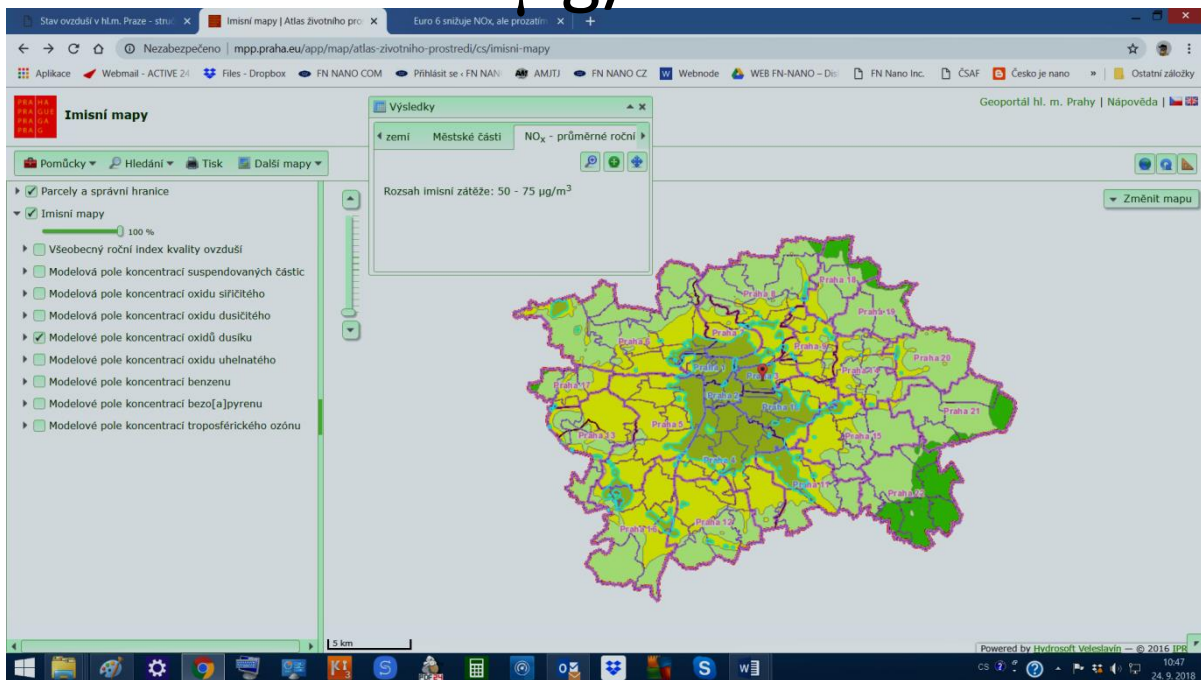
most of areas in Prague outside the legal limits

Clean air

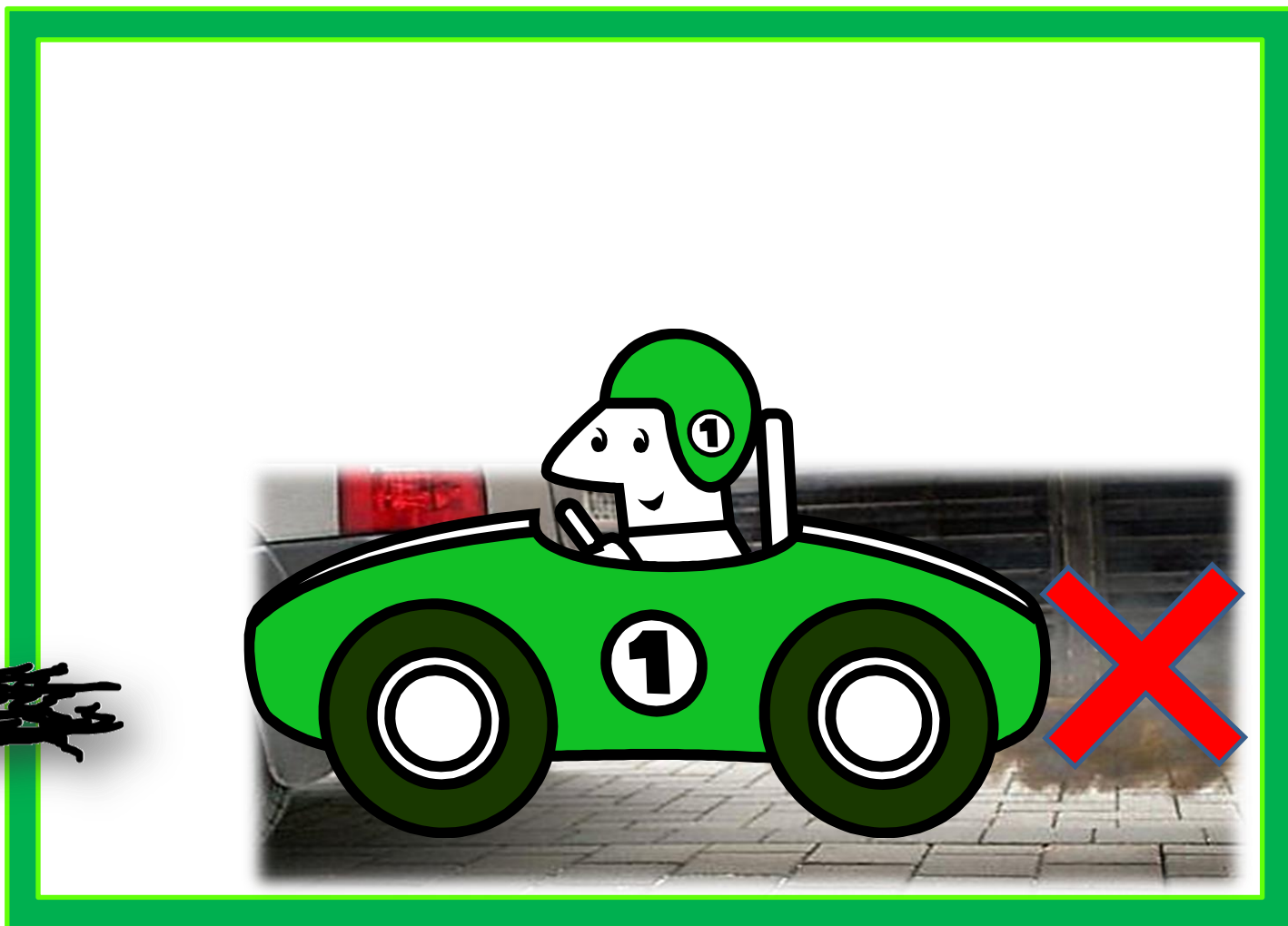
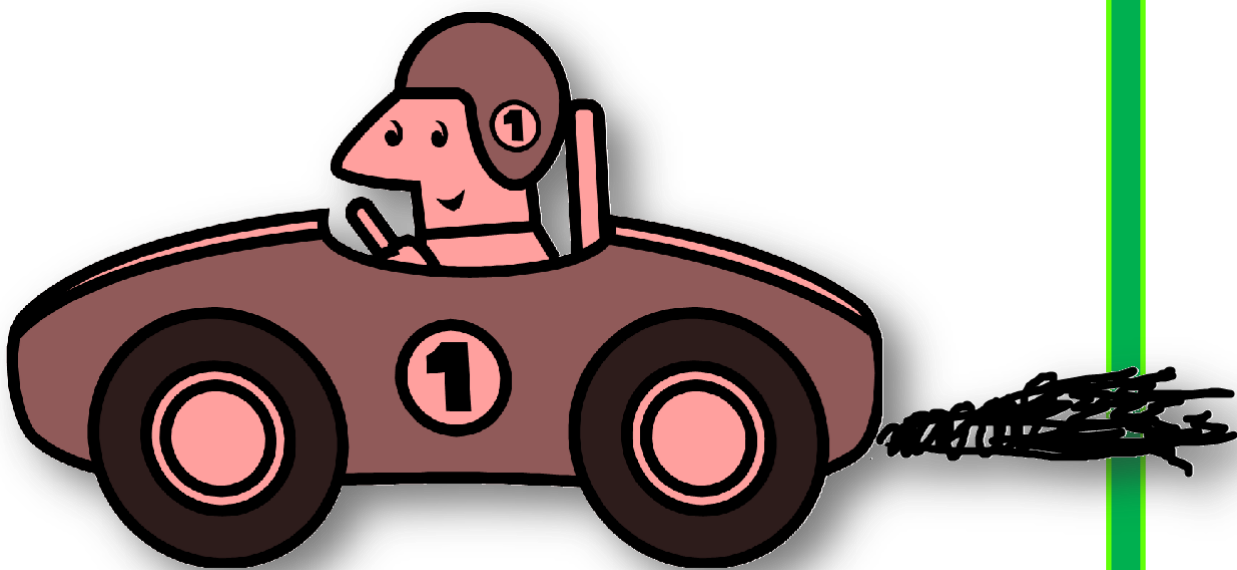


NO<sub>x</sub> – over 40 μg/m<sup>3</sup>

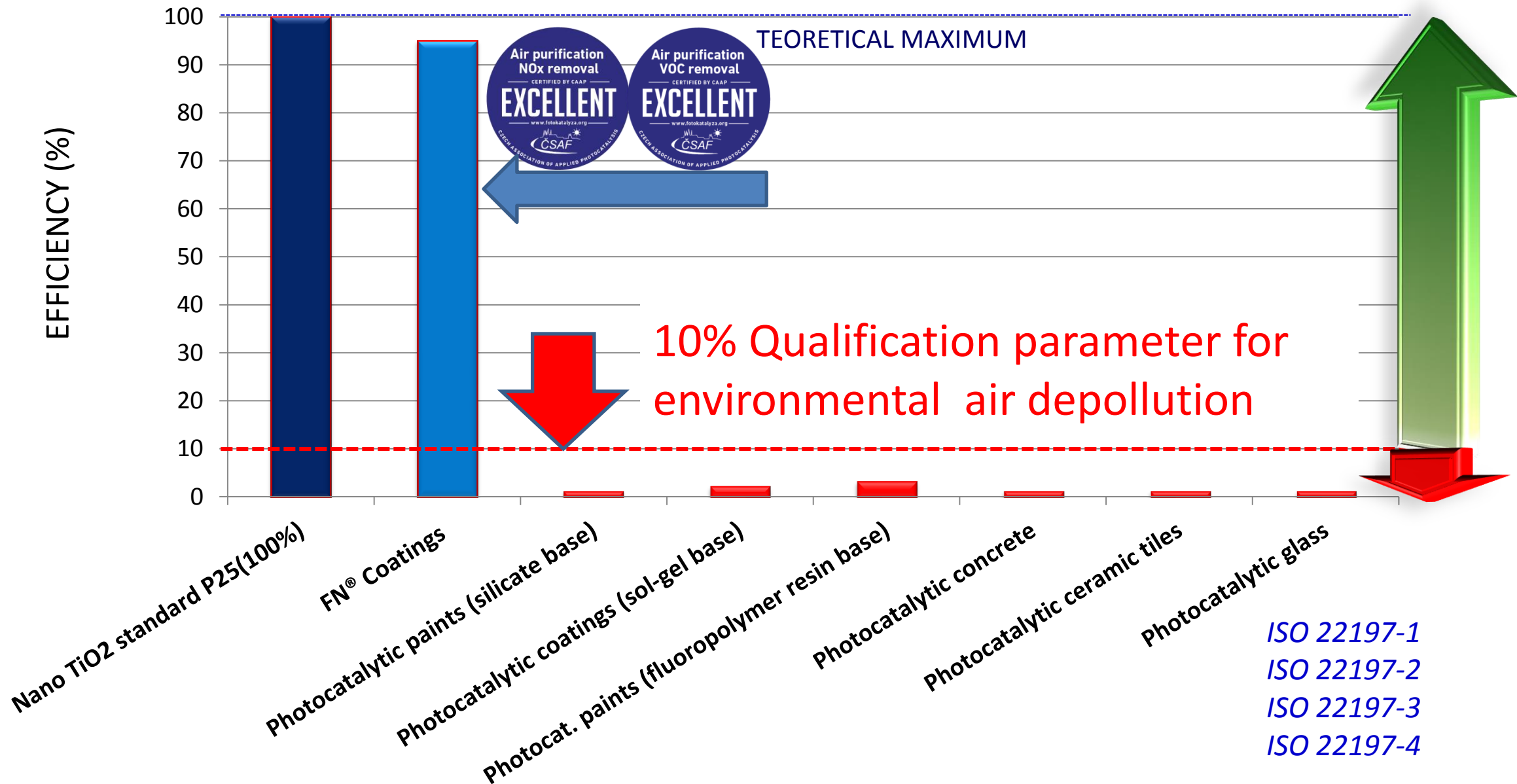
Benzo(A)pyrene – over 1 ng /m<sup>3</sup>



15m<sup>2</sup> (150ft<sup>2</sup>) of FN NANO<sup>®</sup> photocatalytic active surface in a polluted part of a city can **eliminate the emissions of one diesel car or three gasoline cars just like they were taken of the street**



Comparison – efficiency of photocatalytic products with pure photocatalyst (%)  
*FN NANO® efficiency – almost as high as a pure photocatalyst (100%)*



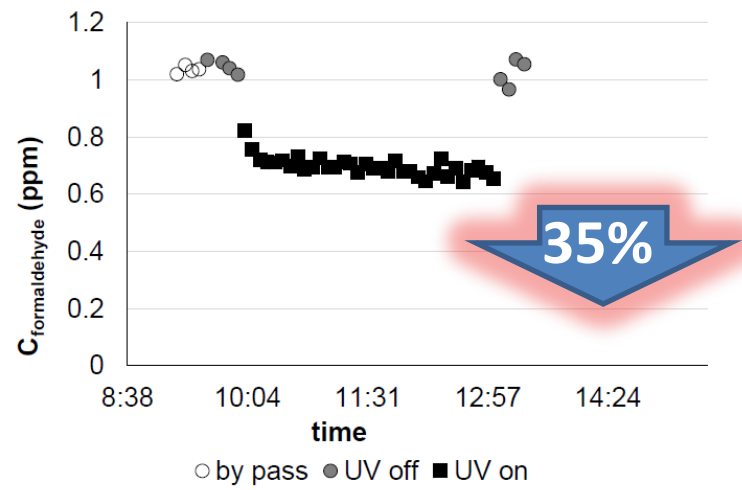




# FN NANO® BRAND HAS BEEN CERTIFIED FOR AIR PURIFICATION

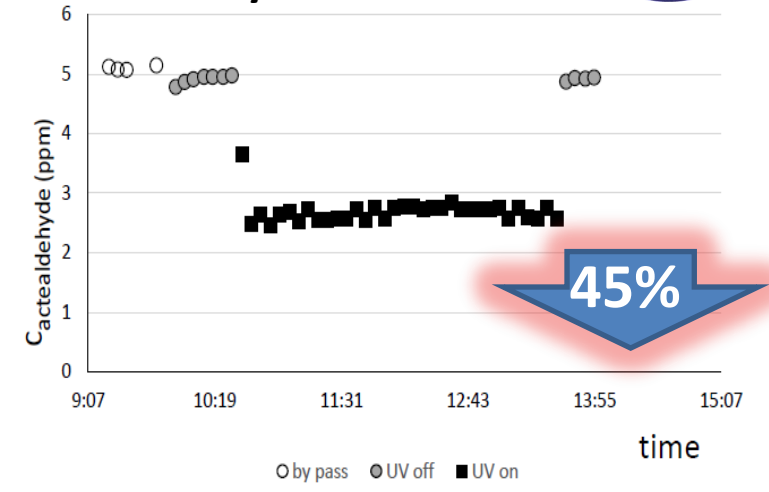
Photocatalytic activity of FN2® coating tested by standard ISO methods

### formaldehyde: ISO 22197-4

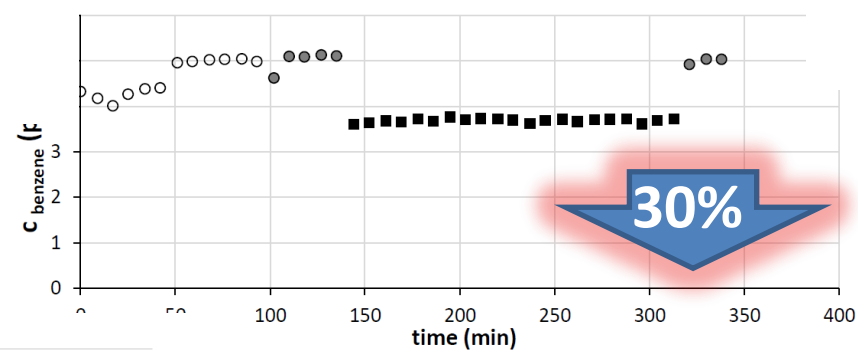


Cleans air of about 40% of pollutants per pass

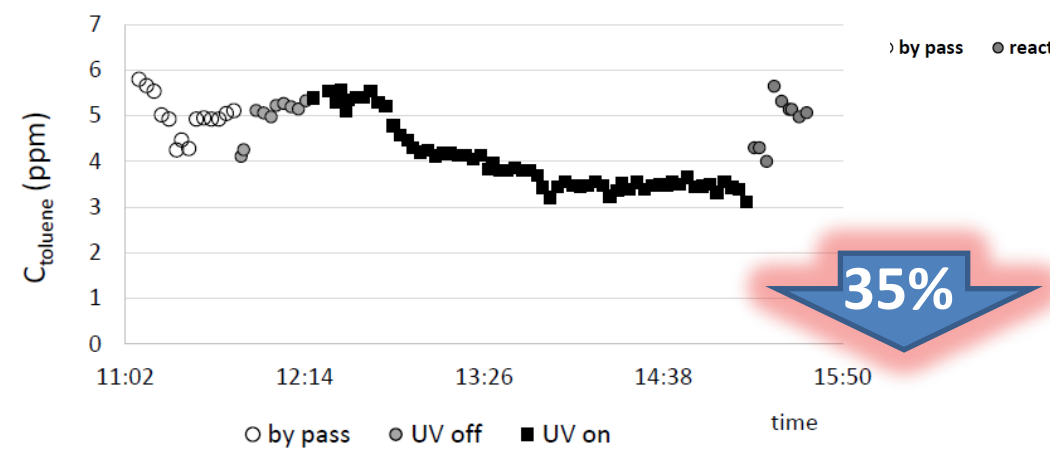
### acetaldehyde: ISO 22197-2



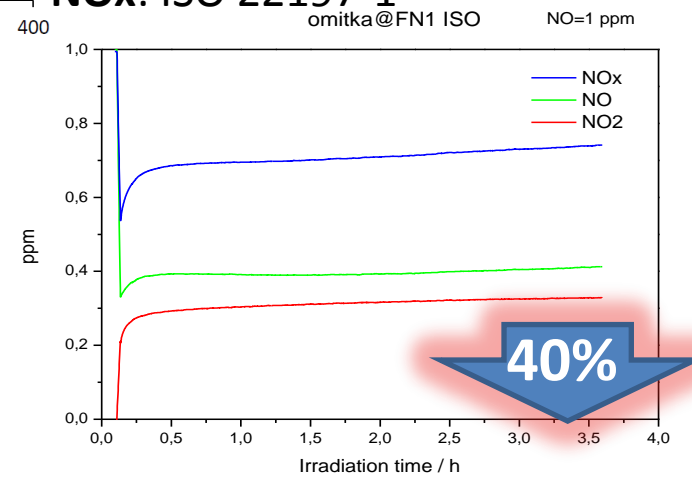
### benzene: ISO 22197-3



### toluene: ISO 22197-3



### NOx: ISO 22197-1



# Practical examples



Provided that the efficiency qualifies for air depollution, 1 m<sup>2</sup> of FN NANO<sup>®</sup> facade surface cleans minimally 3,000,000 m<sup>3</sup> of air per year from photocatalytically degradable pollutants (NO<sub>x</sub>, CO, SO<sub>x</sub>, VOCs, benz-a-pyrene and other pollutants)

Objects treated by FN NANO<sup>®</sup> coatings work as cleaning eco-machines



Testing wall - sound barrier – Barrandov, Prague: Exposed location - 30 000 cars per day.

6/2018

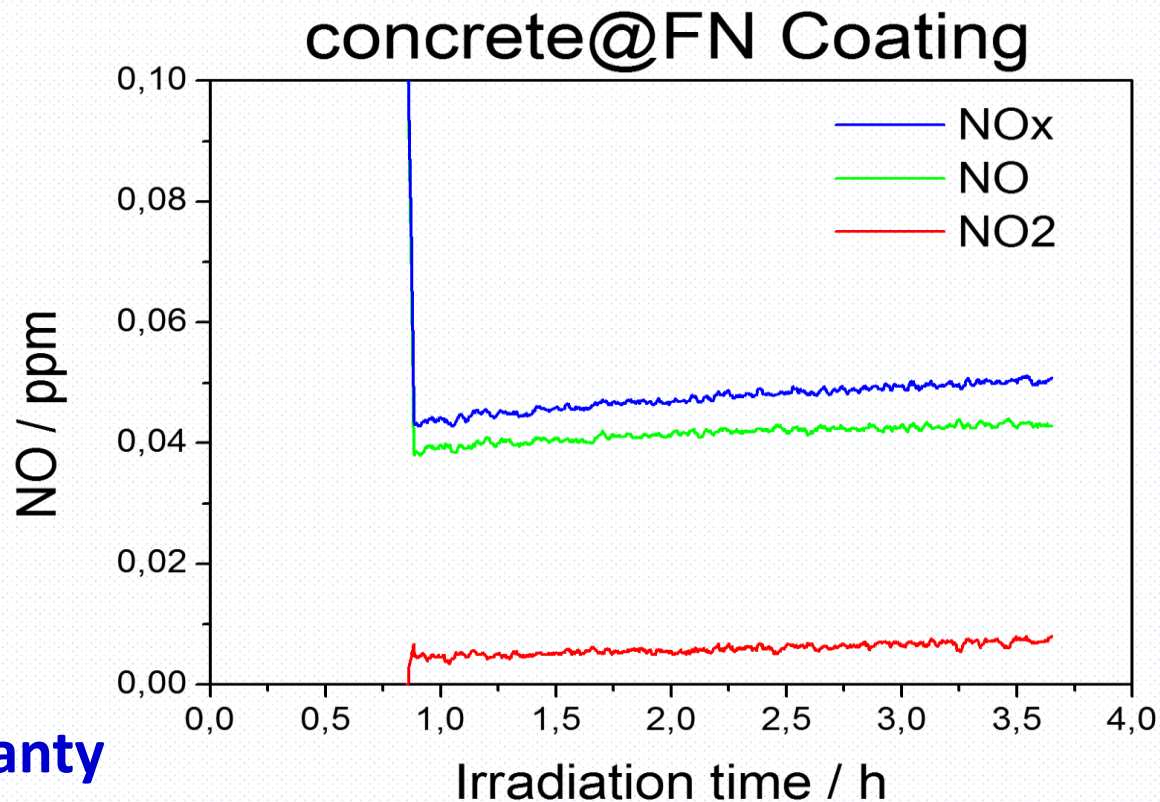


TYTO  
PLOCHY  
ČISTÍ  
VZDUCH  
45m<sup>2</sup> FN<sup>®</sup>

45 m<sup>2</sup> FN<sup>®</sup> in this area will remove the same amount of NO<sub>x</sub> as produced by three diesel passenger cars

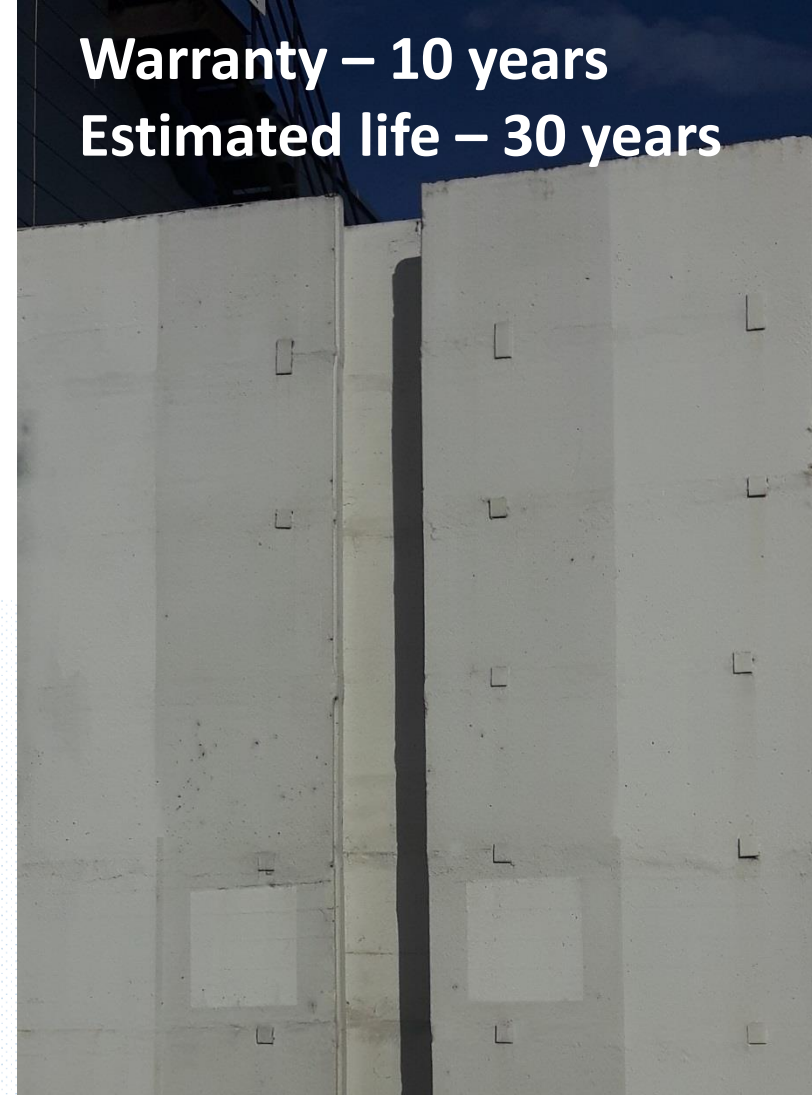
# DURABILITY MATTERS

*After two years of heavy exposure, the coating was still able to remove **any load of NO<sub>x</sub>** from the automobile traffic with the original efficiency (~50%).*



**10 years warranty**

**Warranty – 10 years**  
**Estimated life – 30 years**



Applied Catalysis B: Environmental  
Volume 217, 15 November 2017, Pages 466-476



Photocatalytic abatement of NO<sub>x</sub> pollutants in the air using commercial functional coating with porous morphology

Radek Zouzelka <sup>a, \*</sup>, Jiri Rathousky <sup>a, \*</sup>

◆ •Economy and ecology synergies

# Self-cleaning & AIR CLEANING = Economy & Ecology

before (6 years old building – marble tiles)



Villa Bianca complex 1

6 years after FN1® application



it would look like the previous picture without the coating

Cleans over one billion m<sup>3</sup>/ year

***1 m<sup>2</sup> of FN<sup>®</sup> treated sound barrier cleans enough air per day, how much a person needs per year!!!***

Fresh after application of color varieties of FN<sup>®</sup> coatings.



2014

## **Economy & Ecology**

After 3 years –Darker areas were not painted with FN<sup>®</sup>

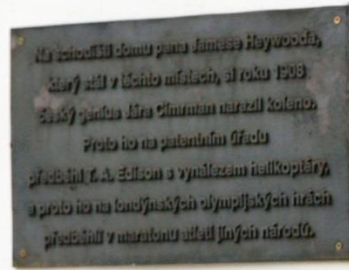


2017

# EXAMPLES

Nanowall at the Czech Embassy in London compensates for emissions from at least 10 diesel cars

## Kensington Palace Gardens London



Embassy of the Czech Republic  
in London

Behave as good guests in a hosting country,  
act as a good guest on our planet



This  
**Nanowall**  
purifies air

This Nanowall compensates for emissions produced by the automobiles used by the Czech Embassy in Budapest.

 [www.fn-nano.com](http://www.fn-nano.com)  Czech Republic  
The Country  
For The Future



Embassy of the Czech Republic  
in Budapest

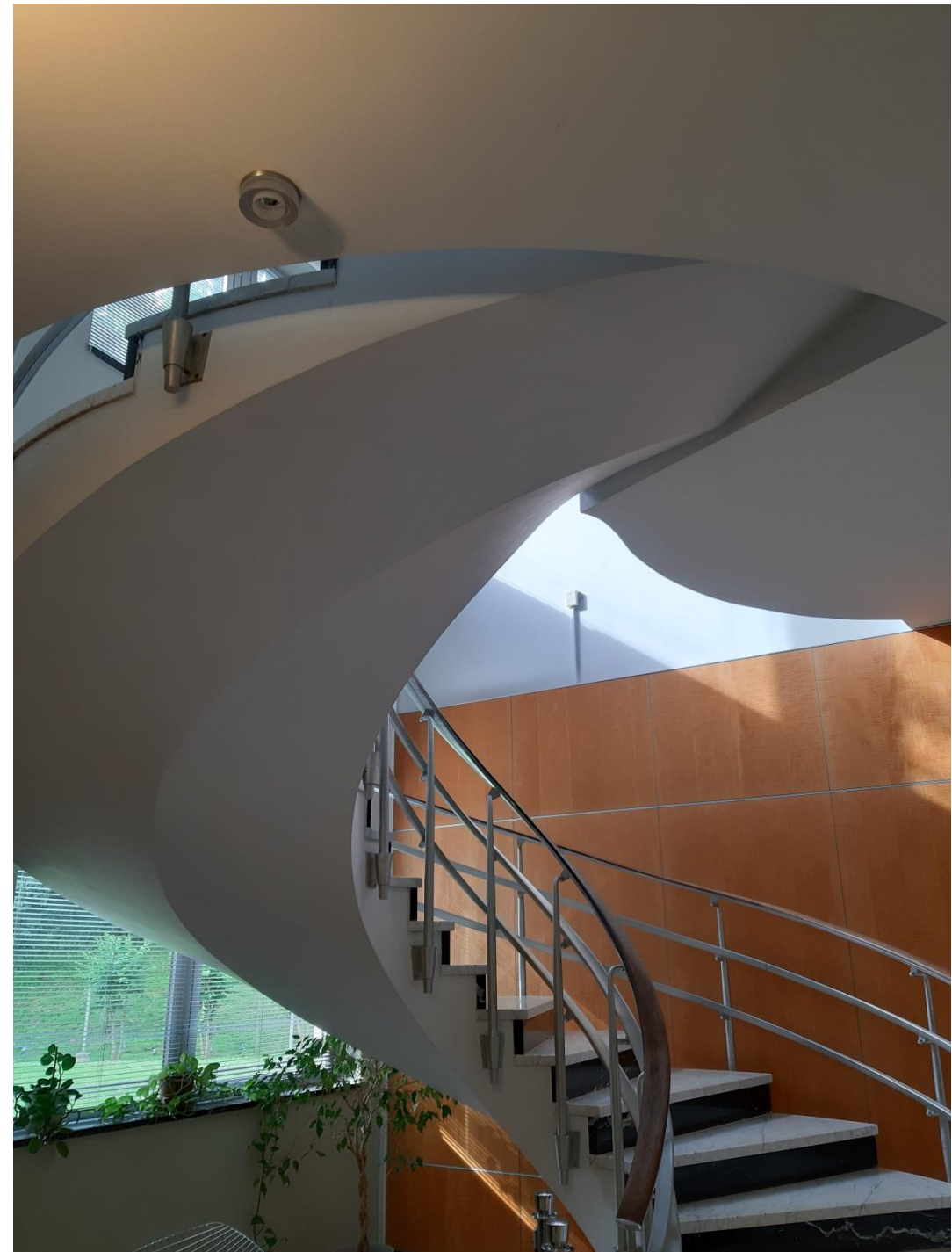
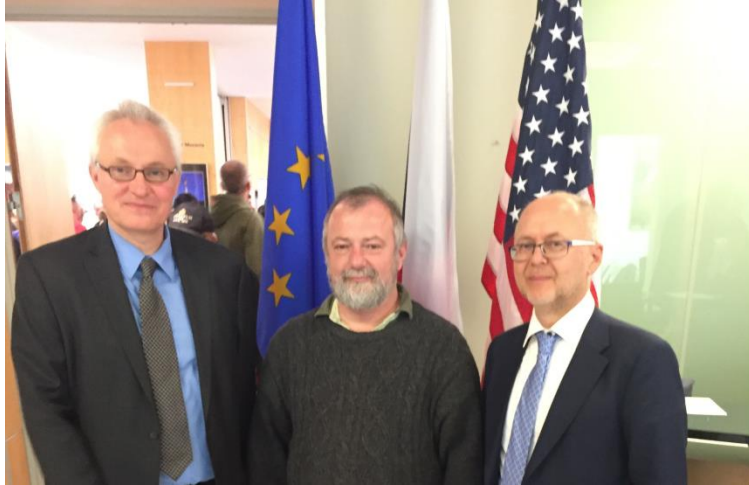
CZECH EMBASSY IN BUDAPEST COMPENSATES  
FOR EMISSIONS FROM ALL ITS CARS





Embassy of the Czech Republic  
in Washington, D. C.

The ambassador Kmonicek  
supports modern technologies  
cleaning air inside the embassy



# FN<sup>®</sup> COATING CLEANS

## 1 000 000 m<sup>3</sup> OF AIR FOR LESS THAN \$1

Only by this way can **1 million** cubic meters of contaminated air be cleaned of pollutants for only one dollar, and at the same time, these costs will be recovered many times in the form of **savings for the maintenance of facades and constructions.**



EASY APPLICATION

[https://www.youtube.com/watch?v=zQp9R1otu\\_g&feature=youtu.be](https://www.youtube.com/watch?v=zQp9R1otu_g&feature=youtu.be)

It pays itself off after saving on maintenance of the facades

Self-cleaning and air cleaning are great benefits

+

Air depollution - CO<sub>2</sub> EQUIVALENTS (OFFSETS)

– benefits to the society

Eco-costs of emissions (Virtual Pollution Prevention Costs, VPPC)

- 3754 Euro/ kg Benzo(a)pyrene equivalent  
for human toxicity, cancer (Usetox 2)



The following marginal prevention costs have been calculated for 2017 (version 1.6):

- 116 Euro/ 1000 kg CO<sub>2</sub> equivalent for **global warming** (characterisation data IPCC 2007, **GWP 100**)

- 8.75 Euro/ kg SO<sub>2</sub> equivalent for **acidification** (ILCD)

- **6.0 Euro/ kg NO<sub>x</sub> equivalent for summer smog** (ILCD photochem. oxidant formation)

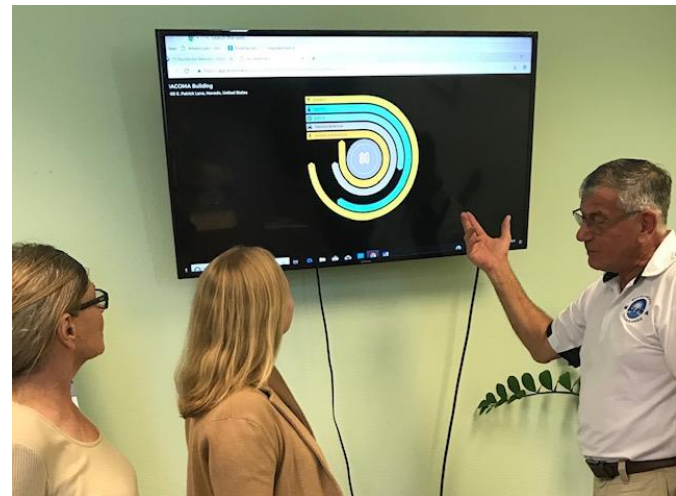
- 35 Euro/ kg fine dust PM 2,5 for **respiratory inorganics** (characterisation data RiskPol)



FN NANO® can bring you valuable points in LEED certification evaluation process

More on FN Nano technology at USGBC

<https://www.usgbc.org/education/sessions/every-breath-you-take-innovative-air-quality-design-11882335>



Regional Director Patti Mason of the USGBC visited FN Nano treated building of Nevada Alliance Against Diabetes on E Patrick Lane in Las Vegas, which has been awarded with LEED Platinum certificate.



AIA

# FN NANO<sup>®</sup> coatings – ideal technology for recovery and sustainable protection of historical objects in urban environment

## Long term protection against:

- UV
- DIRT
- SOOT
- TARS
- DUST
- MICROORGANISMS
- CHEMICALS AND BIOAGENTS
- MUD DROPLETS AND SPLASHES
- OTHER CONTAMINATION



400 color varieties



# Antigraffiti coating

**Graffiti removing (video):**

<https://www.youtube.com/watch?v=xAoHkNLJp8U>

**A combination of several properties which protect the surface against graffiti:**

- 1. Hydrophilicity - spray solvent repealing effect doesn't allow graffiti penetrate through the FN layer,**
- 2. High consumption of spray in comparison with regular surfaces,**
- 3. Porous FN<sup>®</sup> layer can be easily removed by mechanical means without damaging the substrate,**
- 4. Easy recovery of anti-graffiti surface by repainting**
- 5. graffiti removal - soft brush and pressure water**

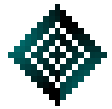


◆ • New standards

Over 80 ISO methods determining photocatalytic properties of products

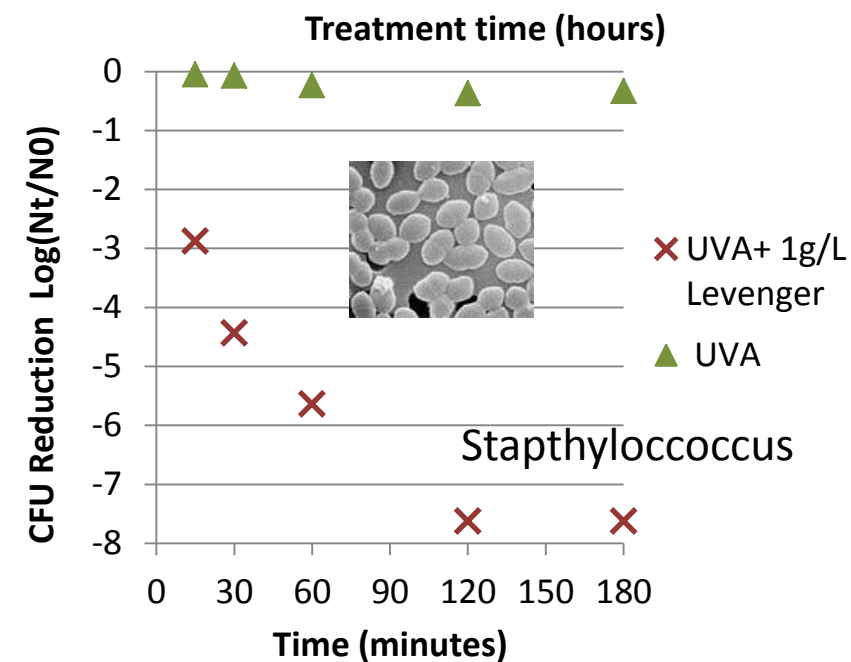
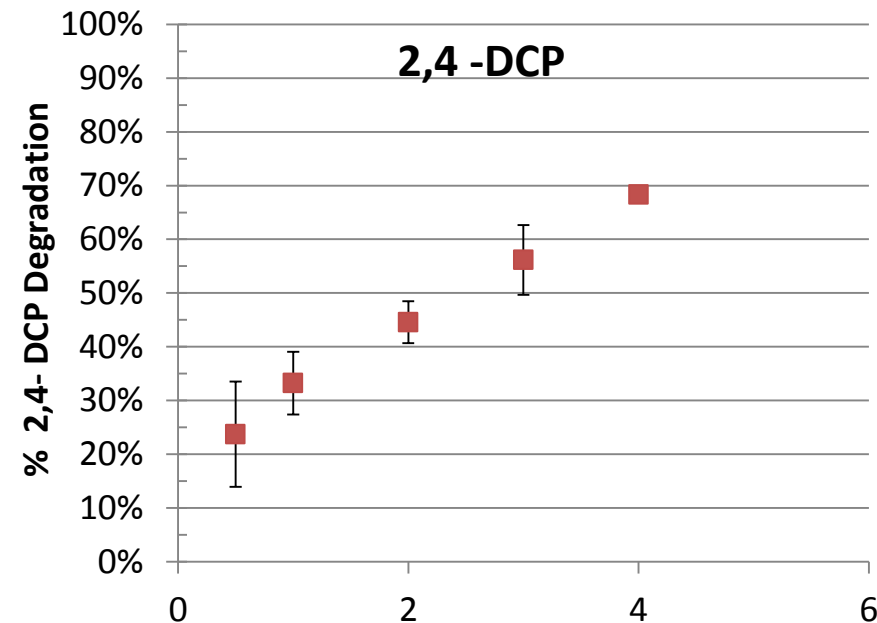
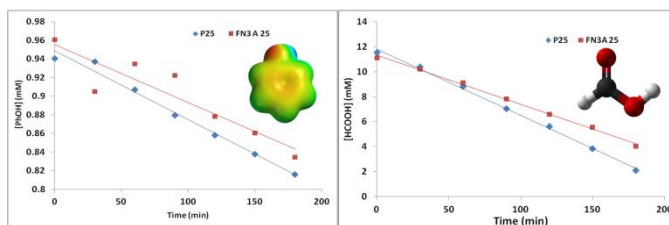
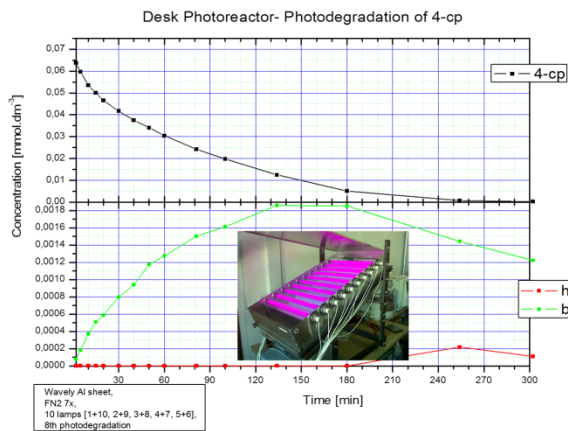
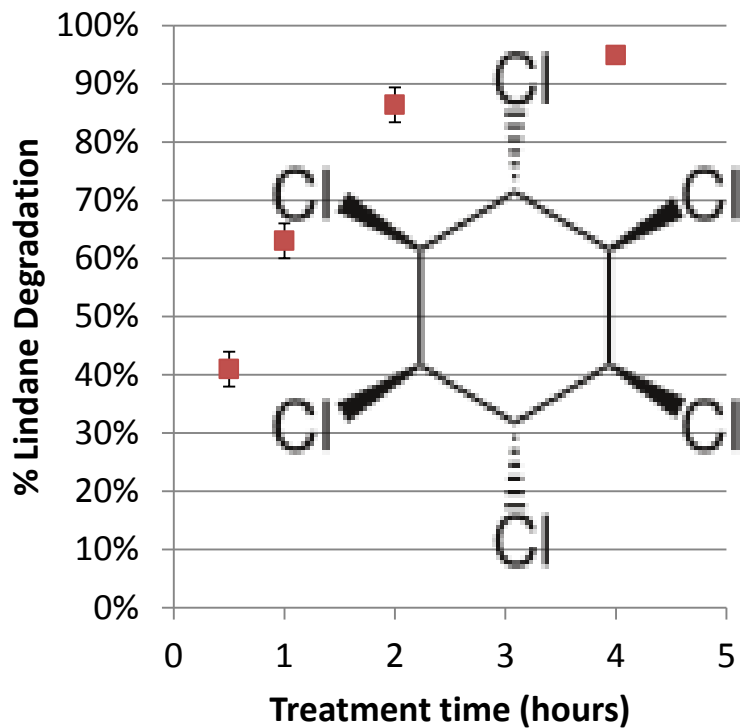
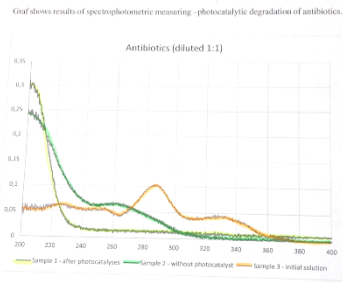
National photocatalytic societies certifications – mutually respected





# Water post treatment

## Elimination of emerging pollutants in water





## ◆ •EU legislative changes and environmental policies

This is what this questionable CLP procedure wants to protect you from:

250 mg of  $\text{TiO}_2$  Evonic P25 per  $\text{m}^3$

**Legal limits – inhabited space**

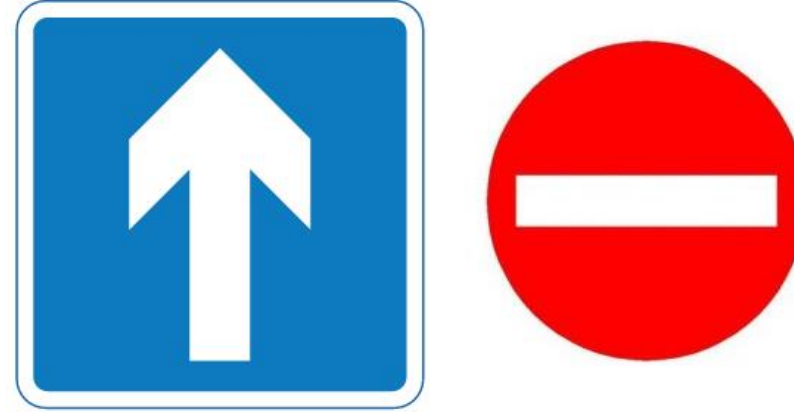
**PM10**                      **150  $\mu\text{g}/\text{m}^3$**

**PM2,5**                      **80  $\mu\text{g}/\text{m}^3$**

Living long term in extremely dusty conditions (18 months and more). Such dusty environment is already illegal in EU.

OSHA 5-10  $\text{mg}/\text{m}^3$

# One way communication

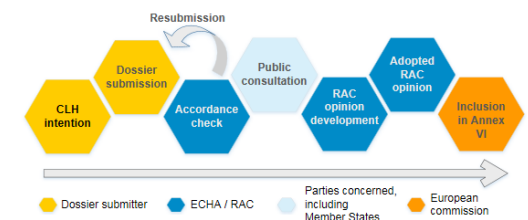


## Severally damaged trust in ECHA and EC capabilities and their trustworthiness

The classification process need to be revised and actualized.

- Firm parameters for evaluation of toxicological studies have to be established as proposed by DANA and CAAP.
- Must include search of overlapping legislatives.

Steps of the CLH process



# A PETITION TO THE EUROPEAN PARLIAMENT REQUESTING THE CANCELLATION OF AN UNSCIENTIFIC CLASSIFICATION OF TITANIUM DIOXIDE AS A HAZARDOUS SUBSTANCE

Titanium Dioxide is one of the world's most plentiful substances and commonly found used in pigments for paint and whitener for food. It is inert and safe.

The classification process over the last few years has left the technical ground and if  $\text{TiO}_2$  is going to be classified by a political decision of EC and EP the decision will ruin the trust in ECHA but also damage reputation of EC and EP since it will have widespread and disastrous economical side-effects to many industries.

Therefore, we the undersigned, representing a broad spectra Titanium Dioxide Industry, users and producers, declare:

1. There is no scientific proof that  $\text{TiO}_2$  is dangerous. Classification cannot be based on a single study, rated 3 by the Klimish codes (not reliable), especially, when the authors declare that there is no link between human cancer and results of the study.
2. The case is too serious to be decided by the Delegated Acts, which are intended only for non-essential situations, and has to be rejected or returned back to ECHA.  
*"A legislative act may delegate to the Commission the power to adopt non-legislative acts of general application to supplement or amend certain non-essential elements of the legislative act."*
3. There was an abuse of ECHA's formal procedures, to the point that it was unethical, if not illegal.
4. We reject classification of  $\text{TiO}_2$  without preceding substance evaluation.

Signed willingly by

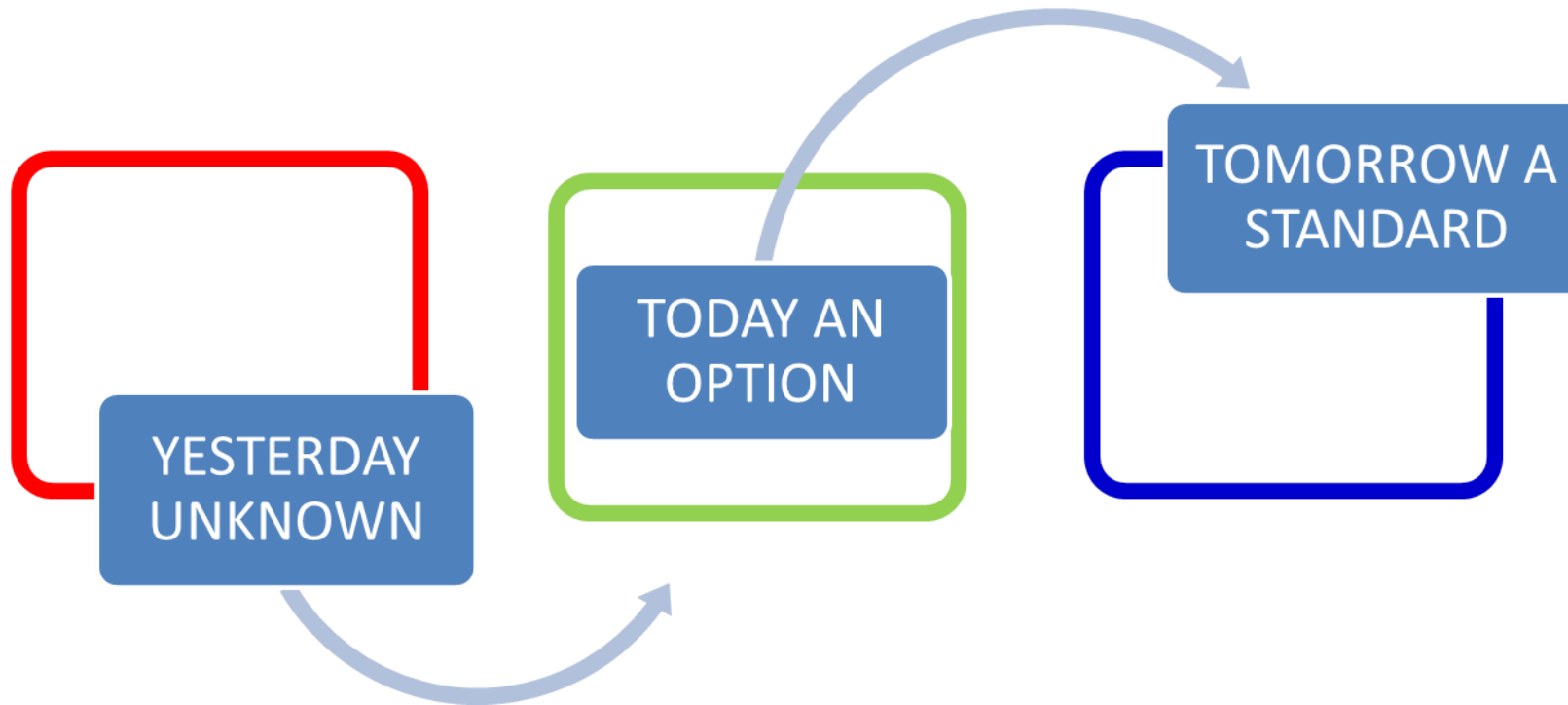
Name - - Email/Contact - - Signature

# FN NANO®

[www.amjtj.com](http://www.amjtj.com)

[www.fn-nano.com](http://www.fn-nano.com)

[www.fnnanoinc.com](http://www.fnnanoinc.com)



Acknowledgement: This work was supported by the Ministry of Industry and Trade of the Czech Republic, project Trio FV40209

