

NanoPhos

Pioneering
Nanotechnology



More Income
Less Effort
for PV installations

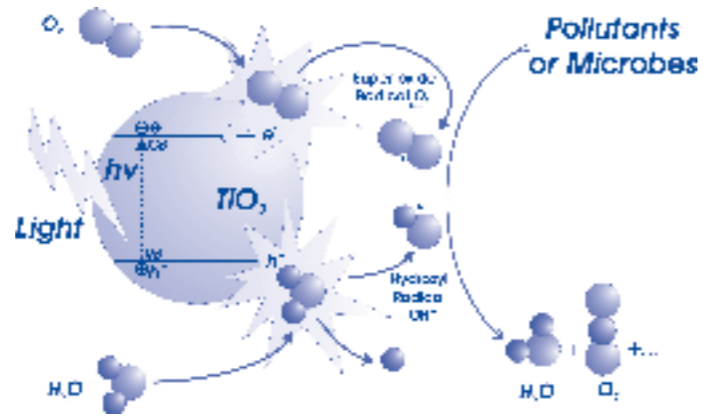


SurfaShield® G by NanoPhos

An **innovative** self-cleaning, anti-reflective & anti-soiling coating that increases annual **energy** output **up to 9%**

How it works

SurfaShield® G is an innovative self-cleaning coating based on proprietary nanostructured Titanium Dioxide (TiO₂) photocatalytic technology for existing photovoltaic installations. It acts by reducing the amount of sunlight reflected off solar panels, absorbing more of the diffused light and preventing dust, soot or dirt accumulation. The super-hydrophilic nature of SurfaShield G adds easy cleaning properties and minimizes maintenance costs.



Techno Economical Analysis

1MW Solar Plant in Spain:

- ▶ Nominal Annual Energy Output: **1,502.334MWh**
- ▶ Expected Energy Output Increase: **+6% (+4% guaranteed)**
- ▶ Expected Extra Income: **20,000 - 30,000 € annually**
- ▶ SurfaShield G Material Needs: **180L**
- ▶ Investment Payback Period: **Less than 12 months**
- ▶ Expected Investment Lifetime: **>120 months**



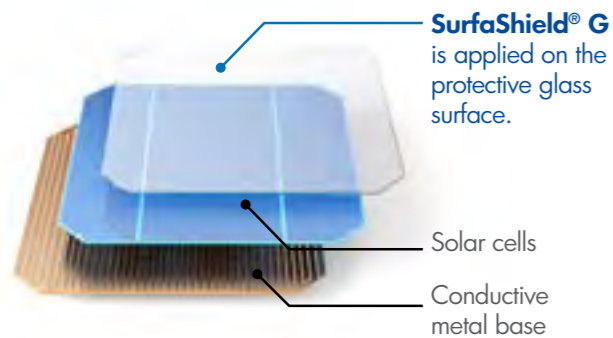
World Patent Protected

2 - 3% Glass Transparency Increase

Up to 9% Energy Output Increase

65% Cleaning Effort Reduction

	SurfaShield® G	Others
Composition	Fused TiO₂ - SiO₂ nanoparticles. TiO ₂ nanoparticles induce self-cleaning. SiO ₂ promote surface adhesion.	SiO ₂ or modified SiO ₂ (silicone) layer. Best case scenario is SiO ₂ provides water repellence, which is falsely claimed as self-cleaning (actually it's easy-cleaning).
Transparency	2.5-3% increase. Nanoparticles reduce surface roughness that would induce secondary light reflection.	Up to 2.5% increase. Silica layers smoothens but still doesn't eliminate surface roughness.
Anti-dusting	Direct. TiO ₂ is a conductor under light and the only to be antistatic.	Indirect. SiO ₂ is insulator and does not present antistatic properties. Anti-dust properties come only from surface smoothing.
Diffuse Light	Power Output Boosting. Significant additional power output increase due to TiO ₂ high refractive index. Incident photons in high angles are directed to the PV instead of getting reflected.	No effect. SiO ₂ does not alter properties under diffuse light.
Applicability	Easy on existing installations. HPLV or air-spraying.	Medium to difficult application. In certain cases, application is linked to special equipment or in manufacturer's premises.
Power Output Increase	Up to 9%. 4.5% guaranteed in any environmental condition.	Up to 4.7%. Be careful on claims of PV efficiency increase: Average PV efficiency is 18%, therefore a 10% increase results only in 1,8% power output increase.
Surface Characteristics	Super-hydrophilic. Water droplets do not stand on SurfaShield® G modified surface.	Super-hydrophobic. Water droplets present lotus effect in case of modified silica coating formulations only.
Cleaning Effort	Reduced by 65%.	Average 55%. Claims between 30-80%.
Post Application Cleaning Medium	Water or Water spraying. No need for de-ionized water.	Water and detergents. De-ionized water still needed to prevent water droplet spots.
Durability	Minimum of 10 years.	Average of 2 years.
References	More than 1 GWp treated.	N/A Estimate for only minor field testing.

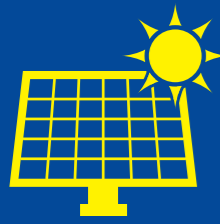


Advantages

- ⚡ More energy is generated.
- 💧 Water consumption (maintenance) is reduced.
- 💰 The investment in renewable energy sources become more attractive.
- 🌿 170m² of surface treated with SurfaShield® G eliminates airborne pollutants ~ 1 adult tree.
- 🌱 Environmentally friendly – Biodegradable product.
- 🌍 Did you know **SurfaShield® G** depollutes the air? **6,500m²** of **SurfaShield® G** treated modules or **1MW** equals the same ability to eliminate airborne pollutants as **41 adult trees**. Ideal for installations next to industrial facilities.

Application

Application takes place by spraying (fine mist). It is easy to align application in both the production of photovoltaic systems as well as on already installed PV systems by using portable spray guns or even drones. **Consumption rate: 35 m²/L**



SurfaShield® G Performance

GLASS TRANSPARENCY

up to **3%** Increase

SUPER HYDROPHILICITY

SurfaShield® G coated surfaces become Super-Hydrophilic

CLEANING EFFORT

65% Reduction

ANTI-REFLECTIVE

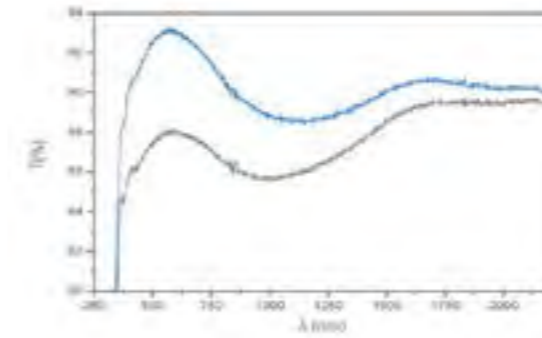
SurfaShield® G coated surfaces exhibit anti-reflective properties
More diffuse or high-angle incident photons are used

ENERGY INCREASE

Up to **9%**

DEGRADATION OF CONTAMINANTS

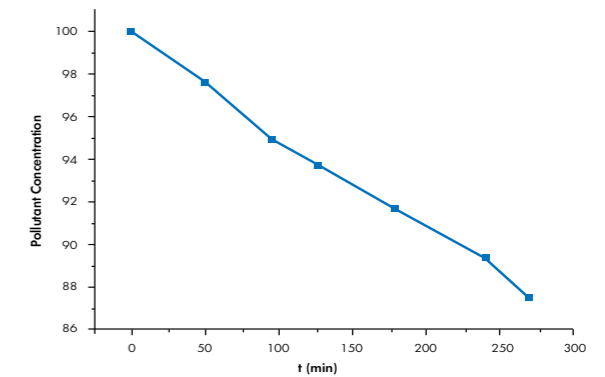
SurfaShield® G decomposes gaseous & organic pollutants



Glass Transparency

Transmittance spectrum of untreated and SurfaShield® G modified glass. The diagram (Transmittance spectrum) depicts an increase in transparency of SurfaShield® G (SSG) treated glass in the interesting wavelength range by ~ 3%.

SSG TREATED GLASS UNTREATED GLASS



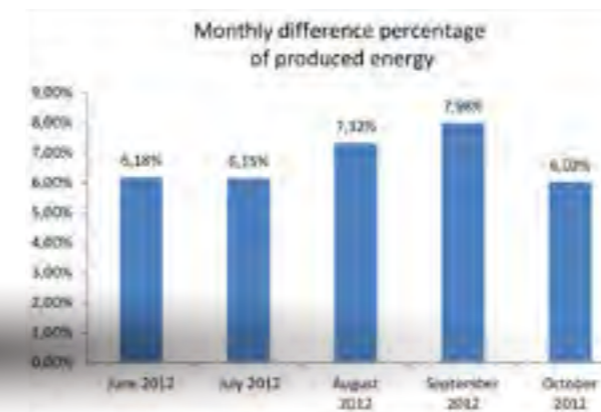
Degradation of Contaminants

SurfaShield® G decomposes gaseous & organic pollutants. Decomposition of pollutant (methyl orange) as a function of time.

Core benefits

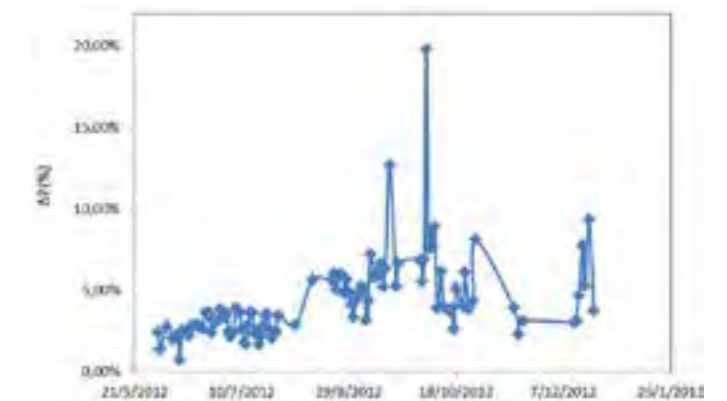


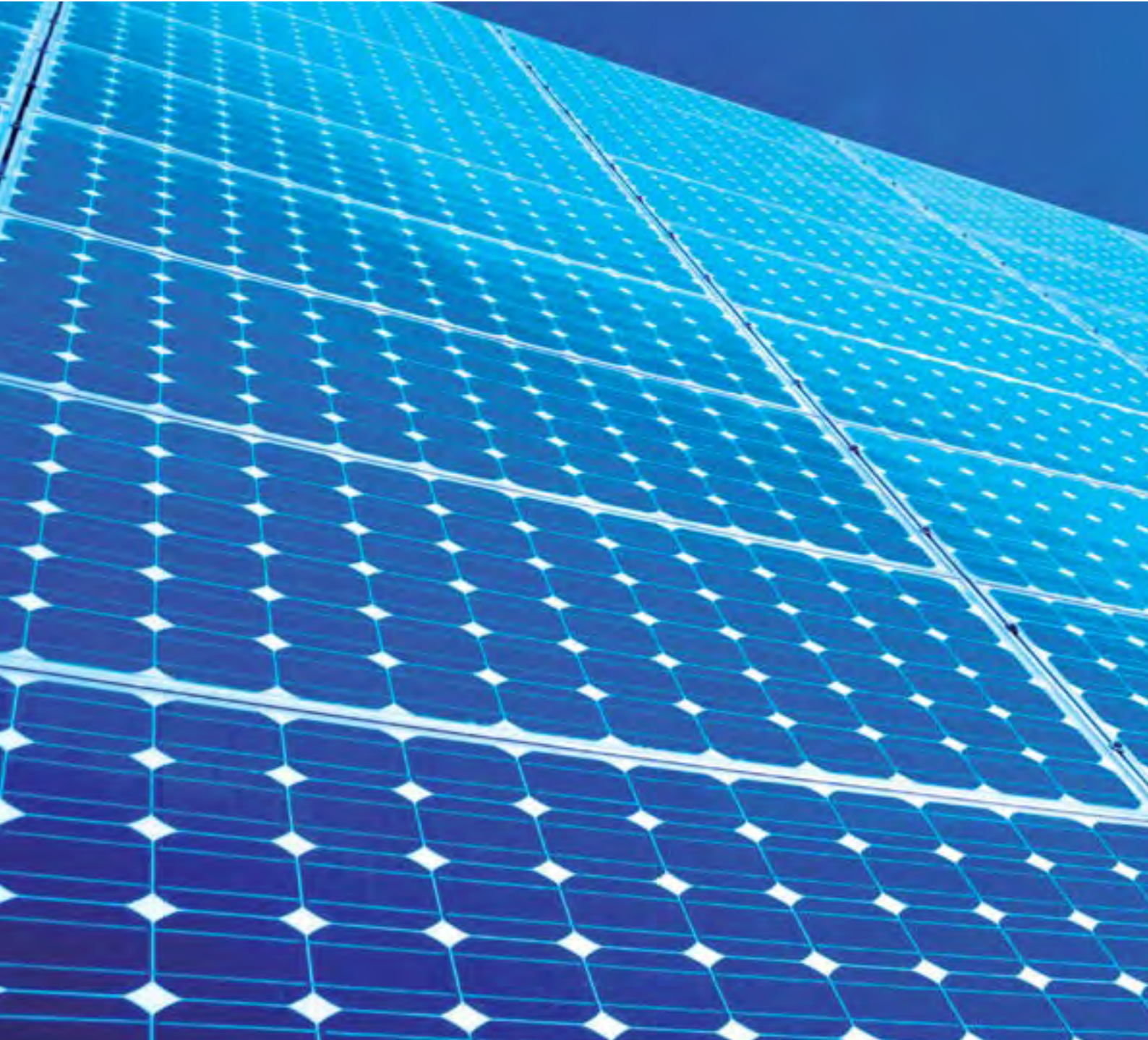
- More Energy Output
- Increased efficiency
- Prevents sand & dust accumulation; Antistatic
- Water can not form droplets that scatter the light; Super-hydrophilic & antifogging properties
- Anti-reflective
- Decomposes gaseous & organic pollutants
- Increases glass transparency
- Increases energy production during cloudy weather conditions
- Minimizes the cleaning effort; Self-Cleaning
- Always active – a photocatalyst that does not get consumed



Energy Increase

SurfaShield® G treated panels produces 5-8% more energy than untreated panel. Diagrams below illustrate a comparison of total energy produced by a SurfaShield G treated PV compared to a non-coated PV panel over a period of 6 months.





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