NanoPhos

Pioneering Nanotechnology

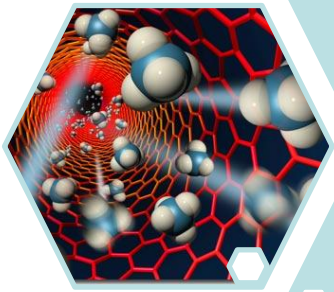
Nanocoatings for the surfaces protection and air depollution

What is your wish for today?

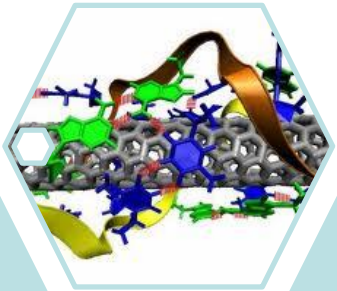
Ioannis Arabatzis, PhD, MBA
Managing Director NanoPhos SA

What's for today?

NanoPhos
Pioneering Nanotechnology

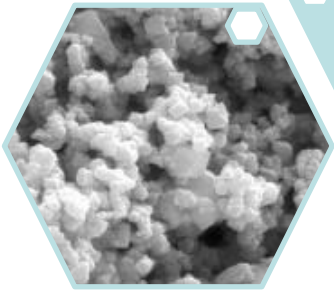


Self-Cleaning



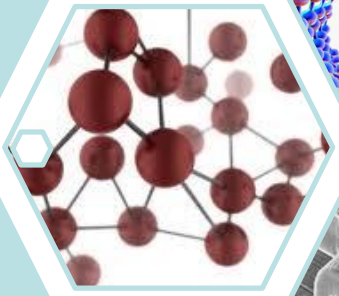
Anti-Corrosion

Structural Stabiliza-tion

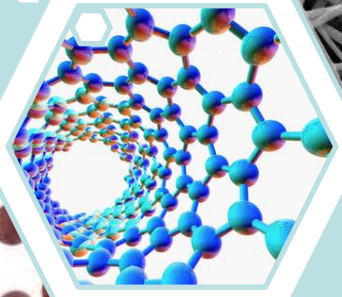


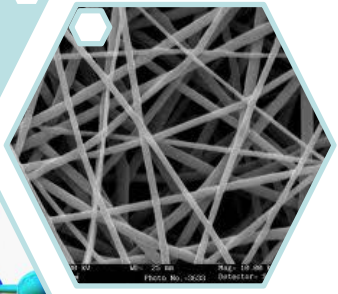
Energy

Strength in Buildings

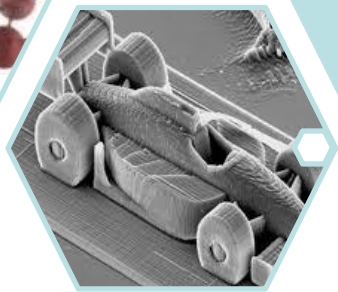


Water/Oil proofing





Thermal Insulating



A global technologically advanced company that produces easy to apply smart and environmentally friendly materials that solve common problems and save costs!

What is nanotechnology?

NanoPhos
Pioneering Nanotechnology

Nanotechnology refers to a field of applied science and technology whose theme is the control of matter on the atomic and molecular scale, generally 100 nanometers or smaller, and the fabrication of devices that lie within that size range. - *Wikipedia*

Green Building

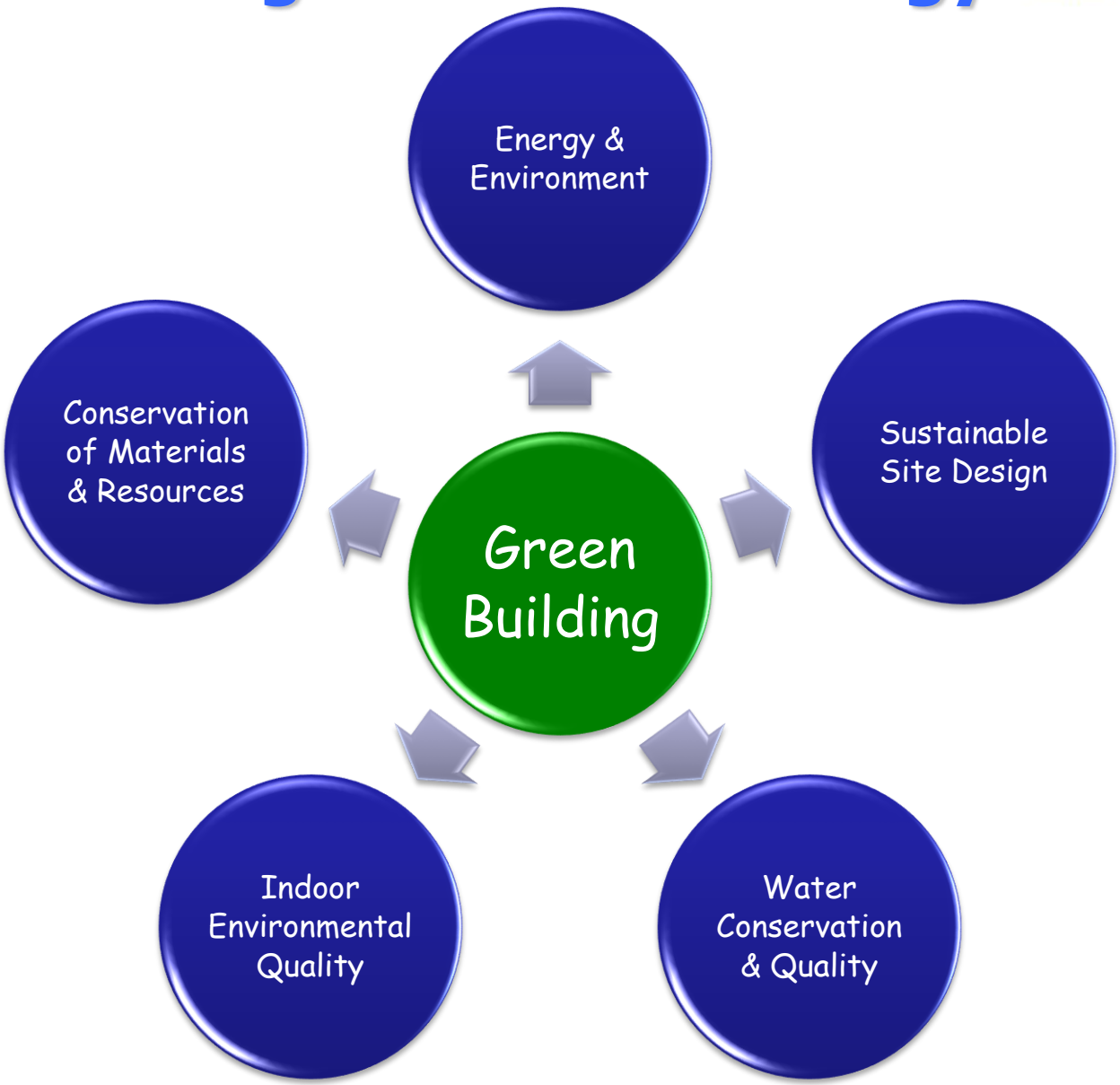
NanoPhos
Pioneering Nanotechnology

Principles - Definition

The ideal "green" project preserves and restores habitat that is vital for sustaining life and becomes a **net producer and exporter** of resources, materials, energy and water rather than being a net consumer. A green building is one whose construction and lifetime of operation assure **the healthiest possible environment** while representing the most efficient and least **disruptive use** of land, water, energy and resources. The optimum design solution is one that effectively **emulates all of the natural systems** and conditions of the pre-developed site - after development is complete.

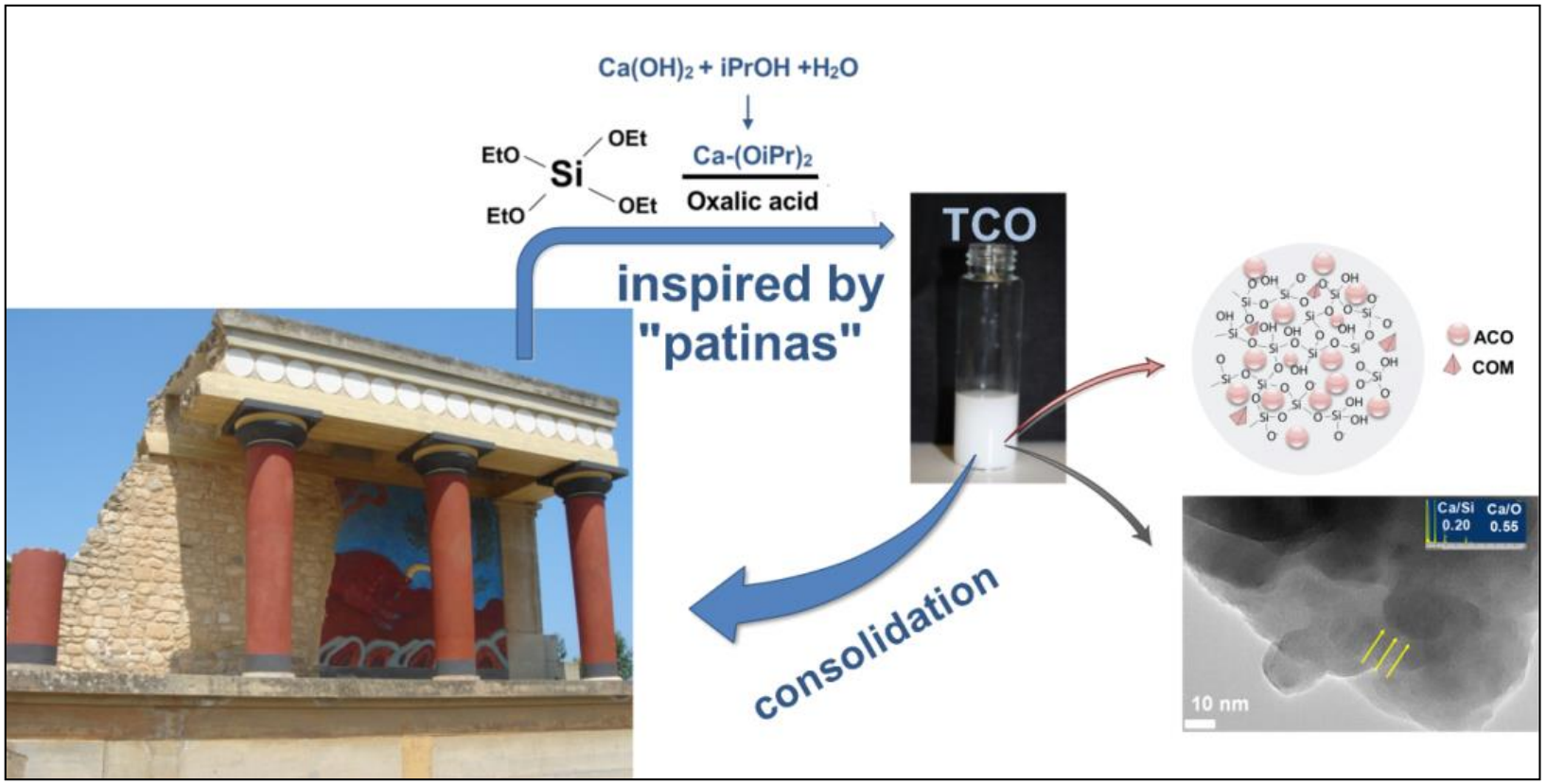
Green Building & Nanotechnology

NanoPhos
Pioneering Nanotechnology



Consolidating Nanoparticles

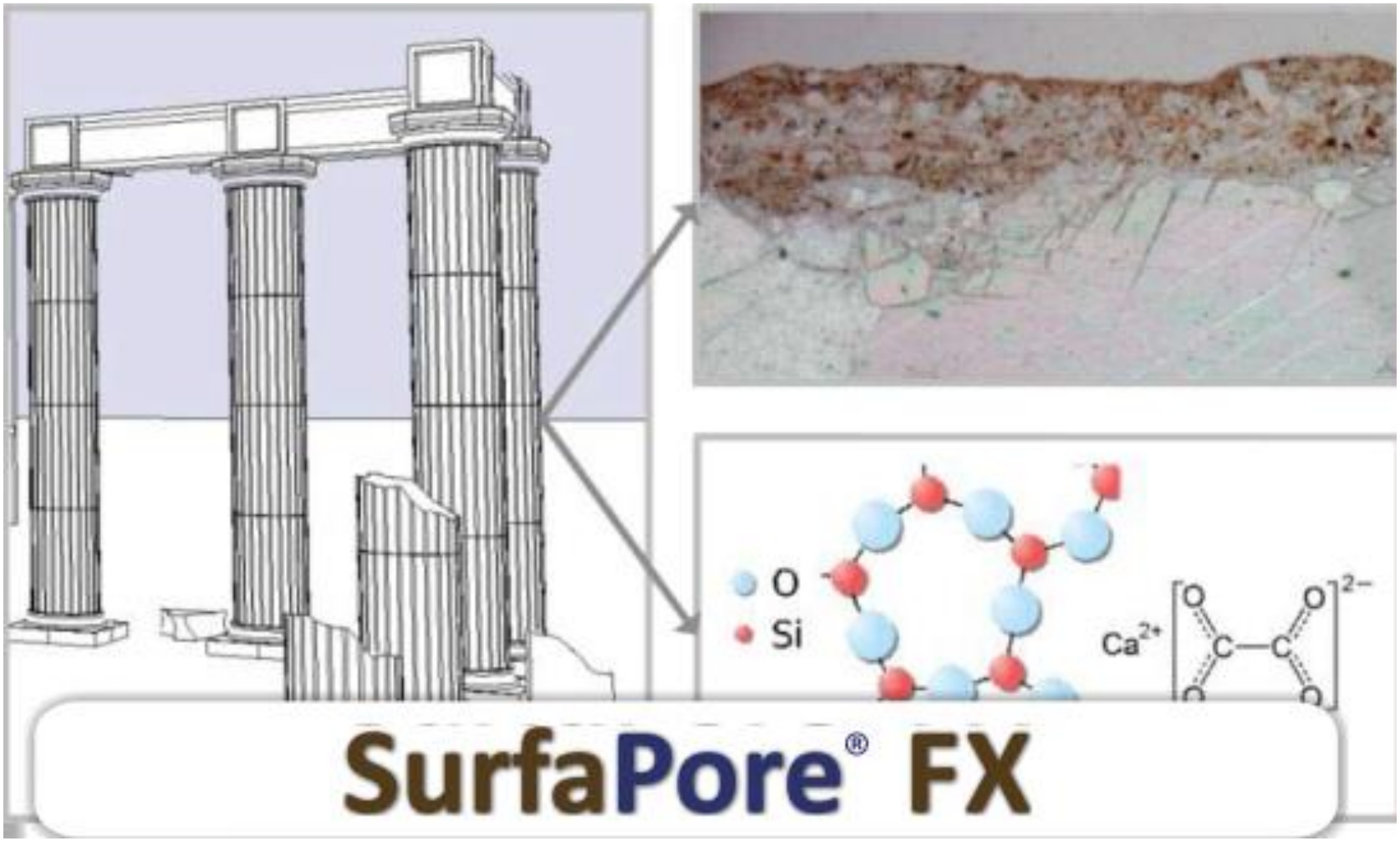
NanoPhos
Pioneering Nanotechnology



In Collaboration with Prof. Maravelaki, **MACHMoB Lab, TUC**

Consolidating Nanoparticles

NanoPhos
Pioneering Nanotechnology



In Collaboration with Prof. Maravelaki, **MACHMoB Lab, TUC**

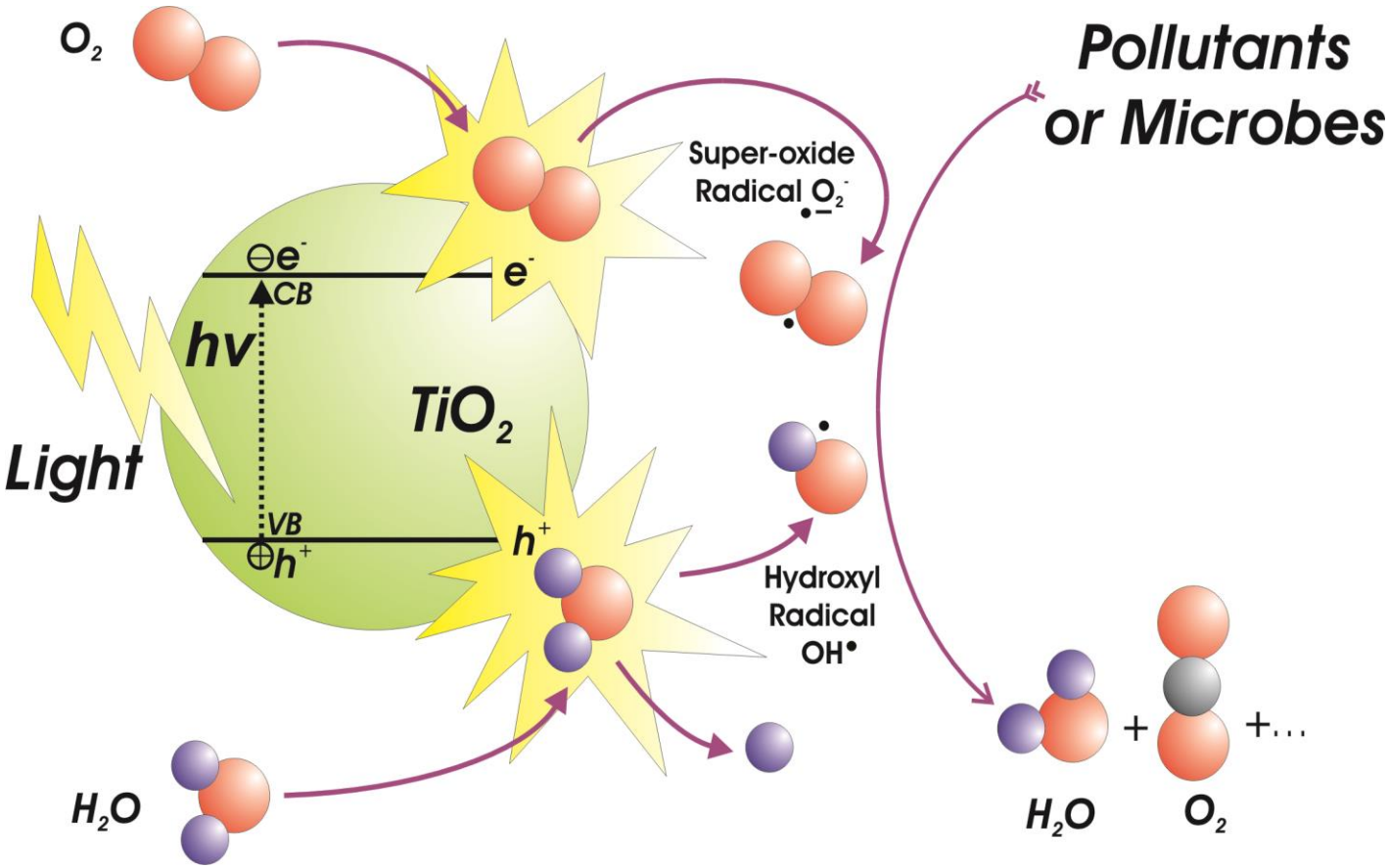
Consolidating Nanoparticles

NanoPhos
Pioneering Nanotechnology

- **Key Benefits:**
- Enhancement of compressive, tensile and flexural strength of building materials
- Stabilizes loose matter
- Does not change natural appearance
- Enhances the elastic Young's modulus
- Reduces water penetration
- Breathable - does not affect porosity or vapour permeability
- Resinless: Inorganic liquid formulation - Not film forming
- Deep penetrating
- Long lasting and weathering and UV resistant
- Easy surface application
- Biomimetic formulation
- Compatible with all natural or traditional building materials.
- Applicable on both interior and exterior surfaces.

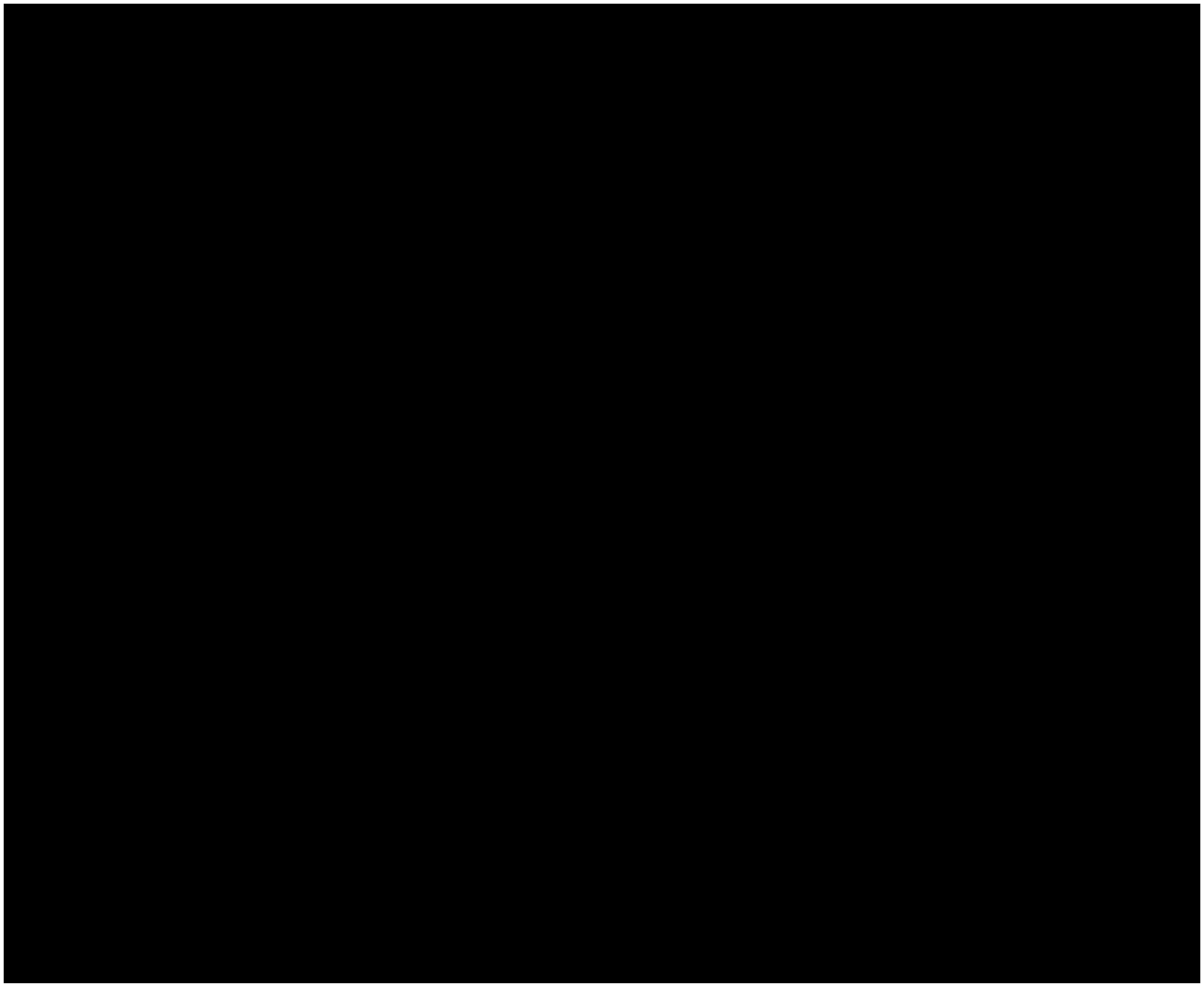
Photocatalytic Nanoparticles

NanoPhos
Pioneering Nanotechnology



Photocatalytic Nanoparticles

NanoPhos
Pioneering
Nanotechnology



Photocatalytic Nanoparticles

NanoPhos
Pioneering Nanotechnology

Photocatalysis using semiconductors under irradiation has been extensively studied for about three decades. In 1972, Fujishimna and Honda* discovered the photocatalytic splitting of water on TiO_2 electrodes. This event marked the beginning of a new era in heterogeneous photocatalysis.

*A. Fujishima and K. Honda, Nature 238, 37 (1972).

TOTO Ltd., EcoClean®

When was the last time you saw a photocatalytic coating??

Photocatalytic Nanoparticles

NanoPhos
Pioneering Nanotechnology

Why Photocatalysts did not find their way to the market?

TiO_2 NanoParticles are blended with other matrices
COST

TiO_2 NanoTechnology is pushed to the visible response range
APPLICABILITY - COST

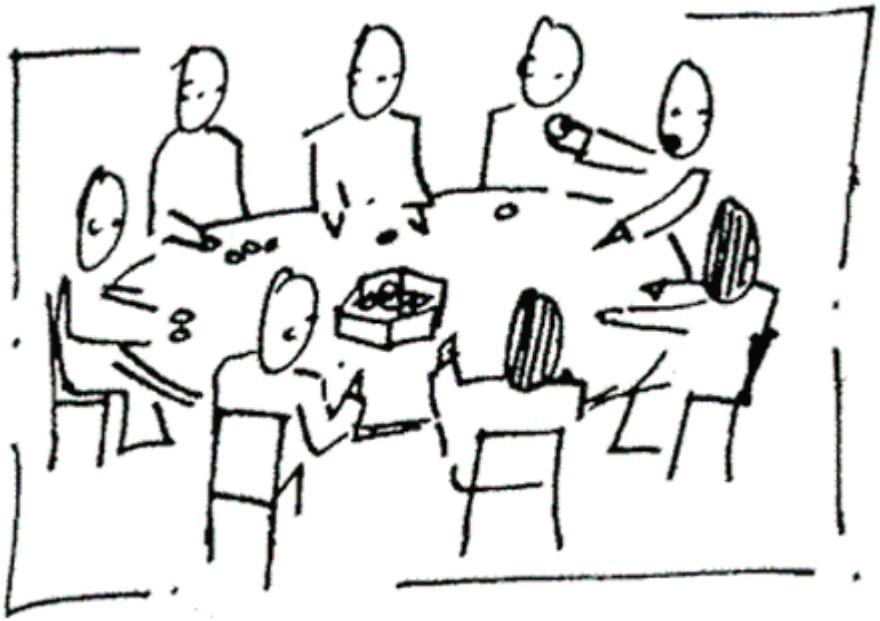
TiO_2 NanoParticles do NOT bind on substrates
LIMITED OPERATIONAL LIFETIME

TiO_2 NanoTechnology is pushed more than the actual benefit
TECH BARRIER

Photocatalytic Nanoparticles

NanoPhos
Pioneering Nanotechnology

The SurfaShield® Approach



Hear Carefully the Market-Need Whispers

Do not Over-Push Academic High-Tech Achievements

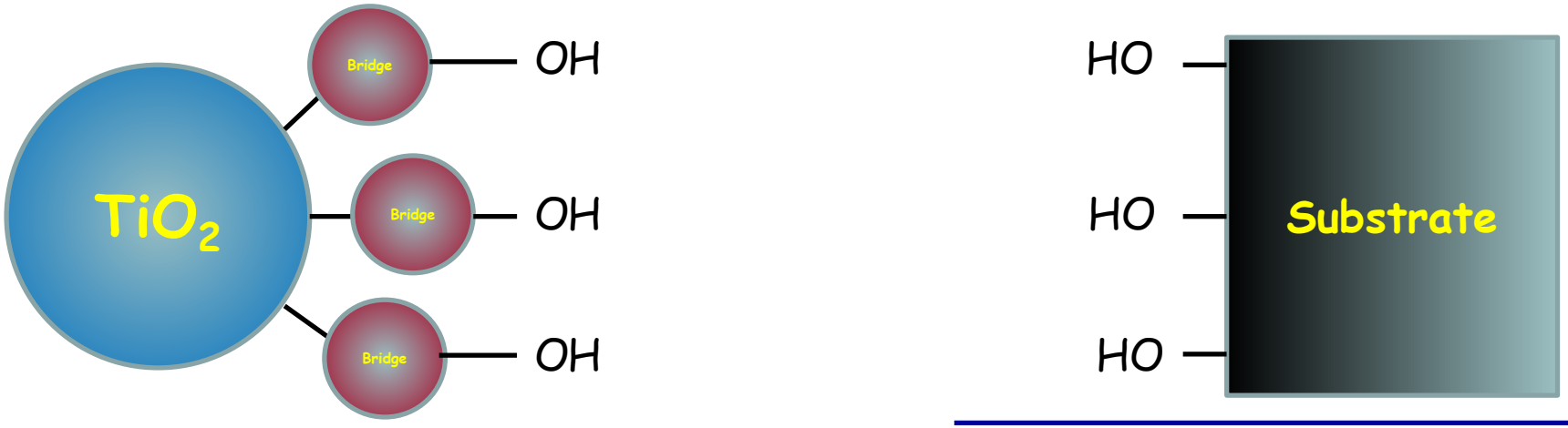
- TiO_2 coatings should be sprayable or brushable
  - 380-390nm photons are abundant out there
- TiO_2 coatings should be self-adhesive at Room Temperature

Photocatalytic Nanoparticles

NanoPhos
Pioneering Nanotechnology

The Traditional Approach Requires Heat Treatment

The SurfaShield® Approach No Heat Treatment is Required



Photocatalytic Nanoparticles

NanoPhos
Pioneering Nanotechnology

Project:
Self-Cleaning and continuous protection of porous building surfaces such as cement, stones, walls and grout

Industry:
Building & Construction

Product:
SurfaShield C

Key Benefits:
- Self-Cleaning
- Self-Sterilizing
- Superhydrophilic
- Decomposes Odours
- Air purifier
- Continuous Action
- Environmentally friendly cleaning technology

Applications:
- Self-Cleaning of Walls
- Protection from mould growth and organic stains
- Stone and Monument Protection
- Environmental Restoration
- Prevents pollutant adhesion
- Decomposes Pollutants
- Bacterial Growth Inhibition
- Exhaust Gas Break-Down

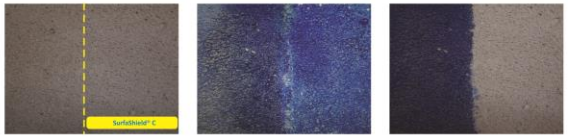
Packaging:
1L, 4L, 10L, 30L Containers, 1000L IBCs

www.NanoPhos.com

SurfaShield® C

Photocatalytic Self-Cleaning Nanotechnology for the Protection of Porous Surfaces

SurfaShield C coated surfaces decompose organic stains and pollutants, prevent microbial and mould growth, purify the air, remove odours. It is an active nanotechnology formulation that can be easily applied on exterior porous surfaces, such as cement, render or plaster, mortar grout, walls, stones or even unpolished marble. By harnessing the surrounding light, treated surfaces become Self Cleaning and Self Sterilizing. The action of SurfaShield C is permanent, as it chemically bonds on the surfaces applied. SurfaShield C modified surfaces are safer, without the use of hazardous disinfectants or chemicals, and are preserved as new.



SurfaShield C Half-treated cement surface

Blue ink stain is placed on the cement surface

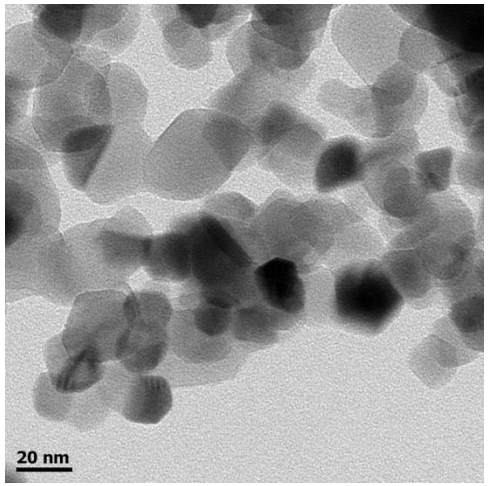
Decomposition of the Blue ink stain, after exposure to sunlight for 5 hours

SurfaShield® is a registered trademark of
NanoPhos SA
PO Box 519,
Science & Technology Park of Lavrio
Lavrio 19500, Greece
T: +302292069312 F: +302292069303
E: info@NanoPhos.com

NanoPhos
Pioneering Nanotechnology

The SurfaShield® Approach

- Water based
- Curing within 4h
- Abrasion Resistant
  - Class III on ceramic tile
- Easy to apply
- Affordable



Photocatalytic Nanoparticles

NanoPhos
Pioneering Nanotechnology

Indoor Air Quality

空气质量等级	颜色区分	判定
符合国家标准		合格
1-5倍超标		不健康
5-10倍超标		非常不健康
10倍以上超标		危险

Area	Application Date	Pollutant	Concentration (mg/m^3)	Critical Value (mg/m^3)	Factor	Application Date	Measurement Date	Concentration (mg/m^3)	Factor	% Reduction	Measurement Date	Concentration (mg/m^3)	Factor	% Reduction	Measurement Date	Concentration (mg/m^3)	Factor	% Reduction
Appartment A	31/12/15	Formaldehyde	0.14	0.12	1.17	31/12/15	3/1/16	0.06	0.5	57%	3/1/16	0.05		64%	4/1/16			
	31/12/15	Benzene	0.16	0.09	1.78	31/12/15	3/1/16	0.08	0.9	50%	3/1/16				4/1/16			
	31/12/15	TVOC	0.23	0.6	0.38	31/12/15	3/1/16	-	-		3/1/16				4/1/16			
Apartment B	1/1/16	Formaldehyde	0.06	0.12	0.50	1/1/16	3/1/16	0.04	0.3	33%	3/1/16	0.03		50%	4/1/16			
	1/1/16	Benzene	0.34	0.09	3.78	1/1/16	2/1/16	0.18	2.0	47%	3/1/16	0.12	1.3	65%	4/1/16	0.07	0.78	79%
	1/1/16	TVOC	0.83	0.6	1.38	1/1/16	2/1/16	0.62	1.0	25%	3/1/16	0.32	0.5	61%	4/1/16	0.20	0.33	76%
Appartment C	1/1/16	Formaldehyde	0.06	0.12	0.50	2/1/16	3/1/16	-	-		4/1/16		-		5/1/16			
	1/1/16	Benzene	0.21	0.09	2.33	2/1/16	3/1/16				4/1/16		-		5/1/16	0.06	0.7	71%
	1/1/16	TVOC	0.96	0.6	1.60	2/1/16	3/1/16				4/1/16		-		5/1/16	0.52	0.9	46%
Appartment D	1/1/16	Formaldehyde	0.09	0.12	0.75	2/1/16	3/1/16				4/1/16	0.05	0.4	44%	5/1/16			
	1/1/16	Benzene	0.18	0.09	2.00	2/1/16	3/1/16				4/1/16				5/1/16	0.04	0.4	78%
	1/1/16	TVOC	0.84	0.6	1.40	2/1/16	3/1/16				4/1/16				5/1/16	0.49	0.8	42%
Dining Hall	2/1/16	Formaldehyde	0.02	0.12	0.17	2/1/16	3/1/16		0.0	100%	4/1/16				5/1/16			
	2/1/16	Benzene	0.12	0.09	1.33	2/1/16	3/1/16	0.05	0.6	58%	4/1/16				5/1/16			
	2/1/16	TVOC	0.57	0.6	0.95	2/1/16	3/1/16		-		4/1/16				5/1/16			
Wine Bar Area	2/1/16	Formaldehyde	0.04	0.12	0.33	2/1/16	3/1/16		-		4/1/16				5/1/16			
	2/1/16	Benzene	0.19	0.09	2.11	2/1/16	3/1/16	0.10	1.1	47%	4/1/16	0.05	0.6	74%	5/1/16			
	2/1/16	TVOC	0.95	0.6	1.58	2/1/16	3/1/16	0.37	0.6	61%	4/1/16				5/1/16			
KTV	2/1/16	Formaldehyde	0.16	0.12	1.33	2/1/16	3/1/16	0.11	0.9	31%	4/1/16				5/1/16			
	2/1/16	Benzene	1.21	0.09	13.44	2/1/16	3/1/16	0.94	10.4	22%	5/1/16	0.66	7.3	45%	8/1/16	0.12	1.3	90%
	2/1/16	TVOC	2.35	0.6	3.92	2/1/16	3/1/16	2.22	3.7	6%	5/1/16	1.46	2.4	38%	8/1/16	0.49	0.8	79%
Fitness - Gym	2/1/16	Formaldehyde	0.02	0.12	0.17	3/1/16	4/1/16		-		5/1/16				8/1/16			
	2/1/16	Benzene	0.25	0.09	2.78	3/1/16	4/1/16	0.07	0.8	72%	5/1/16				8/1/16			
	2/1/16	TVOC	0.84	0.6	1.40	3/1/16	4/1/16	0.52	0.9	38%	5/1/16				8/1/16			
Appartment E	3/1/16	Formaldehyde	0.1	0.12	0.83	3/1/16	4/1/16	0.07	0.6	30%	5/1/16				8/1/16			
	3/1/16	Benzene	0.13	0.09	1.44	3/1/16	4/1/16	0.08	0.9	38%	5/1/16				8/1/16			
	3/1/16	TVOC	0.8	0.6	1.33	3/1/16	4/1/16	0.10	0.2	88%	5/1/16				8/1/16			
	3/1/16	Formaldehyde	0.07	0.12	0.58	4/1/16	5/1/16	0.05	0.5	29%	5/1/16				8/1/16			
	3/1/16	Benzene	0.19	0.09	2.11	4/1/16	5/1/16	0.08	0.9	58%	5/1/16				8/1/16			
	3/1/16	TVOC	0.61	0.6	1.02	4/1/16	5/1/16	0.37	0.6	39%	5/1/16				8/1/16			
Appartment F	4/1/16	Formaldehyde	0.13	0.12	1.08	4/1/16	6/1/16	0.00	0.0	100%	7/1/16				8/1/16			
	4/1/16	Benzene	0.32	0.09	3.56	4/1/16	6/1/16	0.07	0.8	78%	7/1/16				8/1/16			
	4/1/16	TVOC	0.96	0.6	1.60	4/1/16	6/1/16	0.23	0.4	76%	7/1/16				8/1/16			
Appartment G	5/1/16	Formaldehyde	0.19	0.12	1.58	5/1/16	6/1/16	0.02	0.2	89%	7/1/16				8/1/16			
	5/1/16	Benzene	0.13	0.09	1.44	5/1/16	6/1/16	0.06	0.7	54%	7/1/16				8/1/16			
	5/1/16	TVOC	0.8	0.6	1.33	5/1/16	6/1/16	0.26	0.4	68%	7/1/16				8/1/16			
SPA	5/1/16	Formaldehyde	0.05	0.12	0.42	5/1/16	6/1/16	0.07	0.6	-40%	7/1/16				8/1/16			
	5/1/16	Benzene	0.62	0.09	6.89	5/1/16	6/1/16	0.18	2.0	71%	7/1/16	0.04	0.4	94%	8/1/16			
	5/1/16	TVOC	2.11	0.6	3.52	5/1/16	6/1/16	0.52	0.9	75%	7/1/16				8/1/16			
Room A	5/1/16	Formaldehyde	0.12	0.12	1.00	5/1/16	6/1/16	0.01	0.1	92%	7/1/16				8/1/16			
	5/1/16	Benzene	0.15	0.09	1.67	5/1/16	6/1/16	0.05	0.6	67%	7/1/16				8/1/16			
	5/1/16	TVOC	0.73	0.6	1.22	5/1/16	6/1/16	0.29	0.5	60%	7/1/16				8/1/16			
							One Day Average:		54%		Two Days Average:		59%		Three Days Average:		70%	

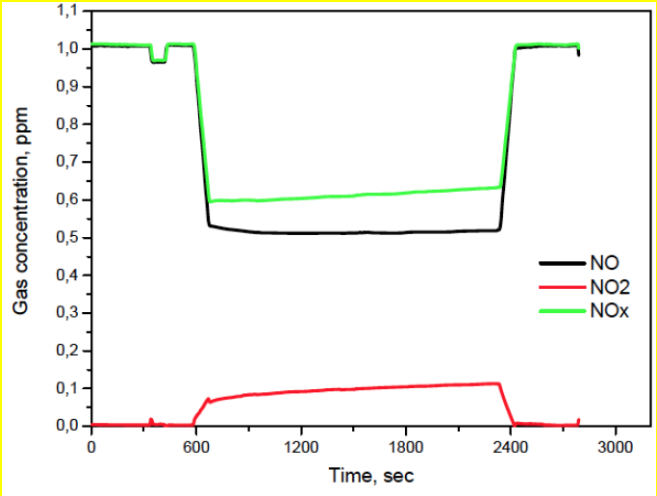
Photocatalytic Nanoparticles

NanoPhos
Pioneering Nanotechnology

SurfaShield® C

Plant a Tree in Your Room

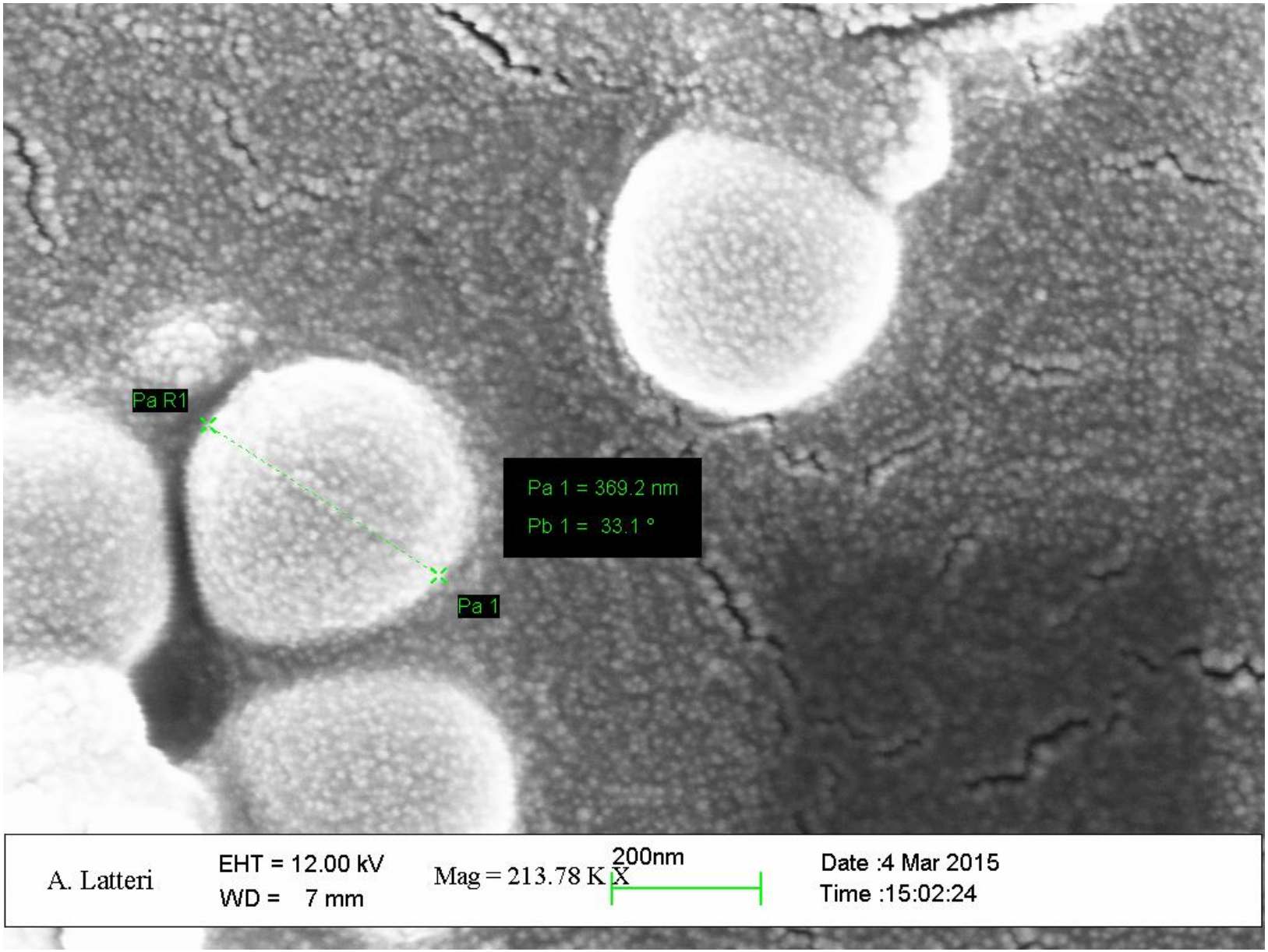
In terms of NOx pollutants 10m² have the same exterior cleaning power as one tree



SurfaShield C has been tested under the **EN ISO 22197-1** Test method for air-purification performance of semiconducting photocatalytic materials — Removal of nitric oxide. The sample under examination exhibited 29% NOx removal. This means that the concentration of NOx dropped from 1ppm down to 0,69ppm. As 1ppm equals to 1mg of NOx in 1Kg of air and the density of air is 1,225Kg.m^{-3}, concentration is translated to 1mg of NOx in 1000/1,225L of air or 1,225*10^{-3} mg of NOx per L of air. The sample was illuminated for 1700s and, at a NOx flow rate of 3L per min, it practically means that 21,86*10^{-3} mg of NOx were eliminated (28.33min x 3L/min x (1-0.69) x 1,225*10^{-3} mg/L = 21,86*10^{-3} mg). Therefore, a sample with surface area of 9.8cm x 4.9cm = 48.02 cm^2 eliminated 21,86*10^{-3} mg of NOx in 28.33min, under 10W.m^{-2} irradiation. A reasonable estimate of 0,155 Kg of NO_2 is removed by the average mature tree (62-76 cm dbh, diameter breast height) in one year. The average estimate of effective daylight hours (based on 120 W.m^{-2}) in the central regions of the U.S. is 7,1 hours per day (2591,5 hours per year). If 5% of those 120 W.m^{-2} is UV, then the UV intensity is 6 W.m^{-2}. Let's drop down the performance of the test by 40%, as in lab conditions we had 10 W.m^{-2}: a sample with surface area of 48.02 cm^2 eliminated 13,12*10^{-3} mg of NOx in 28.33min or 27,79*10^{-3} mg of NOx per hour. Therefore: each m^2 of SurfaShield C, in an hour's time, can eliminate 27,79*10^{-3} mg /48,02*10^{-4} = 5,79 mg of NOx. Therefore: each m^2 of SurfaShield, in a year's time, can eliminate 2591,5 h/year x 27,79*10^{-3}*10^{-3}g/h x 1sqm/48.02*10^{-4} m^2 = 15g of NOx. **Practically this means 10 sqm of SurfaShield C match the performance of a tree!**

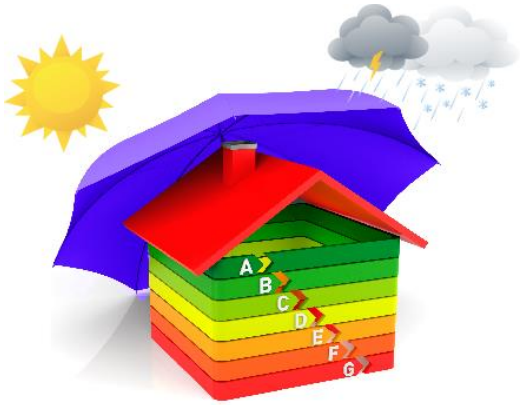
nanoThermal Insulation

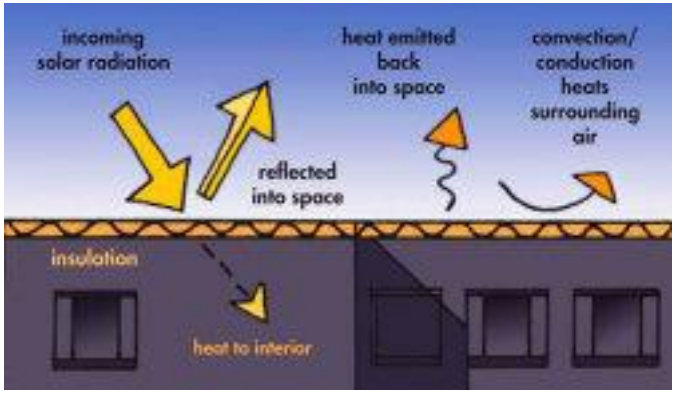
NanoPhos
Pioneering Nanotechnology



nanoThermal Insulation

NanoPhos
Pioneering Nanotechnology



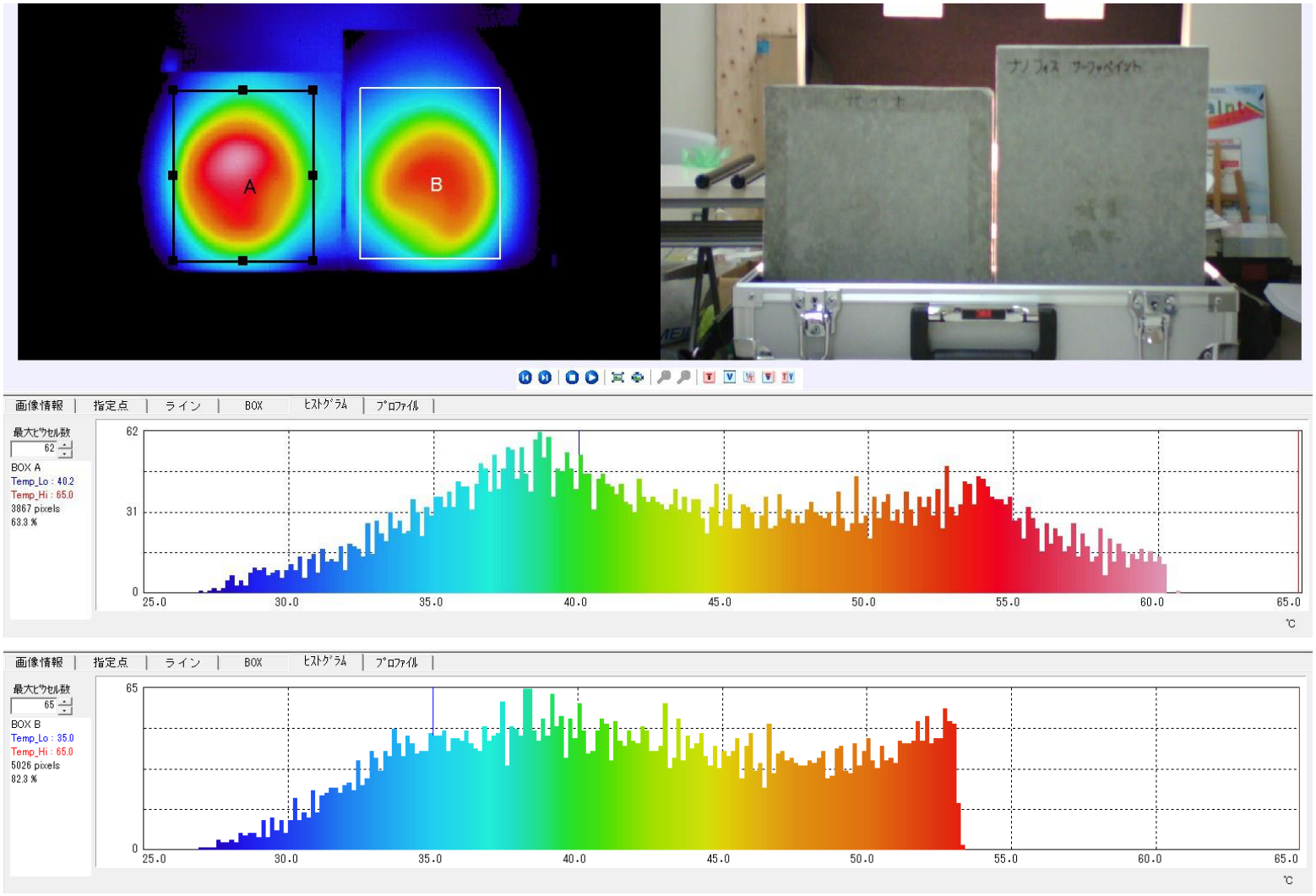


	VIS (380-780 nm)	IR (700-2200 nm)	Solar (250-2200 nm)	Emitance	SRI	Thermal Conductivity ($Wm^{-1}K^{-1}$)
SurfaPaint ThermoDry Elastomeric Roof Paint	0,9479	0,9476	0,9158	0,91	**117**	0,09678
SurfaPaint ThermoDry Exterior	0,9404	0,9419	0,9098	0,91	**116**	0,10789
SurfaPaint ThermoDry Interior	0,9269	0,9464	0,9053	0,91	**115**	0,09599
SurfaPaint ThermoDry Metals	0,9228	0,9397	0,8999	0,91	**114**	0,10014
SurfaPaint Kirei	0,9571	0,9422	0,9184	0,91	**117**	0,44872

The above SRI values indicate that all ThermoDry based products far exceed the LEED specifications (Sustainables Sites Credit 7.2 – Heat Island Effect), which indicate a **minimum Solar Reflective Index (SRI) of 78**. Further, the Energy Star requires a **minimum Solar Reflectance of 0.65**, which is again far exceeded by all ThermoDry based products.

nanoThermal Insulation

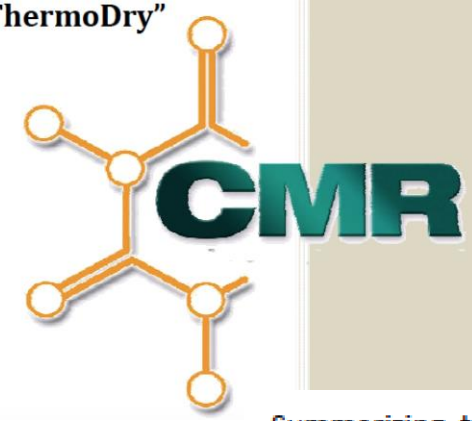
NanoPhos
Pioneering Nanotechnology



nanoThermal Insulation

NanoPhos
Pioneering Nanotechnology

Comparative measurements of Steady Thermal transmittance And of Dynamic Thermal properties of a masonry wall coated with "Surfapaint ThermoDry"



Summarizing, the data found were:

Physical Property	Wall before coating	Coated with "Surfapaint ThermoDry"
Periodic Thermal Transmittance **Yie (W/m^2K)**	0,473 W/m^2K	0,108 W/m^2K
Decrement Factor **fa**	0,66	0,16
Time Shift **Wa (h)**	11 h	13,5 h

The data obtained are comparable with an EPS panel of about 11 cm with regard to the time shift and with a panel of about 7 cm in EPS as regards the decrement factor (data obtained through simulation software).


NanoPhos
Pioneering
Nanotechnology