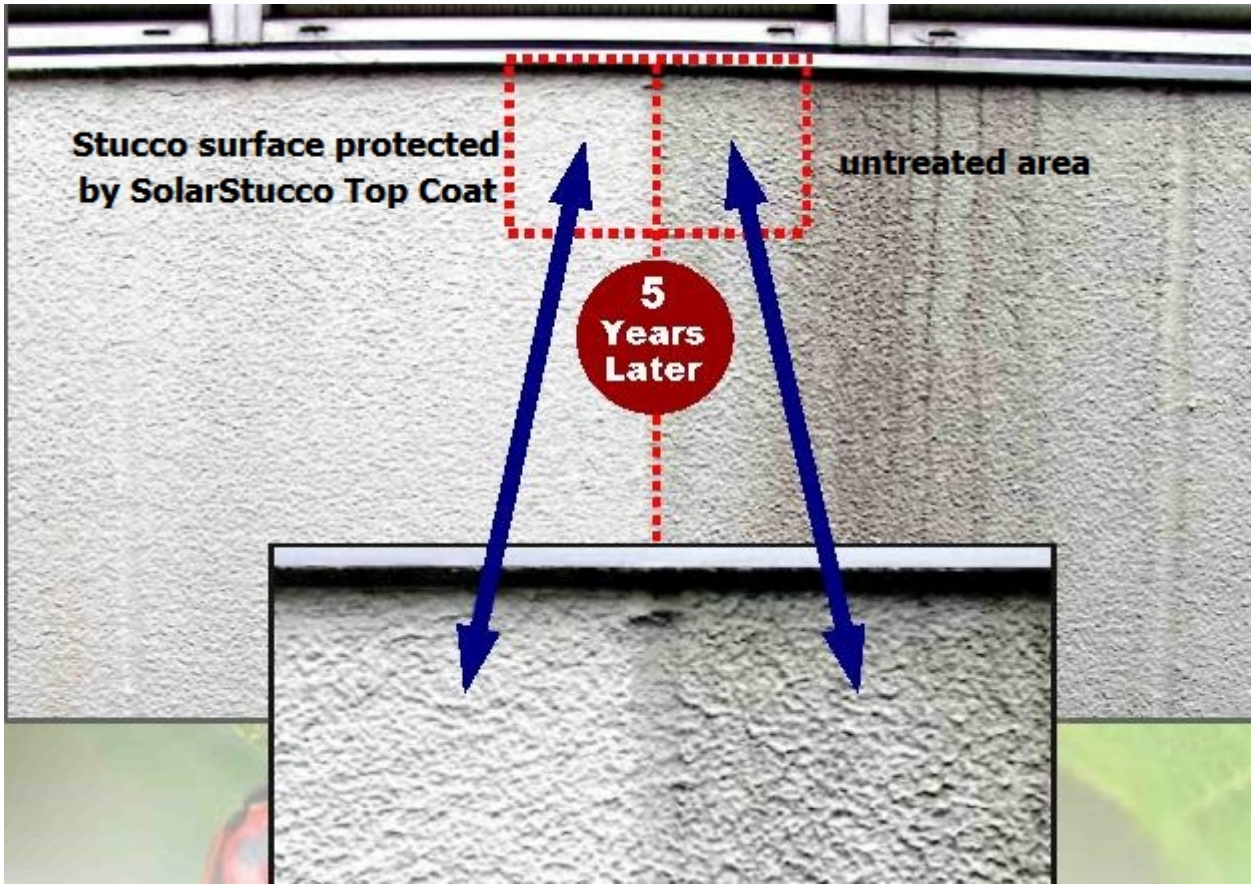
Technical Background

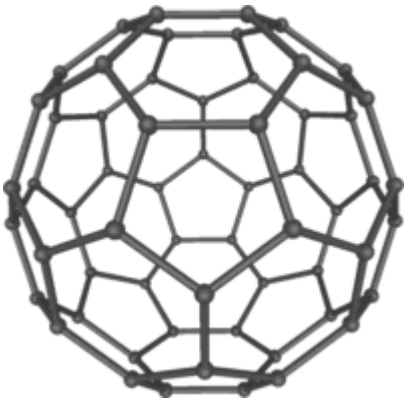
learn more about technology

solar stucco™



What is nano technology?

Nanotechnology refers broadly to a field of applied science and technology whose unifying theme is the control of matter on the molecular level in scales smaller than 1 micrometer, normally 1 to 100 nanometers, and the fabrication of devices within that size range.

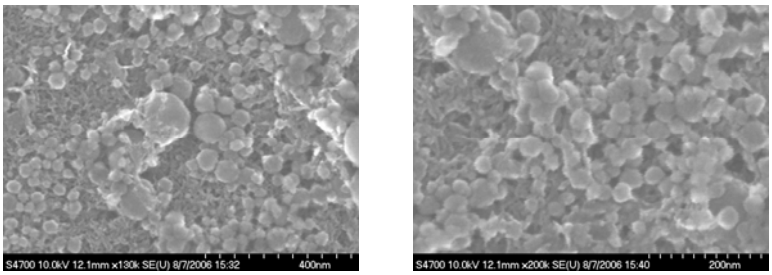


Buckminsterfullerene C60, also known as the buckyball, is the simplest of the carbon structures known as fullerenes. Members of the fullerene family are a major subject of research falling under the nanotechnology umbrella.

It is a highly multidisciplinary field, drawing from fields such as applied physics, materials science, colloidal science, device physics, supra molecular chemistry, and even mechanical and electrical engineering. Much speculation exists as to what new science and technology may result from these lines of research. Nanotechnology can be seen as an extension of existing sciences into the nanoscale, or as a recasting of existing sciences using a newer, more modern term.

Two main approaches are used in nanotechnology. In the "bottom-up" approach, materials and devices are built from molecular components which assemble themselves chemically by principles of molecular recognition. In the "top-down" approach, nano-objects are constructed from larger entities without atomic-level control. The impetus for nanotechnology comes from a renewed interest in colloidal science, coupled with a new generation of analytical tools such as the atomic force microscope (AFM), and the scanning tunneling microscope (STM). Combined with refined processes such as electron beam lithography and molecular beam epitaxy, these instruments allow the deliberate manipulation of nanostructures, and led to the observation of novel phenomena.

Examples of nanotechnology in modern use are the manufacture of polymers based on molecular structure, and the design of computer chip layouts based on surface science. Despite the great promise of numerous nanotechnologies such as nano particles, quantum dots and nanotubes, real commercial applications have mainly used the advantages of colloidal nanoparticles in bulk form, such as suntan lotion, cosmetics, functional coatings, and stain resistant clothing.



SEM Photo for nano TiO2

Fundamental concepts – nanometer

One nanometer (nm) is one billionth, or 10^{-9} of a meter. For comparison, typical carbon-carbon bond lengths, or the spacing between these atoms in a molecule, are in the range .12-.15 nm, and a DNA double-helix has a diameter around 2 nm. On the other hand, the smallest cellular lifeforms, the bacteria of the genus Mycoplasma, are around 200 nm in length. To put that scale in to context the comparative size of a nanometer to a meter is the same as that of a marble to the size of the earth.

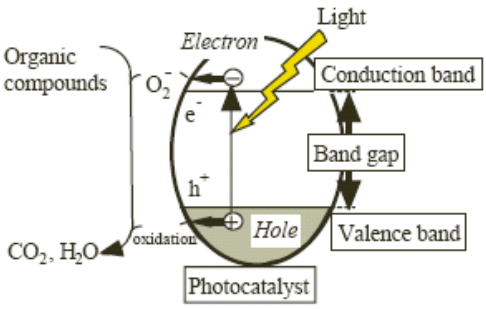
Photocatalysis Mechanism

When photocatalyst titanium dioxide (TiO_2) absorbs Ultraviolet (UV) radiation from sunlight or illuminated light source (fluorescent lamps), it will produce pairs of electrons and holes.

The electron of the valence band of titanium dioxide becomes excited when illuminated by light. The excess energy of this excited electron promoted the electron to the conduction band of titanium dioxide therefore creating the negative-electron (e-) and positive-hole (h+) pair. This stage is referred as the semiconductor's 'photo-excitation' state. The energy difference between the valence band and the conduction band is known as the 'Band Gap'. Wavelength of the light necessary for photo-excitation is:

1240 (Planck's constant, h) / 3.2 eV (band gap energy) = 388 nm

The positive-hole of titanium dioxide breaks apart the water molecule to form hydrogen gas and hydroxyl radical. The negative-electron reacts with oxygen molecule to form super oxide anion. This cycle continues when light is available.



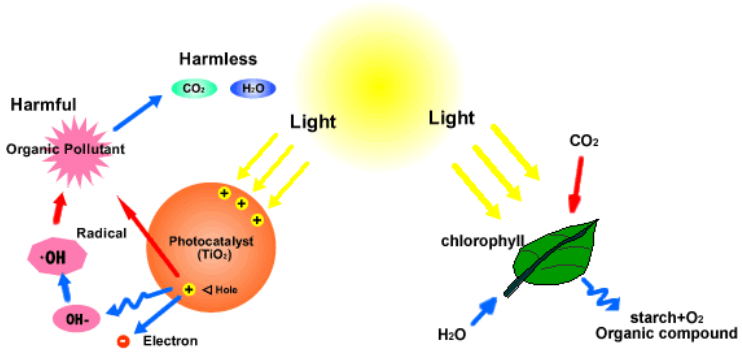
Mechanism of Photocatalysis

Fundamental concepts – what's photocatalyst (photocatalysis)?

The word photocatalysis is a composite word which is composed of two parts, "photo" and "catalysis".

Catalysis is the process where a substance participates in modifying the rate of a chemical transformation of the reactants without being altered or consumed in the end. This substance is known as the catalyst which increases the rate of a reaction by reducing the activation energy.

Generally speaking, photocatalysis is a reaction which uses light to activate a substance which modifies the rate of a chemical reaction without being involved itself. And the photocatalyst is the substance which can modify the rate of chemical reaction using light irradiation.



Photocatalyst & Chlorophyll

Chlorophyll of plants is a typical natural photocatalyst. The difference between chlorophyll photocatalyst to man-made nano TiO_2 photocatalyst (here below mentioned as photocatalyst) is, usually chlorophyll captures sunlight to turn water and carbon dioxide into oxygen and glucose, but on the contrary photocatalyst creates strong oxidation agent and electronic holes to breakdown the organic matter to carbon dioxide and water in the presence of photocatalyst, light and water.

Gens Nano SolarStucco - Self-cleaning Coating Solution

Overview

Gens Nano self-cleaning coating is a special nano photocatalyst coating combined by photocatalyst and nano technology.

Generally, detergents reduce the surface tension of water and the contact angle is lowered. When the surface of nano level photocatalytic film is exposed to light, the contact angle of the photocatalyst surface with water is reduced gradually. After enough exposure to light, the surface reaches super-hydrophilicity. In other words, it does not repel water at all, so water cannot exist in the shape of a drop, but spreads flatly on the substrate. The hydrophilic nature of titanium dioxide, coupled with the gravity, will enable the dust particles to be swept away following the water stream (rain), thus making the key feature of self-cleaning and easy-cleaning.

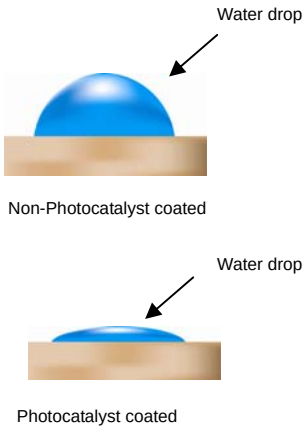
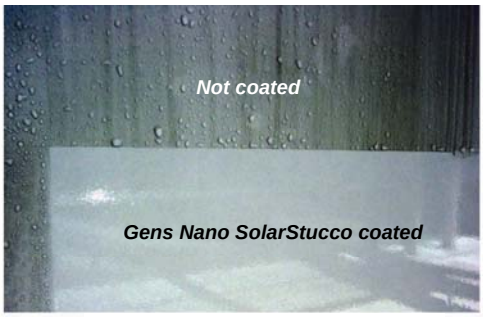


Figure-1

Difference between coated and non-coated surface



Gens Nano Coating on Aluminum panel

Features of Photocatalyst

1. Super Hydrophilicity

The photocatalyst coating will show the super hydrophilicity feature under light irradiation. The contact angle of the surface will be reduced to <10 degree, which brings 5 benefits of this feature.

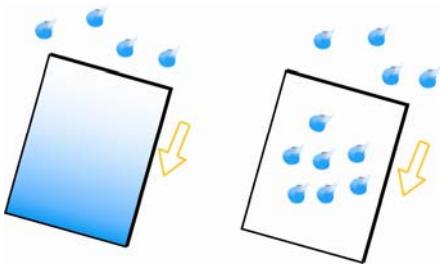
I. *The water will not form a water drop on the surface when its contact angle is <10°, it will form a water film. The water will be in flat condition on the surface. This will help to reduce the water strain after rain wash.*

II. *Generally, detergents reduce the surface tension of water and the contact angle is lowered. We call it hydrophilicity feature. Gens Nano coating's super-hydrophilicity simulates this feature, so that a single surface wash with water on can reach the same effect as a traditional cleaning with detergent. So after a rain wash, the surface will be cleaned like after using traditional wash with detergent.*

III. *The hydrophilic feature can keep the water on the surface and the entire surface can be covered with only a little water. This will prompt its transpiration. So if it is coated on a building wall, the building will need less energy to cool down in summer. If it is coated on a panel in the compressor of air condition, the air condition system will show better efficiency.*

IV. *Since the dust in the air usually has a high contact angle, the low contact angle of the coated surface will avoid the dust adsorption.*

V. *The hydrophilicity can make the surface with no water drops while raining, so it looks cleaner in rain.*



Photocatalyst coated **Non-photocatalyst coated**

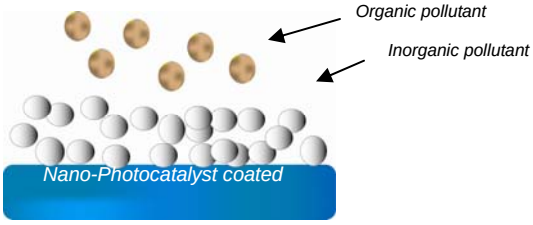
2. Organic Decomposition Feature.

When the coating is exposed to sunlight, it can decompose almost all organic substances on the surface, which have the following 2 benefits.

i. *When the coat decomposes attached organic pollutant on the surface, it will make the surface cleaner, and after the molecule is decomposed, other inorganic pollutant will unlikely stay on the surface, and can be easily washed down by rain or other cleaning method.*

ii. *The coat can also purify the air around the building. Actually, the product is used to purify the NOx gas generated by the car pollution. When the road side walls are coated, the surface will get clean and the environment around can be greatly improved as well.*

(Organic and inorganic pollutants are strongly adsorbed on the surface of the wall which is coated with photocatalyst.)



(At the presence of light, the photocatalyst will decompose organic pollutants. Without the adhesion of organic pollutant, inorganic pollutant left on the surface can be easily swept away.)

3. Anti-bacterial and Anti-mold

There are 2 benefits of this feature.

i. *The product can prevent mold or moss, so it will keep building exterior cleaner.*

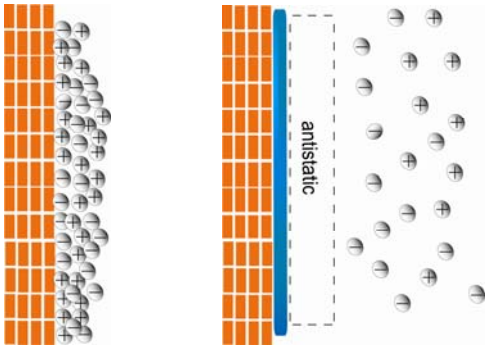
ii. *The anti-bacterial feature will not only effect the coated surface but also kill and decompose bacteria in the surrounding air because of the air flow.*

4. Anti-UV Feature

Gens Nano can absorb some UV and protect the surface. The UV light may couse some colored surfaces to fade. Gens Nano protects the surface from the UV damage.

5. Antistatic Feature

The antistatic feature can resist the static adsorption of the small dust such as ash, coal powder and etc.



Normal surface **Antistatic surface**

Tips: How to take advantage of the super-hydrophilic feature?

The super-hydrophilic feature can provide the same effect like detergent (reduce the contact angle of the surface).

Self-cleaning: *If there is rain, Gens Nano coating provides self-cleaning feature after rain wash. The rain wash have the same effect to your traditional surface cleaning with detergent.*

Easy-cleaning: *If there is no rain, you just need simply wash the surface using water. Your single water wash will also have the same effect to traditional cleaning with detergent.*

SolarStucco Next Generation Building Self-Cleaning Solution

Objective:

Protect building envelope from dirt and biological growth

Protect building envelope against surface UV damage and discoloration.

Reduce cleaning maintanance costs

Solution: *Gens Nano SolarStucco photocatalyst coating is the combination of photocatalyst and nano technology. Just simple application of Gens Nano SolarStucco coating on the building exterior surface will bring diversified excellent features to the building. Also, coating can be sprayed on highway barriers and side walks to provide the self-cleaning & air purification function. Gens Nano SolarStucco coating will keep the surfaces in a very new look and reduce the cleaning & maintenance costs.*

Features:

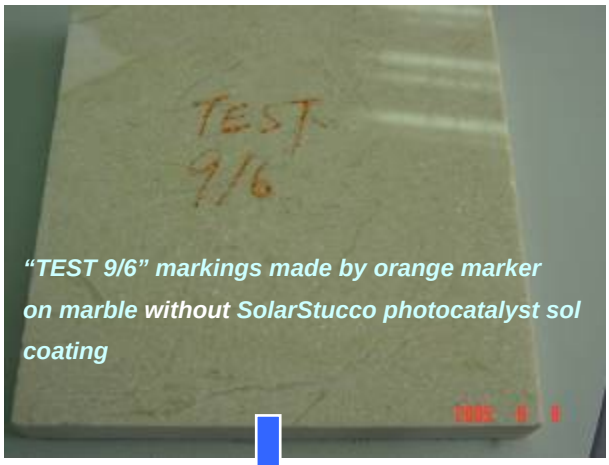
- ✓ *Self-cleaning*
- ✓ *Air-purification*
- ✓ *Anti-mold, anti-moss*
- ✓ *UV damage color protection*
- ✓ *Anti-static surface*
- ✓ *Super hydrophilic surface*

Benefits:

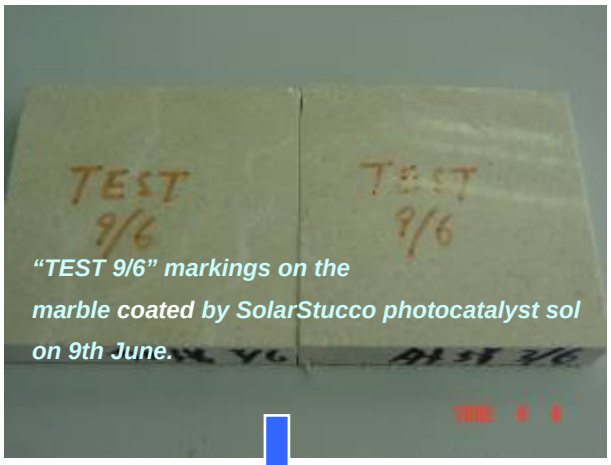
- ➢ *Keeps building envelope clean*
- ➢ *Protects the surface from dirt, acit rain and air pollution damage*
- ➢ *Purifies the air polutants near and on the surface (e.g. car exhausts, NOx, Formaldehyde, Benzene, VOC's)*
- ➢ *Decomposes the organic pollutants on the surface.*
- ➢ *Reduces water stains after rain*
- ➢ *Restrains mildew, mold, algae and bacteria from growing on the surface*
- ➢ *Absorbs UV and protects surface from UV damage and color fading*
- ➢ *Restrains the dust electrostatic adsorption*

Example 1. Organic pollutant decomposition

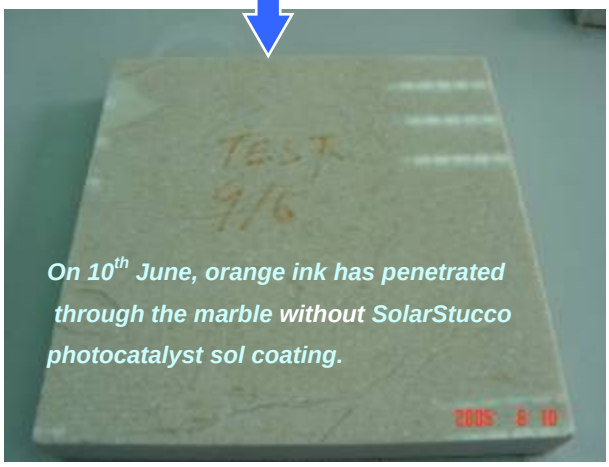
Surface: ***Marble*** ***Application:*** ***by spray***
Product: ***SolarStucco Top Coat*** ***Period:*** ***24 hours***



"TEST 9/6" markings made by orange marker on marble without SolarStucco photocatalyst sol coating



"TEST 9/6" markings on the marble coated by SolarStucco photocatalyst sol on 9th June.



On 10th June, orange ink has penetrated through the marble without SolarStucco photocatalyst sol coating.

On 10th June, the orange ink markings on the marble coated by SolarStucco had been decomposed.

**** Note. Gens Nano SolarStucco photocatalyst coatings are not designed as sealants or anti-graffiti coatings.***
This example shows coating ability to decompose organic materials.
Organge marker contains organic based ink, that is easily decomposed in 24 hr.

**** Permanent markers are not suitable for demonstration of organic decomposition.***

Example 2. Exterior wall self-cleaning demonstration

Surface: ***Granite*** ***Application:*** ***by spray***
Product: ***SolarStucco Top Coat*** ***Period:*** ***3 months***

This picture shows a granite wall which has become old and dirty after years of weathering.
The area divided by yellow adhesive tape will be coated with SolarStucco photocatalyst sol later.
(Photo #1 dated Dec. 14th 2005)

Before photocatalyst coating is applied on the surface, proper pre-cleaning work is necessary.
We applied SolarStucco Top Coat on the left part of the cleaned area.
(Photo #2 dated Dec. 14th 2005)

After 3 months of weathering, the wall on the left side coated with SolarStucco Top Coat s hows the results of our self-cleaning product.
The uncoated area on the right side becomes dirty and dark due to the poor air quality and pollution.
(Photo #3 dated Mar. 15th 2006)

Example 3. Exterior column self-cleaning

Surface: ***Granolith*** ***Application:*** ***by spray***
Product: ***SolarStucco*** ***Period:*** ***102 days***

Day1: 40 years' old granolithic covering had been damaged; air, dust & pollutants had stained the column base as shown on photo 1 dated 2005-7-18. Lower part of the stained column base will be cleaned & treated with Gens Nano SolarStucco Photocatalyst Top Coat.
(Photo #1 dated Jul. 18th 2005)

Day1: Lower part of column base (below the taped area) has been cleaned with cleansing agent. Dirt & stain had been removed off the stained area. Then SolarStucco Top Coat was applied to the treated area of column base.
(Photo #2 dated Jul. 18th 2005)

Day 36: The untreated area - upper part of the column base has become dark & dirty while the area treated with SolarStucco, (lower part of the column) remeines white & clean.
(Photo #3 dated Aug. 25th 2005)

Day 102: The untreated area became dark as a result of contamination by air & organic pollutants. Gens Nano SolarStucco decomposes the pollutants and the self-cleaning power of SolarStucco photocatalyst coating is evident.
(Photo #4 dated Oct. 29th 2005)

Example 4. External Limestone Cladding self-cleaning & anti-moss

Surface: ***Limestone*** ***Application:*** ***by spray***

Product: ***SolarStucco Top Coat*** ***Period:*** ***224 days***

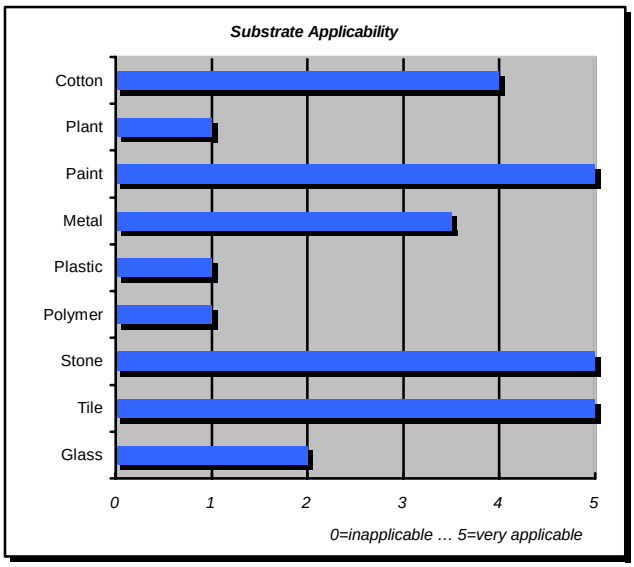
BEFORE

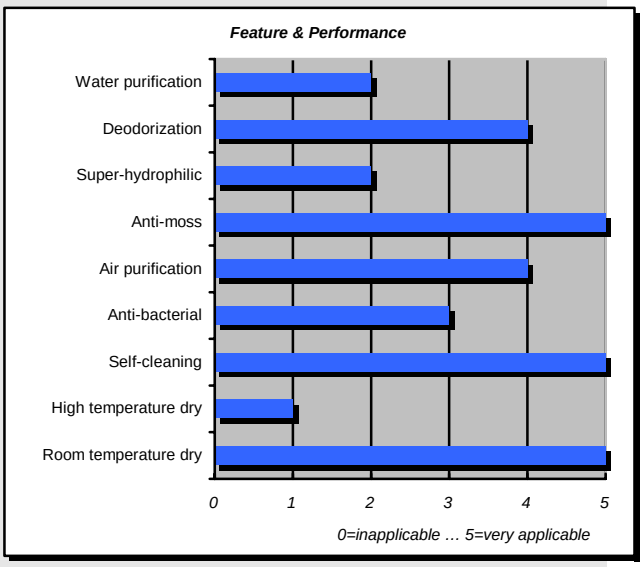
AFTER

**** Note. Gens Nano SolarStucco photocatalyst coatings are most durable when applied on clean surface.***
In this example, we used power wash to remove dirt before coating.

GENS NANO® SolarStucco Top Coat

VLR modified Nano TiO_2 Sol Exterior Coating Agent





Special properties

- water-based nano TiO_2 sol
- high efficiency
- self-cleaning application optimization
- extra binding strength for porous and rough substrate
- room temperature drying

Example of application

- building exterior self-cleaning coating
- stone surface anti moss coating
- high efficient exterior UV/PCO coating for atmosphere purification

Usage instructions

- recommend air mix pressure spraying
- brush for rough surface

Chemical description

nano titanium dioxide sol

Dosage instruction

- refer to relevant coverage data sheet or product manual

Technical Information

• appearance	bluish white transparent liquid
• active matter content	7500-10000(PPM)

Specification *

• PH Value	7.5-9.5
• average primary particle size	<8nm
• crystal structure	anatase
• agglomeration index	2-4
• density	1.0075-1.01 g/ml
• binding strength	very strong (level 4)

Registration status

GENS NANO® E503 ingredients are listed in following chemical inventories: CAS, EINECS, TSCA, AICS, CEPA, MITI

Package

10kg, 25 kg, Plastic barrel with carton

30 kg, 100 kg, 200 kg Plastic barrel

Storage stability

12 months in closed container under 5-45℃, dark condition

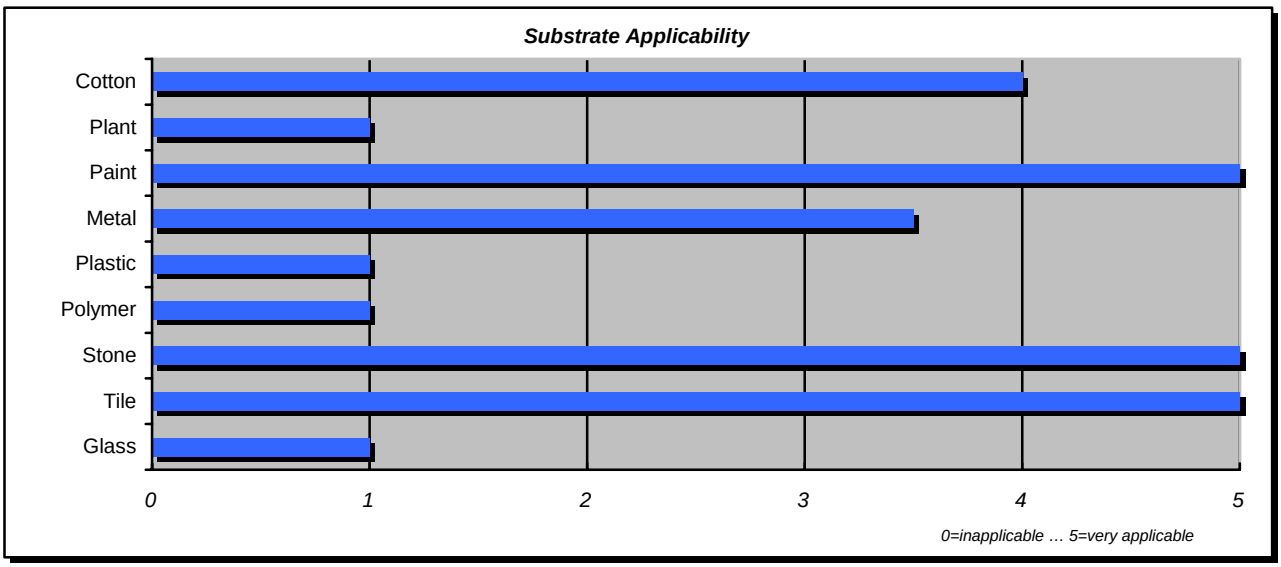
Transportation

No transport danger in air, sea, highway and rail transportation

** For more detailed technical data, please refer to relevant product manual*

GENS NANO® SolarStucco Primer

Primer Coating Agent



Special properties

- water-based primer for nano photocatalyst coating
- block UV
- protect organic substrate from photocatalytic oxidization damage
- improved coating feature on rough surface
- enhance binding strength of top photocatalyst coating

Example of application

- primer on acrylic paint surface to protect substrate
- primer on stone to enhance photocatalyst coating binding
- block UV coating

Usage instructions

- recommend air mix pressure spraying
- brush for rough surface
- dipping for irregular items

Chemical description

nano titanium dioxide sol

Dosage instruction

- refer to relevant coverage data sheet or product manual

Technical Information

• appearance	yellow transparent liquid
• active matter content	7500-10000(PPM)

Specification *

• PH Value	6-8
• average primary particle size	<3nm
• crystal structure	amorphous
• agglomeration index	<10
• density	1.0075-1.01 g/ml
• binding strength	very strong (level 4)

Registration status

GENS NANO® PR-O8 ingredients are listed in following chemical inventories: CAS, EINECS, TSCA, AICS, CEPA, MITI

Package

10kg, 25 kg, Plastic barrel with carton

30 kg, 100 kg, 200 kg Plastic barrel

Storage stability

12 months in closed container under 5-45℃, dark condition

Transportation

No transport danger in air, sea, highway and rail transportation

** For more detailed technical data, please refer to relevant product manual*