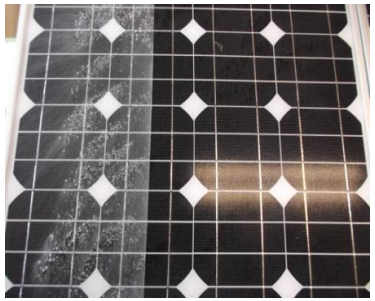
Patent No. 7146223; September 26, 2022
For glass substrates and solar panels
Antistatic antifouling coating agent

Improvement of power generation efficiency degradation problem
due to adhesion of dirt

Strong antistatic antifouling & super hydrophilic self-cleaning coat

「Solar Self Maintenance Coat CNT」



To Nature, Earth & Humans
ECO
Sketch

Antifouling coating that prioritizes antistatic properties

From fluorine and photocatalysts to the age of antistatic

Development of a super-hydrophilic coating agent with top priority on antistatic function

Phase 1: 2000-2021 Super Glass Barrier

At our company, we grasped the problems of fluorine coating and photocatalyst coating, which have been called representative of antifouling coating agents, and in order to overcome these problems, we made a major change in the way we think about antifouling. The anti-static anti-fouling coating agent makes it extremely difficult for inorganic stains such as yellow sand and carbon to adhere, and the attached stains are super hydrophilic and self-cleaning regardless of the presence or absence of light. The world's first 100% inorganic coating agent. Exhibits outstanding antifouling effects on exterior walls, exterior materials, paint films, etc. Since 2000, the antistatic effect of tin oxide based on an inorganic adhesive binder cures quickly at room temperature, and the antistatic property of $10^8\Omega/\square$ to the power of 8 does not attract dirt such as yellow sand or carbon, and minimizes adhesion. increase. Under the product name Super Glass Barrier, we have a track record of construction in Japan and around the world, and have sold a total of 10 million square meters of material.

Phase 2: 2022-Solar self-maintenance coat CNT

This time, we succeeded in adding single-walled carbon nanotubes to the Super Glass Barrier for the purpose of greatly increasing its antistatic effect, and completed a new product that exhibits an amazing antistatic function with conductivity of $10^4\Omega/\square$. Adhesion, strength, chemical resistance, and weather resistance are greatly improved by adding single-walled CNT. In addition, the improved thermal conductivity has greatly expanded the range of applications, including deicing promotion function, anti-fouling measures in salt-damaged areas, and anti-fouling measures in cold areas. Since it does not depend on humidity and exhibits conductivity of $10^4\Omega/\square$ even when dry, antistatic and antifouling effects can be expected even in clean rooms and desert areas.

Conductivity
$10^4\Omega/\square$

Patented

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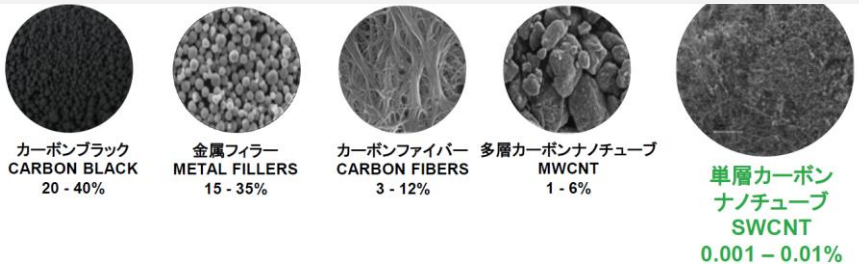
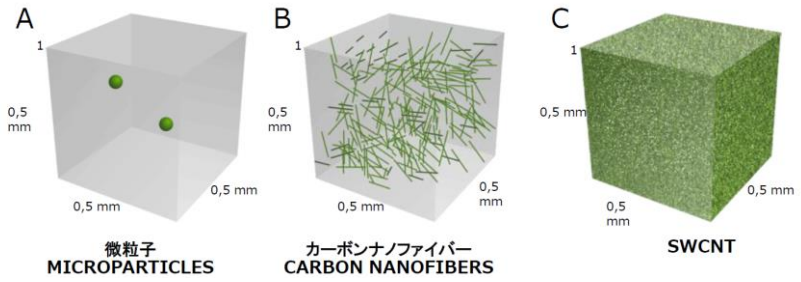
What is SWCNT? =Single Walled Carbon Nano-Tube

The brand name "TUBALL" for single-walled carbon nanotubes is a product manufactured and developed by OCSIAL, which is based in Luxembourg. The current annual production capacity is 90 tons. It accounts for 97% of the world's production of single-walled carbon nanotubes. They have set a production target of 250 tons in 2023.
https://ocsial.com/nanotubes/

Kusumoto Chemicals, Ltd is the sole agent in Japan.
This time, Kusumoto Kasei Co., Ltd. has developed its own coating agent using SWCNT and using its own dispersion technology. By adding them to Sketch's SGB binder, we succeeded in improving the antistatic function by $10^4\Omega/\square$.It was also confirmed that it is compatible with APT.
In addition to improving antistatic performance, SWCNT's strength, adhesion, chemical resistance, and weather resistance have been greatly improved.
Therefore, we will take on the challenge of developing new applications as a manufacturer sketch.
Please participate in application development.



SWCNT is the only additive that changes the physical properties of materials with 0.01% of addition. Why is it possible?
When pervaded in the matrix of materials, single-walled carbon nanotubes form a three-dimensional reinforcing and conductive network. That network creates new physical characteristics. It can enhance mechanical strength, conductivity and thermal conductivity.



Characteristics of SWCNT

1, 5 times lighter than copper
2, 100 times stronger than steel
3. Stable up to 2800 ℃ in vacuum
4, the highest aspect ratio of 3000 or more
5, diameter ~ 2nm, length ~ 4μm
6, 10 times the thermal conductivity of aluminum
7, strong conductivity at low concentration

component
・SiO2
・SnO2
・methanol
・water

6 features of Sketch's SGB binder

①, Super hydrophilic self-cleaning property
②, Antistatic function $10^9\Omega/\square$
③, normal temperature quick drying
④, 100% inorganic hard coat
⑤, high transparency, low refraction
⑥, chemical resistance

Significantly improved functions

component
・SiO2
・SnO2
・methanol
・water

+
SWCNT
APT

①, + strong antistatic $10^4\Omega/\square$
②, + photocatalyst, decomposition of organic matter
③, + Strengthening adhesion
④, + wear resistance / hard coat
⑤, + Ice deicing promotion effect
⑥, + chemical resistance
⑦, + weather resistance

Super Glass Barrier CNT

Evaluation of New product under development “SGB CNT”

Disperse TUBALL single-walled carbon nanotubes from OCSIAL, the world's largest manufacturer in Luxembourg, in Japan ,
An evaluation test of antistatic performance was conducted by adding SW-CNT to the Sketch’s Super Glass Barrier.

What is the difference between "Super Glass Barrier" and "Super Glass Barrier CNT"?

Component
・SiO 2
・SnO2
・Methanol
・Purified Water

Significantly improved functions

Component
・SiO 2
・SnO2
・Methanol
・Purified Water
＋ **Single-Walled Carbon Nano Tube**

Antistatic anti-static super hydrophilic self-cleaning coat for exterior materials. Among the antifouling coats developed by our company, it is the most representative product with application record of more than 15 years in Japan and other countries around the world.

Greatly improved antistatic function, improved chemical resistance, weather resistance, adhesion, and wear resistance.

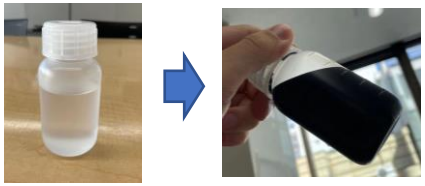
Purpose
Single-walled carbon nanotubes can significantly improve the properties of the material (mechanical strength, electrical conductivity, thermal conductivity) simply by adding them. Super Glass Barrier (hereinafter referred to as SGB) to be added this time is an inorganic transparent coating agent that has both antistatic and super hydrophilic functions. It can also be used as a binder, and other functionality can be imparted by adding nanomaterials that are compatible with each other.
The purpose of this test is to improve the conductivity or coating film strength of SGB and to verify the addition of other new functionality by adding the above-mentioned single-walled carbon nanotubes.

Summary
TUBALL SWCNT (Single-Walled Carbon Nano Tube) was added to SGB. Good stability as a coating agent. It was confirmed that the single-walled CNT improved the conductivity and wear resistance.

After adding CNT to SGB this time, the following verification was carried out step by step.
1) Stability in liquid form
2) Appearance after application
3) Surface resistance value
4) About hydrophilicity
5) About the strength of the coating film in dry friction and wet friction
6) Conductivity and hydrophilicity after rubbing

1)) Stability in liquid form; Stability ◎

It seems that it is stable with no fine particle size.
There is no gelation, separation or sedimentation.



2) Appearance after application

Apply once with Microfiber Cloth without cleaning.
We are not sure if it was caused by hand , but the shades of carbon are linearly uneven and visible.
the glass with a visible light transmittance of 91% dropped to around 85%.
However, when It added it with WO3
It increased VLT a little.

3) Surface resistance value ; Improvement to 10 $^{3\sim4}$ Ω／□

Considering the possibility that water in the coating film remains, I tried to verify it after heating and one day, but it still displayed $10^{3\text{-}4}$ Ω／□.

Conductivity of 10 to the 4th power

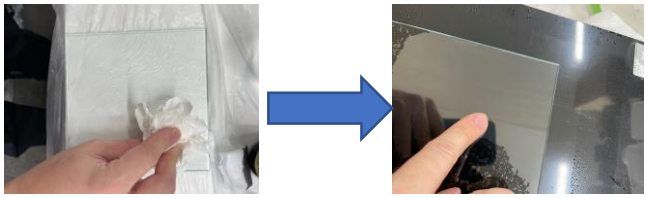
＝10 ^{4} Ω／□

4) About hydrophilicity ; same performance level as only SGB

Normally, the glass surface becomes water-repellent (= high water droplet contact angle) when it is splashed with water. SGB can be modified to a hydrophilic state (= low water droplet contact angle) where water spreads on its surface.
There are three patterns: when the original hydrophilicity is improved when nanomaterials are added, when there is no change, and when it is decreased.

5) About the strength of the coating film in dry friction and wet friction

SGB is a coating and binder that imparts antistatic properties and superhydrophilicity by forming a 200 nm uneven film in a room temperature environment.
SGB has a problem that it is vulnerable to wear due to its structure, and in the past, we have tried to enhance wear resistance with Nano Diamond and WO3.
This time, the state of the coating film was observed by rubbing by wiping with 30 wet wipes and 30 dry wipes. Normally, in the case of SGB alone, wet friction does not affect the coating film, but when dry friction is applied, thin scratches (probably the coating film is scraped) are gradually formed on the coated surface, and this is repeated. The coating film will be completely peeled off.
With SGB + SWCNT, no scratches were found on the coating film even after dry rubbing more than the specified number of times, and a clear improvement in wear resistance was confirmed.



6) Conductivity and hydrophilicity after rubbing

Wet friction and dry friction were performed, and then the measurement was performed again. The measurement results are as follows.

Conventional product SGB	Surface resistance value; same status as before friction Super Hydrophilicity; ○→×
SGB + single-walled CNT	Surface resistance value; 10^{3} Ω／□ ⇨ 10^{3} Ω／□ Super Hydrophilicity; ◎→◎

APT & single-walled carbon nanotube addition significantly improves functionality

Existing product; Super Glass Barrier

As an antifouling coating for exterior materials, it has been used for more than 15 years, and has sold 10 million square meters of materials in Japan and other countries around the world.

6 features of SGB binders from Sketch

component
・SiO2
・SnO2
・methanol
・water

① Super-hydrophilic self-cleaning properties
②Anti-static function $10^8\Omega/\square$
③ Fast drying and hardening at room temperature
④ 100% inorganic, hard coat
⑤ high transparency, low refraction
⑥ chemical resistance

New Product; Solar Self Maintenance Coat CNT

・A high-performance type with no light photocatalyst APT and single-walled carbon nanotubes added to the super glass barrier. Patented.

component
・SiO2
・SnO2
・methanol
・water

+ APT & SWCNT

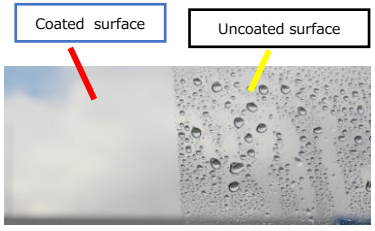
Greatly improved functionality

(1) + Strong anti-static $10^4\Omega/\square$
②+Photocatalyst (decomposition of organic matter)
③+Strengthen adhesion
④+Abrasion resistance/Hard coat
⑤+Deicing promotion effect
⑥+Chemical resistance
⑦+Weather resistance

What is the difference between conventional "Super Glass Barrier" and "Solar Self-Maintenance Coated CNT"?

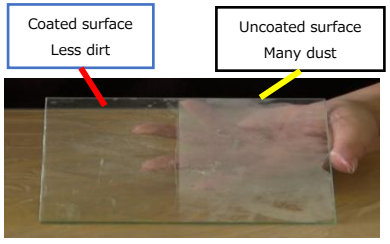
What is super-hydrophilic function?

The base material no longer repels water, forming a thin film of water that stretches and spreads. It has a self-cleaning effect that water gets under the dirt, lifts the dirt and washes it away, and provides a clear view and a clear anti-fogging effect. It also has the effect of deterring raindrops and limescale adhesion.



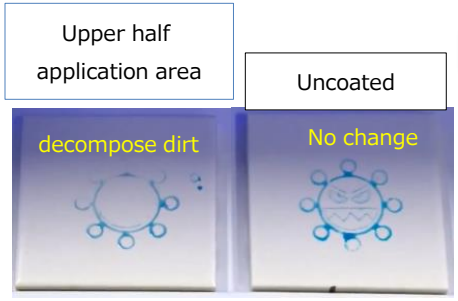
What is antistatic function?

Static electricity is less likely to be generated from the base material, and it is possible to obtain the effect of making it difficult for dirt itself to stick, mainly inorganic dirt such as yellow sand and dust. We were able to commercialize the antistatic nanomaterial = SnO2 as an antifouling coating for building materials, which is the only one technology of our company in the world.



photocatalytic effect

Photocatalysts are nanomaterials that can decompose and remove organic stains (oil stains, resin stains, etc.) that come into contact with them when they are exposed to light such as the sun or fluorescent lamps.

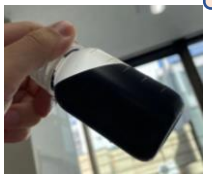


What is strong anti-static function?

Addition of single-walled carbon nanotubes greatly improves conductivity.
The antistatic and antifouling properties greatly reduce the adhesion of dirt.

Conductivity $10^4\Omega/\square$

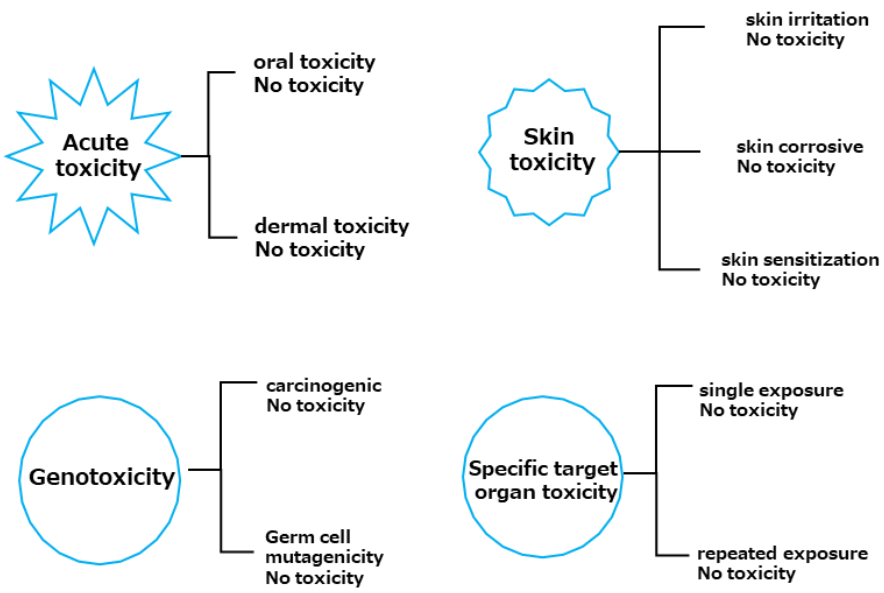
Enhanced antistatic



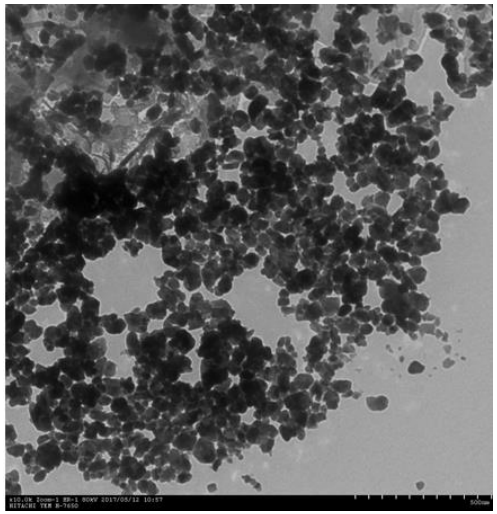
+antistatic
+strong adhesion
+ Wear resistance
+ chemical resistance
+ Promotion of ice breakup
+ Weatherability

What is APT? ＝Ammonium Para Tungsten, Photocatalyst without light

The problem with titanium oxide, which is famous as a photocatalyst, is that it can only be effective where it is exposed to light.
Therefore, we turned our attention to tungsten oxide, which is one of the photocatalyst nanomaterials.
Tungsten oxide is known for its photocatalytic effect and its photo response over a wider wavelength range than titanium oxide.
Initially, we started with research to enhance the performance of tungsten oxide.
The ammonium tungstate produced in the process has the same performance as a photocatalyst even in the dark.
We discovered by chance that it was effective, and shifted to research as a new material, a non-photocatalyst.
And because of repeated trial and error, it was born
"Ammonium tungstate, a deodorizing antibacterial coating made of new materials that does not require light."
This nano-tungsten is the world's smallest class of tungsten particles with a particle size of 5 to 10 nm compared to the conventional particle size of 20 to 40 nm.
Nanoparticles with extremely high surface area per unit deposition maximize catalytic effectiveness.
In addition, the minute tungsten solution is completely colorless and transparent, so it can be used in all aspects of daily life, from clothing to home painting. There have been no reports of the toxicity of ammonium tungstate to humans.



Colorless transparent ammonium tungstate



Transmission electron microscope image

Characteristics of Solar Self-Maintenance Coat CNT

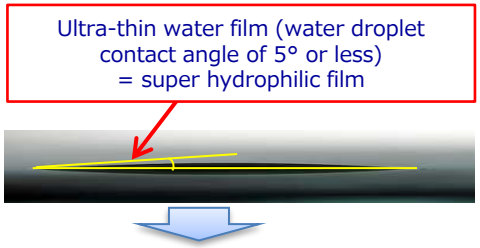
Hard-coated type for sandy desert areas
Deicing promotion coat type for cold regions with a lot of snow

Solar self-maintenance coat CNT･･･For solar panels only

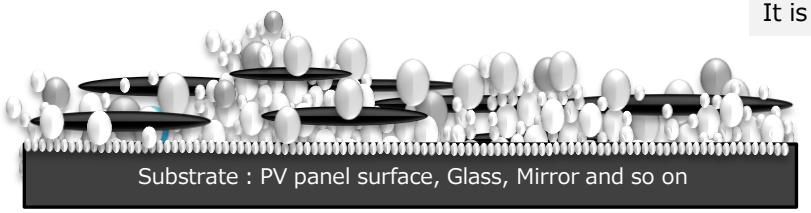
① SiO2 (silica) ; Ultra-hydrophilic adhesion binder function
②SnO2 (tin oxide) ; antistatic function
③ SWCNT ; strong antistatic $10^4\Omega/\square$, strong adhesion, chemical resistance, super hard coat properties, deicing effect
④ APT (Ammonium Para Tungsten) ; photocatalyst without light
⑤ Methanol, water

Solar self-maintenance coated CNTs are made of 100% inorganic adhesive binders that use silica particles of 10 nano-size or less, and are highly transparent, hardening at room temperature, quick-drying, and super-hydrophilic. Demonstrates strong anti-static function. In addition, SWCNT & APT (Ammonium Para Tungstate) is added to significantly improve photocatalyst, adhesion, chemical resistance and hard coat properties, enabling coating on solar panels without reducing VLT.

Due to antistatic properties, dirt such as yellow sand and carbon does not adhere easily, making it ideal for the Middle East and desert areas where the surface is scraped by sand. In addition, SWCNT, which has 10 times the thermal conductivity of aluminum, and the super-hydrophilic effect, are effective in promoting deicing in winter.

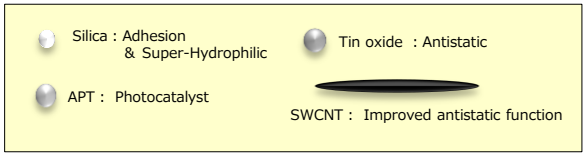


Superhydrophilicity by fractal theory



◆ Mechanism of antistatic/super-hydrophilic antifouling coating

100 to 200 nanoclass silica is used on the surface of the glass substrate to create an uneven surface and create a base coat that always creates a super-hydrophilic film. They are used as a 100% inorganic glue that adheres to the base material.
A coating film of tin oxide is formed on top of it, and by adding antistatic (antistatic) function, it becomes difficult for dirt to adhere.
By adding APT and single-walled CNT to SGB, adhesion, weather resistance, and chemical resistance can be improved, and the antistatic function can be greatly improved.
It is the world's first coating technology created by cutting-edge nanotechnology.



Evaluation test

Solar self-maintenance coat CNT performance evaluation

solvent	Methanol
Antistatic (surface resistivity) (Humidity 25~50%)	10^{4} Ω/□
Superhydrophilic (glass)	Water droplet contact angle 10° or less
transparency	No change
Surface hardness (wear resistance)	7H or more
Ease of installment	Effortless and easy
Adhesion to substrate	glass, metal, tile, etc.
Frictional	low
Transmittance after application	Maintain transmittance
Normal glass application	Maintain transmittance

1 , Strong anti-static function

2 , Normal temperature quick drying

3, super hydrophilic

4 , hard film

5, chemical resistance

6, De-icing promotion function

7 , High transparency/low refraction

8 , Ultra weather resistant

Weather resistance test results by a listed glass manufacturer Conducted in May 2013

		Uncoated	SSMC
Before the test	Surface resistance (Ω/□)	–	5.8E+09
	Visible light transmittance (%)	90.3	92.9
	Contact angle (°)	–	0.0
After the test	Surface resistance (Ω/□)	–	7.5E+08
	Visible light transmittance (%)	–	92.2
	Contact angle (°)	–	3.3

Evaluation test

■Weathering test content

・Weathering test of 1,000 hours at 85% humidity under 85 ℃ room temperature=10~15 years equivalent (Weathering test of strict criteria to determine whether to adopt as processed products)

・It checks the following three items degradation situation of the membrane surface by the elution of sodium ions.

① Surface resistance value = antistatic effect② Visible light transmittance = transparency ③ Contact angle = super-hydrophilic

■ Acceptance criterion

Test results judgment

・ Surface resistance value : **less than** $10^{10\Omega/\square}$ ⇒ $10^{9\Omega/\square}$ ~$10^{8\Omega/\square}$ Pass ◎

・ Visible light transmittance :**More than 90%**⇒ 92.9%~92.2% Pass ◎

・ Water droplet contact angle :**Less than 20°** ⇒ 00°~ 3.3° Pass ◎

■ Conclusion :

As for application market,

it is passed weathering test equivalent to 10 ~15 years

What is the cause of fouling?

Causes of dirt	Solutions	Function/Performance
Dust, iron powder, oxide	Anti-Static	Suppress adhesion of inorganic stains and organic stains that cannot be decomposed
Carbon, coal ash, smoke, exhaust gas		
Pollen, sap, oil stains	Super-Hydrophilic	Make it easy to remove dirt that adheres and is difficult to remove with rainwater
Animal droppings, carcasses of insects	Chemical resistance, hard coat property	Strongly to strong acid and alkali, a hard coat, and easy to clean.
NOX, SOX, Acid rain, Degradation due to chemical change		
Deterioration fading , shape deterioration due to ultraviolet rays	100% inorganic film	100% inorganic coating suppresses deterioration
Stain caused by mold		
Degradation and fading due to heat and oxidation		

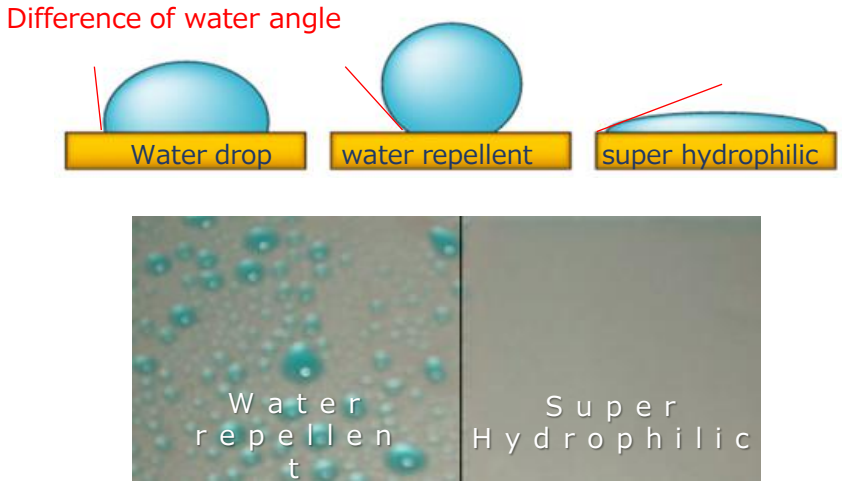
Requirement for Anti-fouling coating?

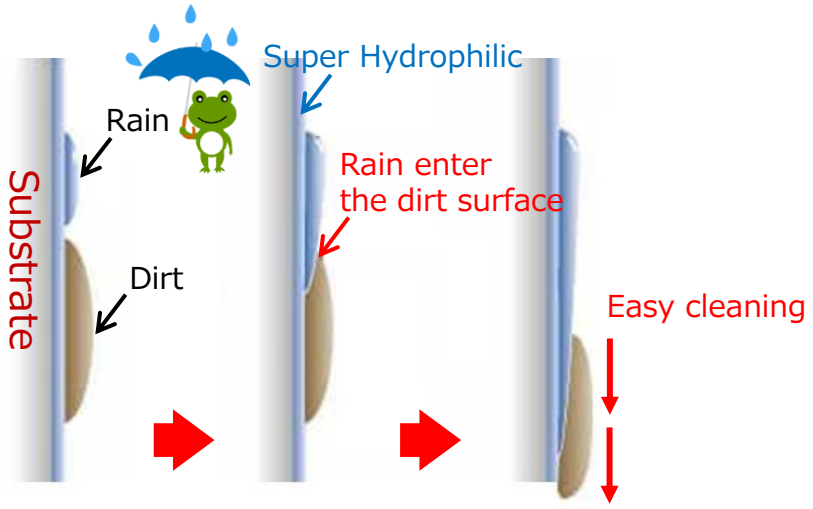
・Reduce the adhesion of dirt, also easy to fall attached dirt
・When compared to the cost of cleaning, there is a merit of cost
・High-transparent and does not impair the texture of the base material
・Inorganic 100%, there is a chemical resistance, excellent durability and environmental resistance

Function of Anti-Static & Super Hydrophilic Self Cleaning Coat (2)

Wash away the dirt in the rainwater with super-hydrophilic effect

Super hydrophilic means less than 10 degree of water angle to the substrate.
Water droplets remain as they are on the untreated surface, But they will seep into the layer under the fouling on the hydrophilic surface, thus removing it. The water-repellent surface only repels the water, and has no function to clean itself.

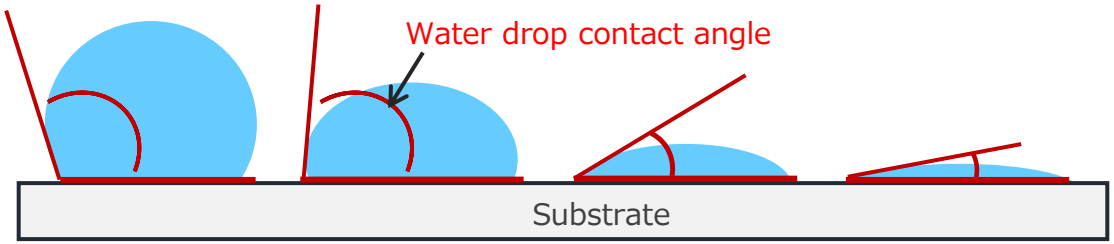




Which can keep the clean Water-repellent or Super hydrophilic coating?

Water drop contact angle

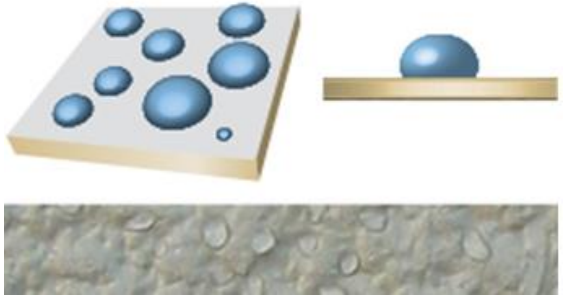
When Water drop contact angle is small, the dirt is easy to take off.



Super water-repellent 110～180°　Water repellent 70～100°　Hydrophilic less than 40°　Super hydrophilic less than10°

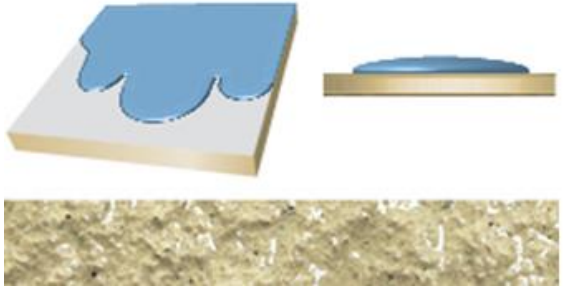
Painting	Water drop angle (°)	Dirtiness by water drop angle
Teflon	110～115	Easy to take off the dirt
Fluorine resin paint	100～105	Easy to adhere the dirt
Silicone paint	100～105	Easy to adhere the dirt
Acrylic urethane paint	85	Easy to adhere the dirt
NOF Bell clean paint	30～40	Difficult to adhere the dirt
Titanium oxide coating	～10～	Photo catalyst/Super hydrophilic
SUPER GLASS BARRIER	Less than 3～5	Antistatic/Super hydrophilic

Water-repellent:
Water is rolling on the dirt.



Exterior material of the water-repellent: general organic coating film, etc.

Hydrophilic: water is spread on a flat
Water enters the bottom of the dirt

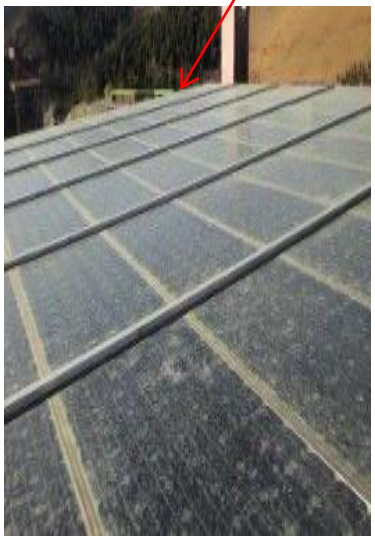


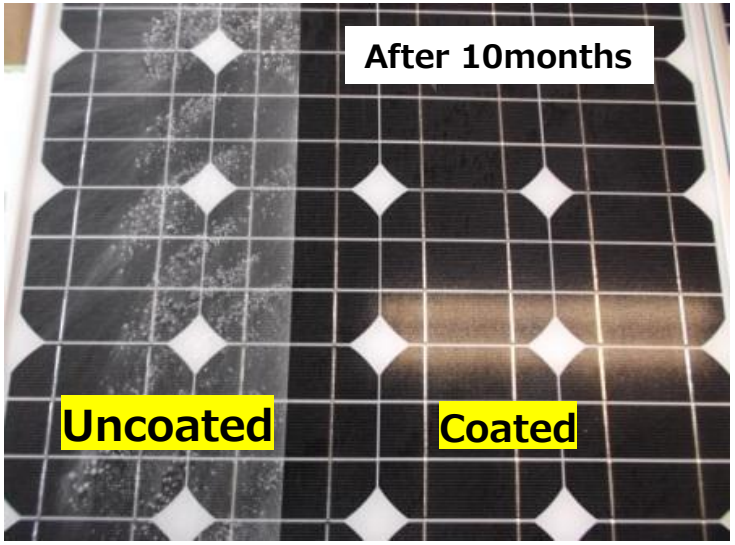
Hydrophilic exterior materials: tile, stone, etc.

Importance of antifouling coating for solar panels

Currently, the photovoltaic power generation market is rapidly spreading throughout Japan and around the world. In particular, solar power generation facilities are under construction mainly in the Middle East with an average sunshine duration of 12 hours or more (5.5 hours in Japan). However, there is a problem of a decrease in the amount of power generation due to sand contamination because there is a lot of sunshine hours = a desert area where it does not rain. Therefore, in order to maintain power generation efficiency, the panel is always cleaned, and if it is not cleaned, the amount of power generation will be reduced by 20% due to sand contamination. (A decrease of 16% is also shown in the California area of the United States.) In addition, the AR coating (Anti-reflection Coat) for increasing the transmittance of the solar panels made in China gradually decreases from the third year, and the power generation efficiency decreases accordingly. This time, we have developed a P V-AR UP Coat with an AR ratio of 2 to 3%, which is effective in solving the above problems and has an anti-static and super hydrophilic function that is hard to get dirty.

The decrease in power generation due to dirt is 5% to 10% in Japan. 10% to 20% in China and Southeast Asia, 10% to 30% in the Middle East





In the desert area where it doesn't rain like the panel in the left picture above, the air is a dry and the sand is charged and easy to adhere. Solar panel glass is required to have a surface that is difficult to adhere.
Also, regular cleaning maintenance makes it easier to remove dirt due to the super hydrophilic effect, shortening cleaning time, reducing water usage fees, and using detergents.
Therefore, there are many maintenance benefits by reducing the detergent cost and coating.

Decrease in power generation efficiency due to dirt on the solar panel

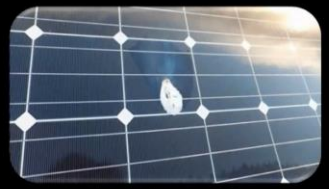
In Europe, it has been announced that the decrease in power generation efficiency due to dirt is up to 9.3% per year. In China, Southeast Asia, and the Middle East, even more contamination is expected to reduce power generation efficiency by more than 10% annually.

Efficiency drop due to contamination on the module surface

Contamination by Dust

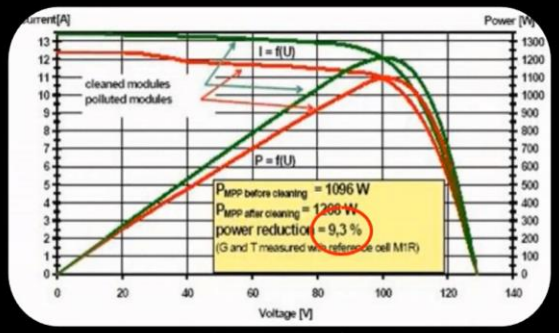
Contamination by Yellow sand

Contamination by rain



Contamination by bird drop

Output drop due to module contamination



source : 19th European PV conference, 2004

Up to 9.3% reduction in power generation output due to contamination

Academic conference presentation of improvement of 10% or more in demonstration test in Egypt

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Influence of Seasonal Effect on Dust Accumulation on Photovoltaic Panels that operate Light Posts

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Abstract

Dust accumulation on Photovoltaic (PV) panels is a severe threat that decreases the energy production of PV panels and therefore, lowering their efficiency especially in the Middle East and North Africa (MENA) region. Cleaning of the PV panels has always been a challenge for most of the countries in this region, due to scarcity of water resources and high dust accumulation rates throughout the year. A new dust mitigation technique has been developed, which consists of a dust shield, antistatic hydrophilic coating and a mechanical vibrator. The objective of this research is to study the seasonal effects on the performance of this new dust mitigation technique for PV panels that operate light posts. Two experiments were conducted for six weeks in 2021; the first one was in winter while the other one was in summer. In both experiments, two PV panels were examined. The first PV panel is used as a reference panel for comparison and the second panel is installed with a dust shield, a mechanical vibrator, in addition to being coated with an antistatic hydrophilic coating. The function of the dust shield is to obstruct the wind coming from the South towards the North direction. The antistatic coating prevents the dust particles from adhering to the panel's surface. The role of the mechanical vibrator is to shake off the deposited dust particles on the panel's surface. The experimental results show that applying the antistatic coating together with the dust shield with vibrating the panel in case of the first experiment conducted in winter preserved the efficiency of the panel, such that the drop in efficiency did not exceed the maintenance limit of 10% during the experiment. While in summer, the maintenance limit has been exceeded in the fifth week. This is mainly due to the effect of winds direction and rainfalls, which were present in the winter, unlike the summer experiment where winds and rainfalls are rarely found. This clearly shows that the combination of the dust shield and the mechanical vibrator together with the coating is a promising dust mitigation technique for PV panels operating light posts especially in winter.

Keywords: Photovoltaic; dust mitigation; shield; coatings; Mechanical Vibrator.

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Prevention of deterioration in power generation efficiency due to dirt on solar panels & measures to reduce regular cleaning costs

As a measure to reduce power generation efficiency due to dirt adhering to the surface of the solar panel and to reduce maintenance cleaning

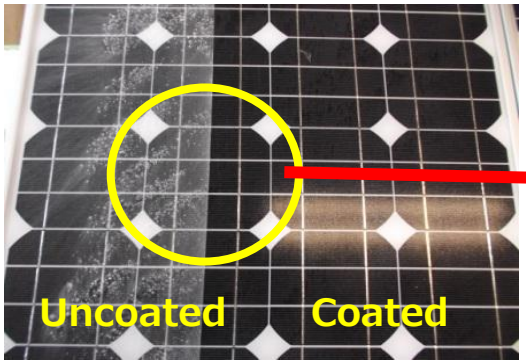
Strong antistatic, antifouling, super hydrophilic self-cleaning coat

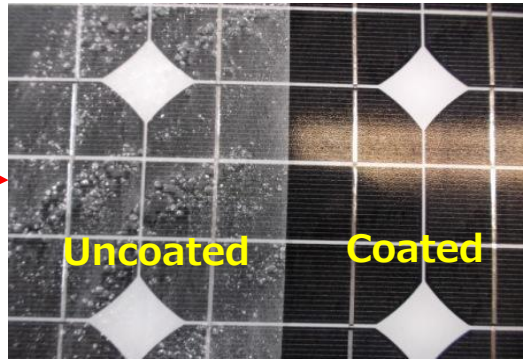
① Even in regular cleaning operations, the ultra-hydrophilic self-cleaning effect makes it possible to simply wash with water without the need for detergents, and the reduction in the number of cleanings also reduces costs.

② Depending on the region and environment, the power generation efficiency of a solar panel can be reduced by contamination.

③ Solar panels are installed at a low angle and tend to adhere to bird droppings, yellow sand, pollen, etc., so the coating surface of the coating material has an antistatic function and a hard coat to increase chemical resistance. Tungsten oxide and SWCNT are added. Corresponds with "Solar Self-Maintenance Coated CNT".

④By using nanomaterials with low refraction materials, the visible light transmittance of the solar panel does not decrease even if it **is** applied, so the power generation efficiency does not decrease. It is a patented product that has a strong antistatic function and super hydrophilic function without reducing the transmittance when coated with Solar Self-Maintenance Coat CNT.





Confirmation of De-icing promotion effect after 3days of 1,000㎡ coating in China

Snow surface becomes a lump, it was easy to slip off.

Reason

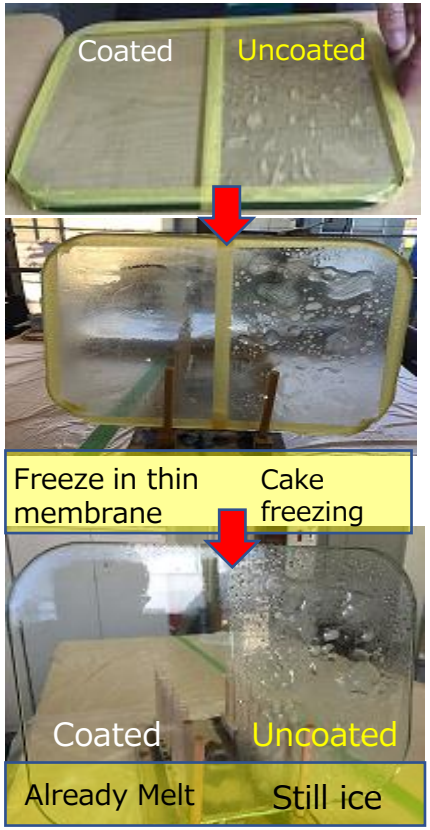
Its function is effectively demonstrated and dust and the like in the air hardly adhere to the surface. In addition, even if it gets dirty, it is possible to self clean the surface stain due to rainwater or the like due to the superhydrophilic function. When water is applied to the uncoated surface, it is in a water repellent state, and the dirt becomes a water spot remaining in the polka dots. If this is repeated for a long time the surface becomes dirty,Resulting in a decrease in power generation efficiency.Since the coated surface is in a superhydrophilic state with a contact angle of water of 5 degrees or less,It can easily wash away. Therefore, it is difficult for water spot to be formed, and reduction in power generation efficiency can be reduced.

Accelerated dissolution test

Prepare a glass with half of this product applied and half unapplied, put it in a freezer with water.

Freeze the coated surface as a thin film. → It is easy to dissolve The uncoated surface freezes as a lump. → hard to melt

I could confirm the result.



The Data of PV Plant in Taiwan is measured from Oct,2017 until Sep,2019

■Place : PV Plant in Taiwan

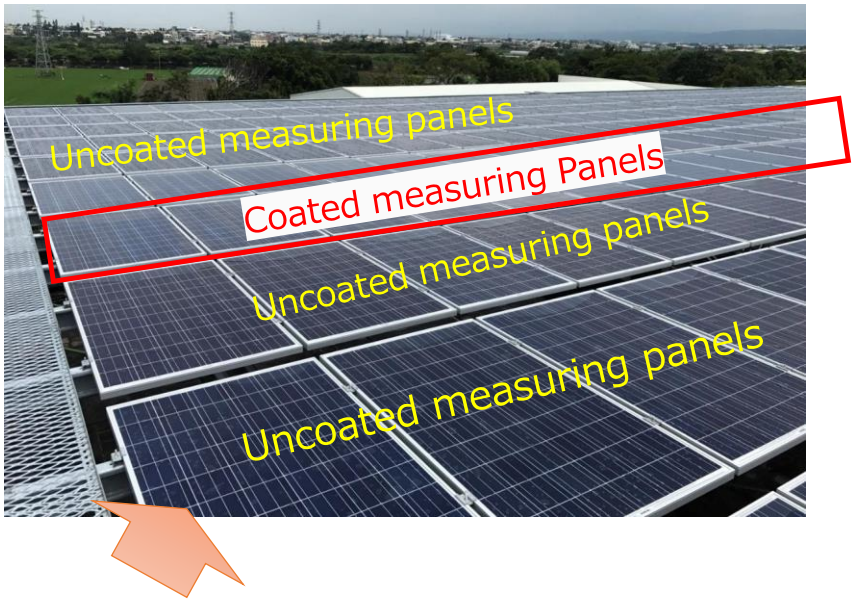
■Measuring Target : 18 pcs of solar panels in 1 row in the middle

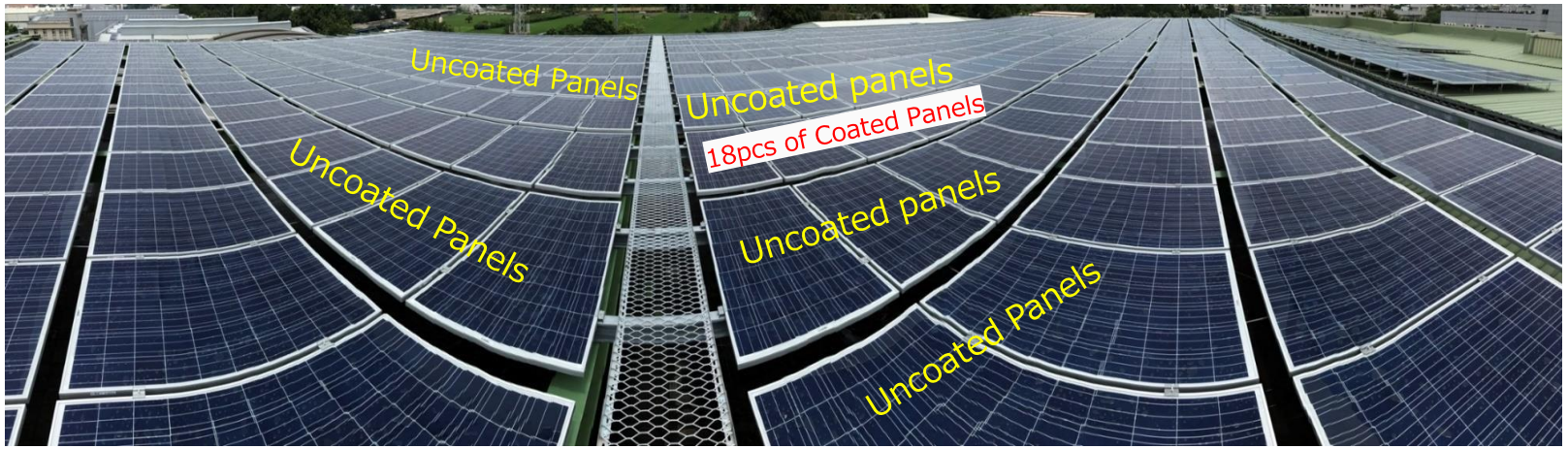
■Purpose :

Six rows of solar panels were prepared and only one middle row was coated. The power generation amount of each string was measured every day. The measurement method was based on the amount of power generated in a pre-coated string. Compare the remaining five uncoated columns with the amount of power generation increased or decreased from the reference amount of the coated panel.

■Record

Anti-fouling Coat was applied in the factory in June 30th, 2017
PV panels was installed on August 10th, 2017
Power generation and Electricity sales started at the end of September 2017.
Measurement of power generation started in October 2017.





Measurement data from October 2017 to September 2019: Measurement record for about 2 years

First year : 6.03% Annual average

Date	Difference in power generation efficiency (%)
Oct, 2017	2.89%
Nov, 2017	8.83%
Dec, 2017	17.75%
Jan, 2018	10.85%
Feb,2018	12.9%
Mar, 2018	5.97%
April, 2018	3.23%
May, 2018	1.26%
June,2018	2.7%
July, 2018	2.56%
Aug, 2018	2.2%
Sep, 2018	1.25%

Second year : 5.64% Annual average

Date	Difference in power generation efficiency (%)
Oct, 2018	4.61%
Nov, 2018	10.83%
Dec, 2018	7.37%
Jan, 2019	13.53%
Feb,2019	5.16%
Mar, 2019	6.03%
April, 2019	5.04%
May, 2019	5.54%
June,2019	4%
July, 2019	1.81%
Aug, 2019	2.63%
Sep, 2019	1.2%

Applied for 4000sqm in Tochigi, Japan

Applied for 198pc panels(508.8sqm)

Step②Wash with water
and wipe off

Step③Application

Installment record

100 sqm in Ibaraki, Japan

310 sqm in Kagoshima, Japan

70 sqm in Kagoshima, Japan

1500 sqm in Osaka, Japan
1000pc of panels

162 sqm in Korea
100pc of panels

Applied in Thailand