Photocatalytic Air Depollution in Contaminated Cities

Creating Healthy Environments

IEEE Advancing Technology for Humanity

Smart Cities Symposium Prague 2015

CZECH TECHNICAL UNIVERSITY IN PRAGUE
FACULTY OF TRANSPORTATION SCIENCES

Advanced Materials JTJ

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AIR QUALITY IN LARGE CITIES - A SERIOUS PROBLEM

The main source: car traffic and industrial production

CONSEQUENCES

- increased incidence of cancer, respiratory diseases and asthma and allergic diseases
- the overall weakening of the immune system, especially in young children, elderly and sick people
- negative impact on soil and water quality
- economical losses

INSTRUMENTS FOR SOLVING THE POLLUTIONS PROBLEM

I. REDUCTION OF EMISSIONS

- Legislation and administrative legal measures
- Support for introduction of modern low-emission technologies and equipment for air purification at source into practice

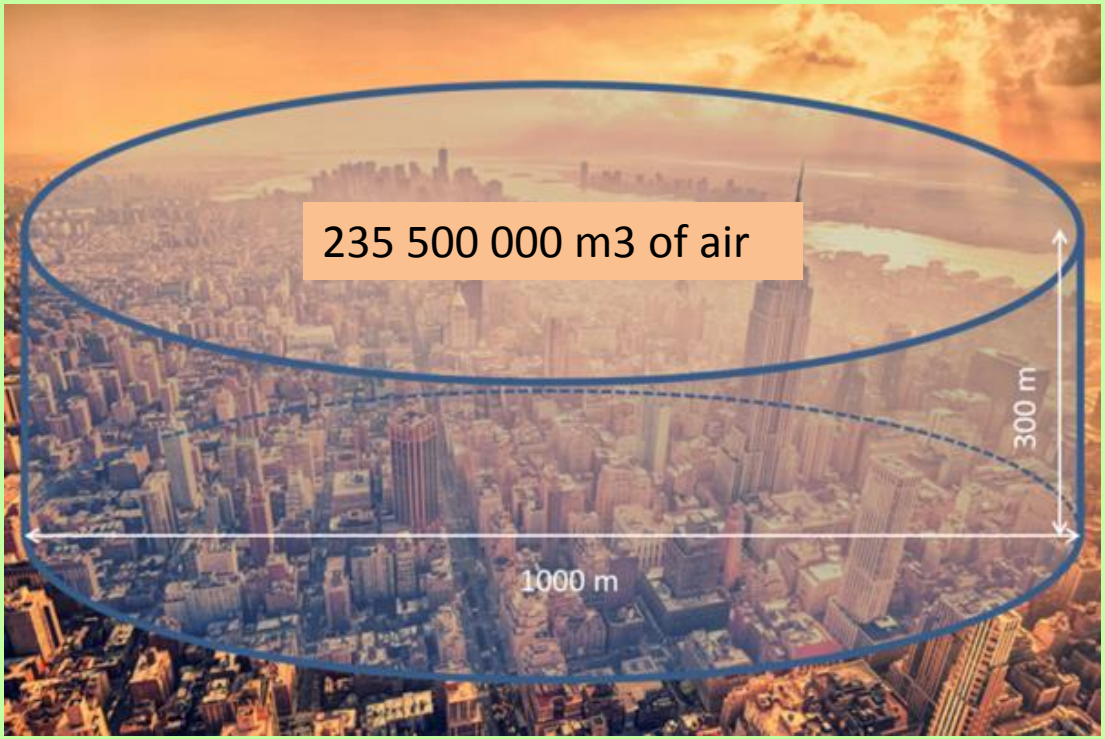
II. CLEANING THE ATMOSPHERE FROM AIR POLLUTANTS

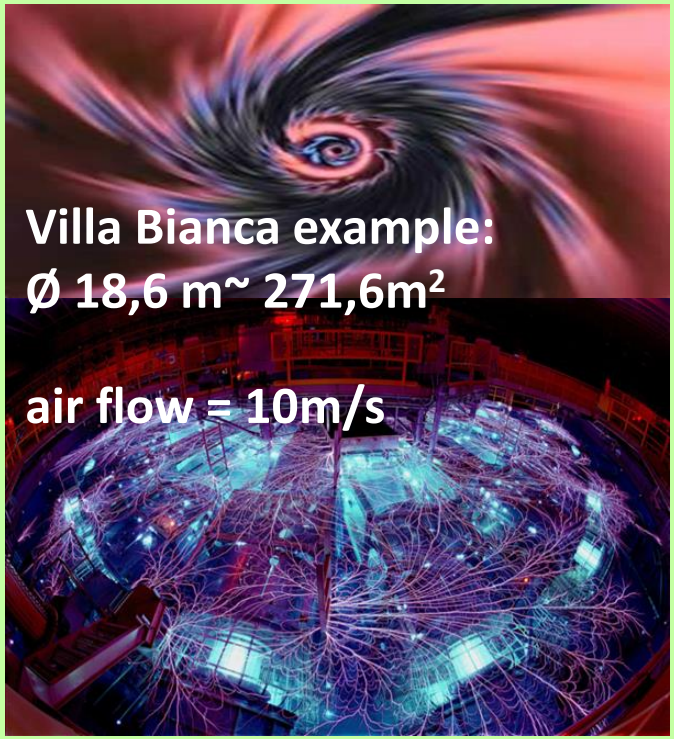
- Support for outplanting of greenery and to sustain.
- New technologies for atmosphere purification ??? Are there any in the world?

NEW TECHNOLOGIES FOR ATMOSPHERE PURIFICATION

They must have huge capacity and the ability to clean even very low concentrations of pollutants.

Dimensions? Power consumption? Noise? Investment costs? Maintenance costs? Lifetime? Disposal costs?



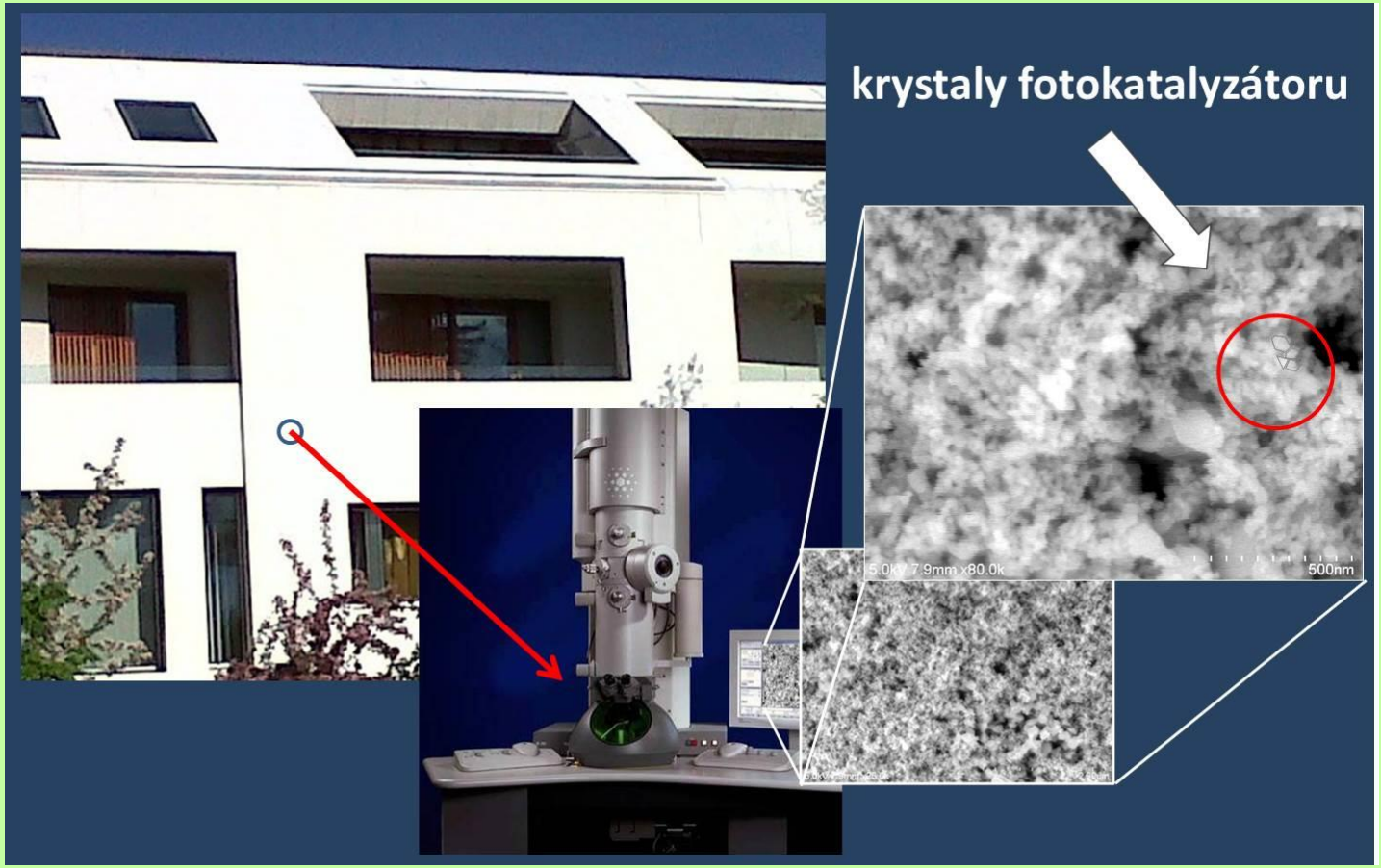


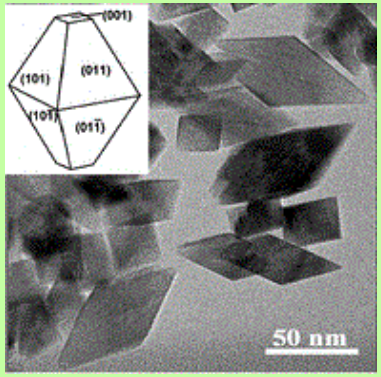
TECHNOLOGIES SUCH AS FILTRATION, ADSORPTION, EM SEPARATION AND PLASMA BURNING ARE NOT USABLE!

SOLUTION: HIGHLY EFFICIENT PHOTOCATALYTIC SURFACES

VILLA BIANCA MARBLE FACADE (WHICH IS TREATED BY PHOTOCATALYTIC TECHNOLOGY FN®) CLEARS FROM 40% OF POLLUTANTS OVER A BILLION M³ OF AIR PER YEAR!!!

PHOTOCATALYTIC SURFACE TECHNOLOGY





The surface is formed by the semiconductor nanocrystals - TiO2

The photocatalytic surface transforms light energy into electro-chemical power, which effectively cleans the air, destroys microorganisms and ensures self-cleaning surfaces.

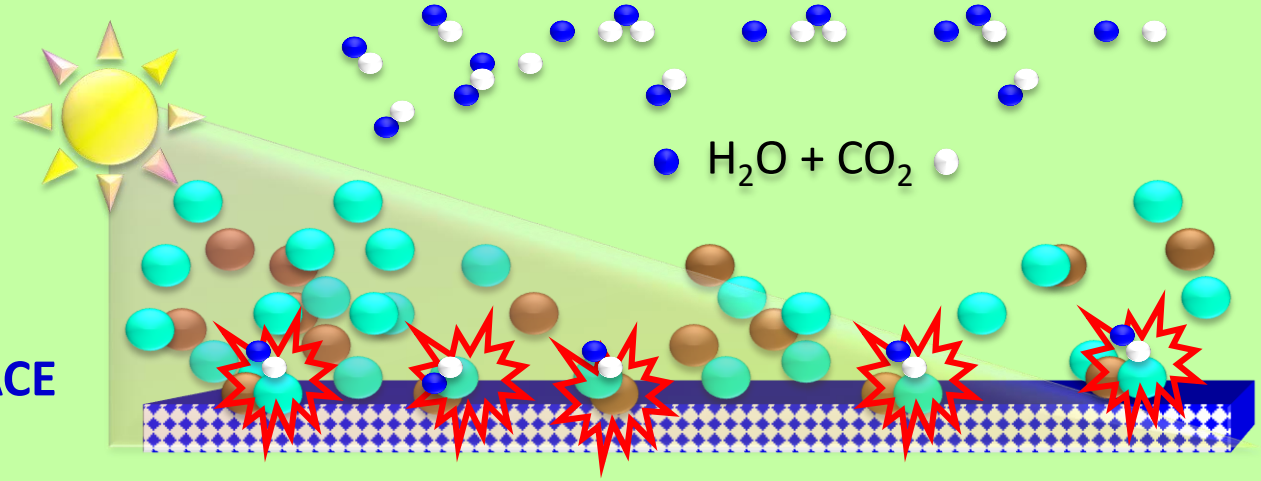
PHOTOCATALYSIS

ORGANIC PARTICLES + OXYGEN

(smoke, toxins, organics, microbes)

+ LIGHT

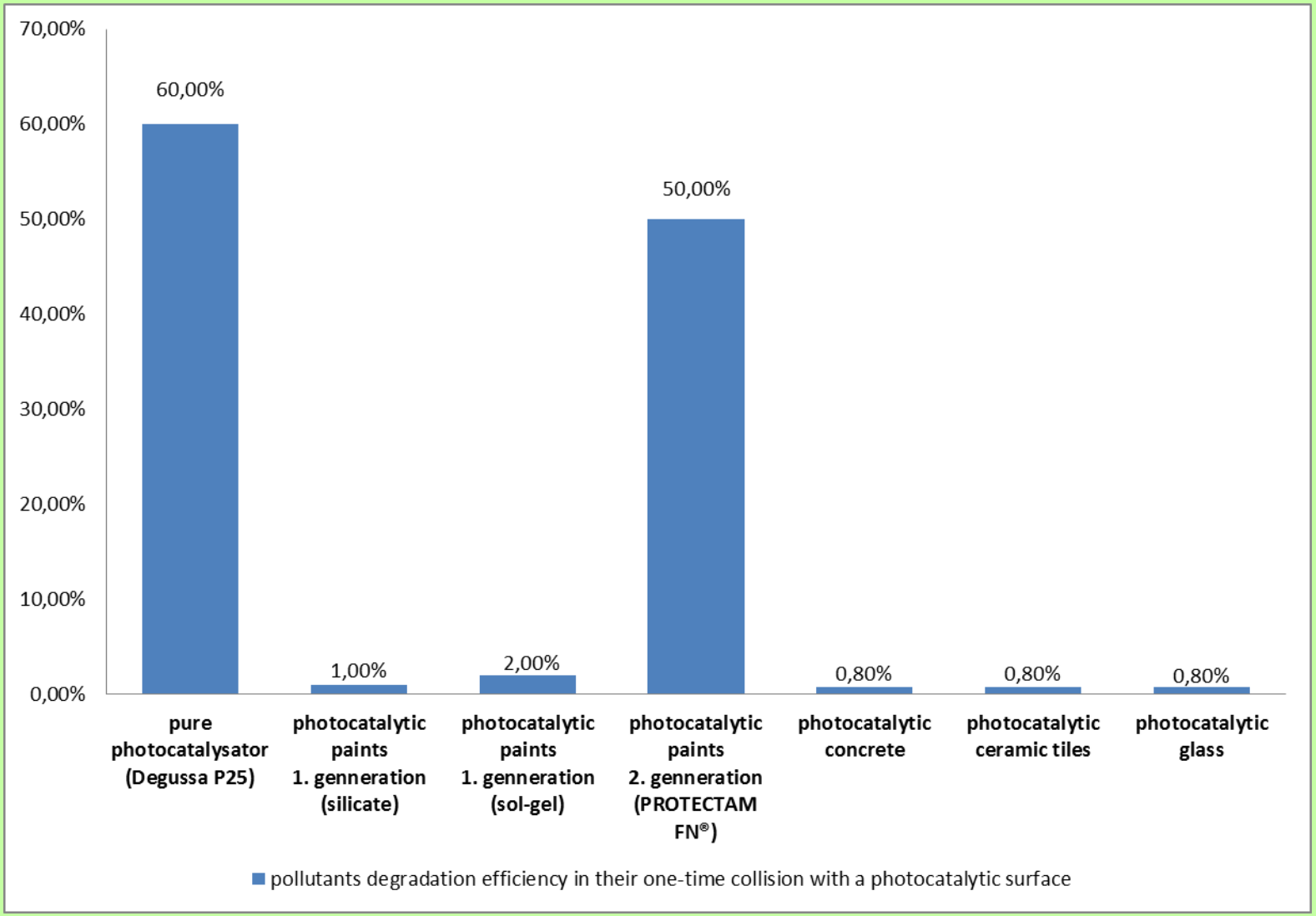
+ TiO_2 SURFACE



Eg ~ 3.2eV

Higher oxidation potential than chlorine or ozone !!!!!!!

PHOTOCATALYTIC PRODUCTS EFFICIENCY



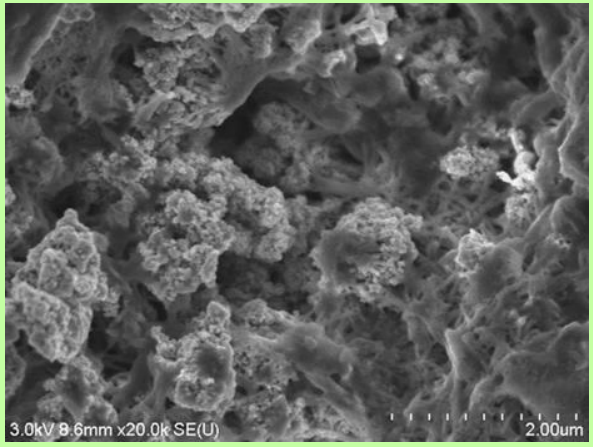
PROTECTAM FN®-EFFICIENCY UP TO 100%

Multifunctional coatings PROTECTAM FN ® with photocatalytic effect

- **patented in all major global markets**
- **sale in 15 countries**
- **certified and tested**
- **nanotechnology - awards: Innovation of the Year 2010 (2nd place); nominations: CZECH HEAD AWARD 2011 - MINISTER OF THE ENVIRONMENT PRICE, EUROPEAN BUSINESS AWARD 2011, MEDICAL FAIR BRNO AWARD, CZECH INNOVATION 2014 (AWARD FOR SOCIAL CONTRIBUTION)**

The coating creates a highly porous 3D spatial microstructure on the surface of which are securely anchored TiO2 nanoparticles. Those confer of this coating layer covering by water molecules (H2O) and a highly oxidative effect caused by the photocatalytic property.

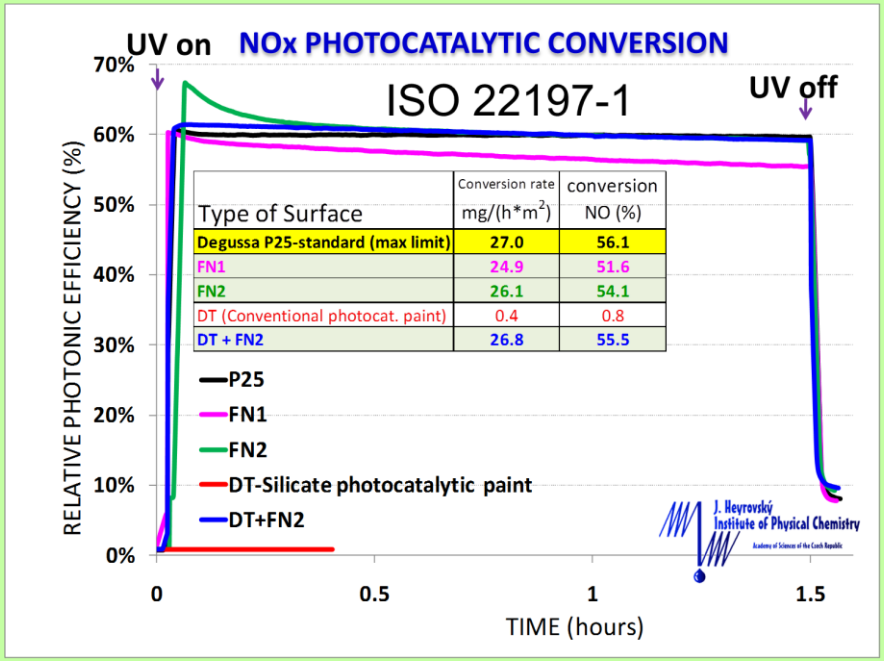
AIR PURIFICATION, SELF-CLEANING SURFACE, ANTI-GRAFFITI EFFECT



TESTING OF FN® POLLUTANTS DEGRADATION

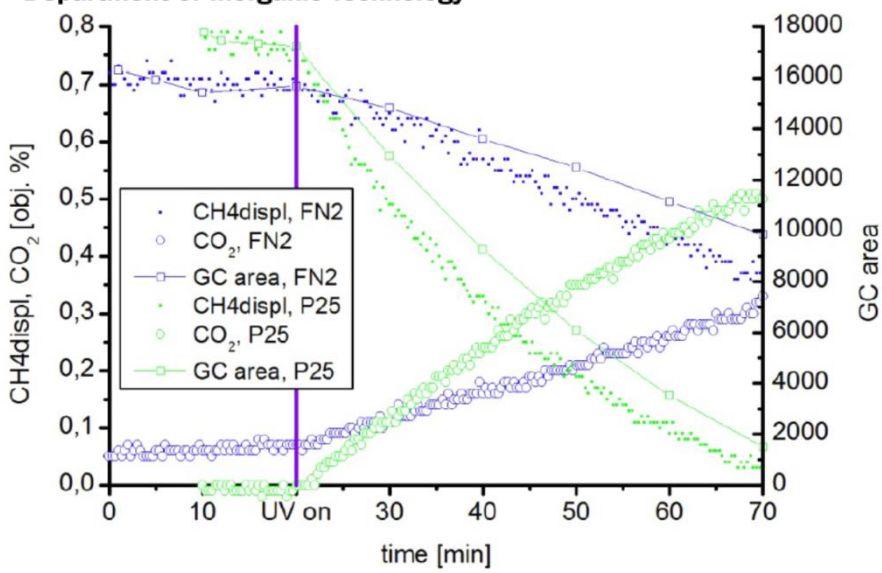
FN® COATING APPLIED ON A HIGH POROSITY SUBSTRATE CAN DEMONSTRATE NOx CONVERSION AS HIGH AS **100% AT 6 ppm NO**
AND
EVEN VERY HIGH NOx CONVERSION OF **20% AT 500ppm NO**

NO concentration 6 ppm	Elimination of NO (ppm)
FN2	6,15
FN3	6,1
FN1	5,99
P25	6,09
P90	6,07



Type of Surface	Conversion rate mg/(h*m²)	conversion NO (%)
Degussa P25-standard (max limit)	27.0	56.1
FN1	24.9	51.6
FN2	26.1	54.1
DT (Conventional photocat. paint)	0.4	0.8
DT + FN2	26.8	55.5

INSTITUTE OF CHEMICAL TECHNOLOGY, PRAGUE
Faculty of Chemical Technology
Department of Inorganic Technology



Tests of hexane degradation in the FN2 ® paint on the roof bag.

FN2® - Hexane Degradation : ***The concentration of hexane was 700 ppm (10 microL injection) at the beginning of the experiment. The experiments conducted in stages: 20 min dark and a further 50 minutes of UV.***

Reference: pure nano - TiO_2 Degussa P25 (5 g TiO2/m²) - the theoretical maximum.

Conclusion - photoactivity proven air cleaning.

Comparison of degradation rate according to GC:
P 25 - 4.1 mmol/h/m2; FN2 ® - 2.4 mmol/h/m2.
FN2 ® surface = 59% of the photocatalytic efficiency of Degussa P 25 (100 %)

1 M^3 OF CLEANED AIR FOR € 0.00005

For improving the air quality is best to apply FN in areas with the highest concentration of pollutants - for example noise barriers and other structures near roads.

- FN photocatalytic surface decontaminate from the air 40% of the decomposable pollutants regardless if their concentration is 100 µg/m^3 or only 15 µg/m^3
- By deploying of photocatalytic surfaces in the most polluted areas will reduce spreading of pollutants into the environment and achieve the lowest concentration of harmful substances also on surrounding area

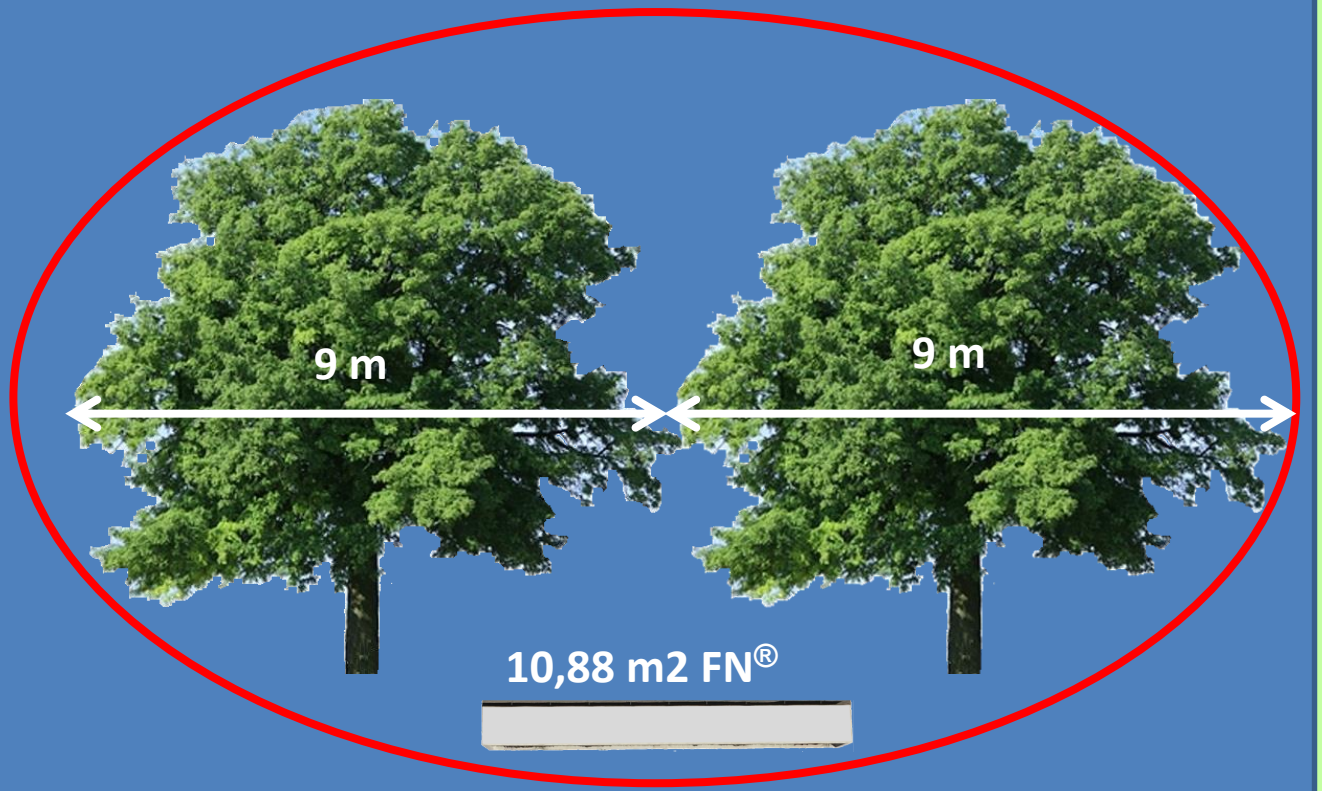
1 km of noise barriers with a height of 5m, which are painted on both sides FN, reduced for one day about 40% of the pollutants concentration of in the air volume of 700 to 900 thousands cubic meters. Price per coat – 131 000 €, functionality warranty - 10 years.

PHOTOCATALYTIC TECHNOLOGY AND THE TREES ARE COMPLEMENTARY

One FN painted container (10.88 m2 FN surface)clean from pollutants (NOx, Sox, PM10, PM2, 5 and PAH) the same volume of air as two trees with a treetop diameter of 9 meters (32.6 million cubic meters per year)

Trees absorb harmful pollutants from the air with their leaves, cooling the air, produce oxygen and shades noise. They can not be planted everywhere

FN coating photocatalytic technology can, together with trees, contribute to a significant improvement in urban air and industrial agglomerations



FN® TECHNOLOGY CERTIFIED AS A CONCRETE PROTECTION

- HIGH WATER PERMEABILITY Sd[m]=0.06
- HIGH ADHESION TO THE SURFACE 3.4MPa
- DURABILITY IN DECADES (SEE MANUFACTURER'S DECLARATION AND WARRANTY)
- CHEMICALLY RESISTANT (1542:2000; EN 13529:2004)
- FREEZE RESISTANT 3.2MPa AFTER 25 FREEZING CYCLES (ISO 4628-1,2)
- SALT WATER RESISTANT
- NO VOC; FULLY MINERAL COMPOSITE
- NO HEALTH RISK (ISO 16000-10, 16000-10/11)
- ENVIRONMENTALY SOUND AND SAFE
- MECHANICALLY REMOVABLE WITHOUT DAMAGE TO THE SURFACE
- FUNCTIONAL EVEN AT THICKNESS UNDER ONE MICRON
- PHYSICAL EFFECT – NO CHEMICALS INVOLVED
- LONG SHELF LIFE (3-5 YEARS)


TECHNICKÝ A ZKUŠEBNÍ ÚSTAV STAVEBNÍ PRAHA, s.p.
Technical and Test Institute for Construction Prague

Notified Body 1020

CERTIFICATE OF CONFORMITY
OF THE FACTORY PRODUCTION CONTROL

No. 1020 – CPR – 010034325

Products and systems for the protection and repair of concrete structures

Part 2: Surface protection systems for concrete

Coating (C) – Chemical Resistance (K 1)

FUNKČNÍ NÁTĚR (FN-1), FUNKČNÍ NÁTĚR (FN-3), FUNKČNÍ NÁTĚR (FN-3), PROTECTAM FN1®, PROTECTAM FN2®, PROTECTAM FN3®

produced by

Advanced Materials – JTJ s.r.o.
Kamenné Žehrovice č.p. 23, 273 01 Kladno, Nic 26763942

and produced in the manufacturing plant

Kamenné Žehrovice
Kamenné Žehrovice čp. 570, 27301 Kladno

This certificate attests that all provisions concerning the assessment and verification of constancy of performance described in Annex ZA of the standard

EN 1504-2:2004

under system 2+ for the performances set out in this certificate are applied and that

the factory production control fulfils all the prescribed requirements for these performances.

This certificate was first issued on 17 December 2014 and will remain valid as long as the test methods and/or factory production control requirements included in the harmonised standard, used to assess the performances of the declared essential characteristics, do not change, and the construction product, and the manufacturing conditions in the plant are not modified significantly, unless suspended or withdrawn by the factory production control certification body.

The stamp of the Notified Body 1020

Prague, 17 December 2014

Ing. Iveta Jirmusová
Deputy Manager of the Notified Body


TECHNICKÝ A ZKUŠEBNÍ ÚSTAV STAVEBNÍ PRAHA, s.p.
Technical and Test Institute for Construction Prague

Authorized Body 204
empowered by the Decision of COSMT No. 111/2013 of 6.5.2013
Branch Office 0100 – Prague

PRODUCT CERTIFICATE

No. 204/CS/2014/010-033869

Products for protective coatings and coatings of the mineral substrates and masonry

Type / variations: FUNKČNÍ NÁTĚR (FN-2), FUNKČNÍ NÁTĚR (FN-3), PROTECTAM FN2®, PROTECTAM FN3®

manufacturer:

Advanced Materials - JTJ s.r.o.

IN: 26763942
address: Kamenné Žehrovice čp. 23, 27301 Kladno
plant: Advanced Materials - JTJ s.r.o.
IN: 26763942
address: Kamenné Žehrovice čp. 570, 27301 Kladno
order: 2210050145

the Authorized Body has reviewed documents submitted by the manufacturer, performed the initial type-testing of the product samples, assessed factory production control and has stated, that

- this product fulfils the requirements derived from related essential requirements given in the above mentioned Government Decree and detailed in the national technical approval
  STO No. 010-0208/16 of 2.5.2012
- the factory production control complies with technical documentation and ensures that products put on the market meet the requirements laid down in the above mentioned national technical approval and comply with the technical documentation according to the provisions in Article 3 Clause 3 of the above mentioned Government Decree.

The Product Certification Report No. 010-0208/E of 16.12.2014 concerning the conclusion of the findings, evaluation and verification of constancy of the product performance for classification is to be considered as an integral part of this certificate.

This certificate remains valid as long as the requirements given in the national technical approval referred to hereinbefore or the manufacturing conditions in the factory or the factory production control itself are not modified significantly.

The Authorized Body performs at least once a 12 months the surveillance of proper function of the factory production control, selects samples at the factory and performs an audit-testing of samples to assess whether the characteristics of the product comply with the national technical approval according to Article 3 Clause 4 of the above mentioned Government Decree. If the Authorized Body identifies some failures, it is competent to cancel or change this certificate.

The person taking overall responsibility for this certificate

The stamp of the Authorized Body 204

Prague, 16 December 2014

Ing. Iveta Jirmusová
Deputy Manager of the Authorized Body 204

FN® TECHNOLOGY - EXAMPLES OF APPLICATION

NANO TiO_2 APPLICATIONS

Applied nano-technology

G-PHOTOCAT

AQUA-PULSE Pure Water Technology

NANOPIN

SEVENTH FRAMEWORK PROGRAMME

Award winning products

European Business Awards™

ČESKÁ HLAVA

Patented technologies

US 8,647,565

US 8,435,915

CA 2,707,319

SA 2010/04416

CN 200980106037

CN 200880120276

CZ 303366

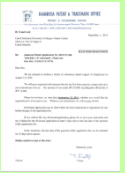
CZ 301315

CZ 301387

WO 2009/074120 A2

WO 2013000441

JP2010-537244



Member

The American Ceramic Society

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