



**THE FUTURE OF PV PROTECTION**

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# **Solar Sharc®**

## **FAQ**

**June 2020**

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**Opus Materials Technologies Ltd**

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## General

### What is Solar Sharc®?

Solar Sharc® is a novel easy clean coating built on Patented technology. It has been developed for application onto solar PV panels. Multi-functionalised silica nanoparticles in a siloxane matrix provide a unique combination of repellency and durability needed for a long effective lifetime of low maintenance for solar PV.

### What makes Solar Sharc® different?

The Nano-particle structure provides high transparency, improving module efficiency by up to 4%. The coatings characteristics include:

- Easy Clean & Reduces the accumulation of soiling
- Hydrophobic > 110° contact angle.
- Highly repellent.
- Anti- Reflective -Enables the transmittance of more light than uncoated glass.
- Resistant to High Temperatures - Stable to temperatures in excess of 150°C.
- UV Resistant.
- Exceptional durability.
- Optimises PV Efficiency.

### How does Solar Sharc® work?

The novel breakthrough of Solar Sharc® is to co-locate water repellent functional groups alongside active functional groups on nano-structured particles which bond to the resin matrix, cementing the silica nano-particles into the resin giving a tough, durable and transparent coating. The nano-particles are smaller than the wavelength of visible light, so do not scatter light, providing a high degree of transparency. The transparent coating once cured creates a film on the PV glass. The coating acts as a barrier to reduce the accumulation of soiling on the glass substrate whilst optimising the amount of light transmitted to the PV cell.

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## Ultimate PV Protection how?

The origin of Solar Sharc® technology was research work carried on functionalised silica macro-molecules to improve the hardness of polymer coatings. The significant breakthrough came with the ability to functionalise silica nano-particles (30-500 nm) rather than macro-molecules. Nano-particles enable both tailored roughness and multi-functionalisation to achieve the required combination of high water repellency, durability and transparency to give you the ultimate PV protection.

## What do you mean by easy clean & anti-soiling?

The accumulation of dust, or other debris on the surface of PV modules leads to a reduction in power output by up to 50%. Research studies have shown that of the 17 types of dust pollutant, 6 types are likely to have significant impact on the power generation of a solar cell, including sand, dust & ash. Solar Sharc® is a novel advanced easy -clean coating which when applied reduces surface contamination.

## What does Anti Reflective & resistant to high temperatures really mean?

Solar Sharc® is not only durable & easy -clean it is anti-reflective, resistant to high temperatures and offers outstanding weather resistance. The anti-reflective properties of Solar Sharc® leads to an improvement in transmittance to enable over 93% of all available light. The Solar Sharc® coating is also stable to temperature in excess of 100°C for extended periods of time and shows only minor loss in repellence after 1000 hours QUV testing.

## Solar Sharc® is Hydrophobic what does this mean?

Solar Sharc® is a coating that is only a few microns thick. Consisting of silica (glass) chemically bound with repellent organic materials. Solar Sharc® readily repels water and water-borne contamination. Rather than wetting the surface water droplets form beads on Solar Sharc® and readily roll-off at low angles. Solid contamination such as dust and sand is reduced because it finds it difficult to bind to Solar Sharc® so are easily removed by the action of wind or by the use of reduced volumes of water.

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You claim unrivalled protection & specification what does this mean?

With high UV & chemical resistance Solar Sharc® represent a new and disruptive coating technology for the PV sector. With key attributes such as high light transmittance, ambient curing and versatile deposition methods the coating offers a compelling anti-soiling solution for the PV sector.

## Deposition

At the forefront of the development of Solar Sharc® has been the method of deposition. Different PV market sectors have different requirements. That's why we have focussed on the development of a coating that can be cured under ambient conditions. This versatility allows Solar Sharc® to be integrated into a manufacturing process through to retrofit deposition in the field for O&M application.

So how do you apply Solar Sharc®?

Solar Sharc® is a versatile coating technology. The coating can be wiped on for retrofit applications or sprayed on in OEM environments. The most suitable application for retrofit applications is wipe on with a Micro fibre cloth facilitating the solution to flow and form a uniform film\*. (\* full application instructions are detailed in deposition specification supplied with Solar Sharc®)

Do you have an Applicator?

We are in the R&D phase of a hand-held applicator for retrofit application. The powered applicator will facilitate application of a 2-micron coating and can be used on existing PV installations.

What other conditions should be considered when applying Solar Sharc®?

The coating should be applied at ambient temperature and at a relative humidity of 30-70%. The coating should be applied in dry conditions and never in the rain. Direct sunlight should be avoided where possible as it could affect the film forming and final properties. Strong wind conditions should be avoided, if this happens after deposition, aim to cover the asset with a suitably sized canopy, but avoid touching the coating.

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How thick should the coating be?

The coating should be applied no thicker than 2 Microns, to ensure optimal performance.

What is the thickness tolerance (lower and upper limit) for the current version of Solar Sharc®?

Below 1 microns thick is the lower tolerance and likely to have little effect above 4 microns is likely to result in cracking.

What if I make an error when applying through wipe application?

Mistakes can be rectified within 10 minutes.

How long does it take to cure?

The curing time depends on the ambient weather conditions, however, the coating will be fully cured within 3 days. In certain cases the coating may be non-tacky in a matter of hours.

What is the coverage of Solar Sharc®?

Based on a 2-micron thick coating 1 Litre will cover approximately 144 Square Metres.

How do I handle Solar Sharc® and is it safe?

All necessary handling & and safety information is contained within the MSDS which has been prepared in accordance with ECHA guidelines and complies with all relevant regulatory obligations. You should wear appropriate PPE equipment (refer to MSDS). Always open any container holding Solar Sharc® in a well-ventilated area. Be mindful that Solar Sharc® contains ammonia which may be released when opened so ensure that your face is held away.

How do I prepare the substrate?

The substrate to be coated should be clean, grease free and dry. We recommend the following cleaning protocol:



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- Use a soft brush to remove coarse surface debris. If the debris is 'caked' on the through wash to remove before initiating this step.
  - Wash the surface with warm water (if possible) with an added surfactant to remove remaining dust and dirt.
  - Wash the surface with clean water (warm if possible)
  - Ensure that the surface is grease free. Any spots can be removed with a cloth impregnated with alcohol.
  - Dry the surface ensuring that it is fully dry.
  - The glass surface must be fully dry before Solar Sharc® is applied.

How do I store Solar Sharc®?

Always store in a cool dry well-ventilated area. Protect against light and do not store above 25°C. Pot life is 12 Months if stored in containers up to 5 L. larger volumes than this will store for 3 months.

## Technical

I would like to know more of the technical features of Solar Sharc®

The coating has been independently field tested by CEA in France. These independent tests verified the compliance with IEC61215 standard the equivalent of 25 years. The tests included the following:

- DH, Damp Heat: 1000 hours at 85C, 85% relative humidity
- TC, Thermal Cycles: 200 cycles from -40°C to 85°C
- HF, Humidity Freeze: 15 kWh of UV light, 50 thermal cycle -40°C to 85°C, 20 cycles humidity freeze -40°C to 85°C with humidity rate monitoring
- UK Tests carried out determined a roll of angle of 38 degrees for Solar Sharc®
- Contact angle testing is notoriously variable and dependent on many factors. The variability of CA measurements means a value of  $\pm 5$  degrees is not uncommon. We would expect 99° and 106°

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What about light transmittance?

Normal Glass 91-92%

Glass Coated with Solar Sharc® 94.40%

What about DOI (Distinctness of Image)?

Normal Glass 96.5

Glass Coated with Solar Sharc® 97.1

Refractive Index (n)

Normal Glass 1.5 - 1.6

Glass Coated with Solar Sharc® 1.35

Diiodo Contact Angle

Normal Glass 50°

Glass Coated with Solar Sharc® 72.7 °

Sand impact test - WCA after sand impact test

Normal Glass – No test applied (as not coated)

Glass Coated with Solar Sharc® 87°(-19%) Partial degradation.

You highlight durable but how long does the coating last?

Solar Sharc® has been independently lab & field tested according to all IEC 61215 standards and has passed. This standard is the equivalent of 25 years.

So if I apply Solar Sharc® will it last for 25 years?

IEC61215 is the only current standard that can be used to measure the efficacy of the coating's capabilities. Local and global weather conditions can of course have an impact on the coating's durability as well as contributing factors such as cyclical cleaning regimes.

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So will I need to re -apply Solar Sharc®?

As with any type of coating, being be it wax, paint, varnish environmental conditions over time will have a detrimental impact. Accordingly, we anticipate that re-application will be required at some point to ensure optimised yield.

What energy boost have you seen with coated modules?

In independent lab and field tests we have seen an instant boost of 3 to 4% when compared to non-coated. Independent tests carried out by CEA in France on average, the energy produced by coated systems was significantly higher (+2.7%) than the energy produced by uncoated systems. This result confirms that the coating process does not alter the ability of the module to withstand outdoor conditions. It also demonstrates that anti-reflection property of Solar Sharc® generates increased optical absorption especially when angle of incidence is high.

Can Solar Sharc® save water and reduce O&M costs?

Yes, in a laboratory test two glass substrates (one coated with Solar Sharc®, the other uncoated) were exposed to an Arizona sand solution with 5 layers of sand deposited on top of each other, over a period of 20 hours at 4-hour intervals. In between each deposit, the substrates were baked at 45°C. (note that the sand did not fully adhere as part of the baking process to the Solar Sharc® coated substrate) They were then washed with deionised water, and the Solar Sharc® coated surface took 49% less water to be fully cleaned. So in terms of an O&M perspective this demonstrates a saving in the use of water and of course associated labour. Here is a link to a video which demonstrates the test: <https://solarsharc.com/solar-sharc-news/solar-sharc-release-new-anti-soiling-video/>

Are there any harmful chemical added in Solar Sharc® coating? When the coated glass is washed with water and rain, will it dissolve?

Solar Sharc® comprises of silica nano particles functionalised and embedded in a polysilazane matrix. As with any new disruptive technology the management of the potential environmental impact is of critical importance. The properties of these nanoparticles and chemicals used in Solar Sharc® have been investigated through a detailed literature review and we will continually engage with nanomaterial safety practices and relevant public bodies.

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- Solar Sharc® technology is in compliance
  - Solar Sharc® is safe: nanoparticles are chemically bound into the coating matrix.
  - Solar Sharc® follows best nanomaterial safety practices. Accordingly, we do not envisage any harmful waste.

Is Solar Sharc® shatterproof and able to contain broken glass fragments?

Unlikely, since the coating is very thin, if the glass shatters the coating is most likely to fail with the glass rather than acting as a laminating layer.

Thermal stability: Is Solar Sharc® able to withstand operating temperatures of 150-200°C?

Solar Sharc® stable to these temperatures for continuous operation for at least 168 hours.

What if the operating temperature is reduced to 100°C? Do you expect that to greatly increase the coating's life span?

We have not determined the lifespan at 150°C, at present we have only evaluated for one week. We expect the coating to have a considerable lifetime at 100-150°C since there are very few inherent mechanisms to degradation. Lower temperature would probably extend the lifetime.

What is the pot life of Solar Sharc®?

Assuming storage guidelines are adhered to we anticipate the pot life to be 12 Months +.

What is the measurement for Solar Sharc's® adherence to glass?

On glass, adhesion is measured as 5B against standard ASTM D 3359-97.

Is Solar Sharc® just an anti-reflective coating that has been adapted?

No, competitor type technologies have adapted existing AR coatings in an effort to provide additional sought-after characteristics that Solar Sharc® demonstrates. With Solar Sharc® we adopted a bottom-up approach that incorporates functionalised silica nanoparticles into film-forming matrices. It is well established that such nanoparticles are used to provide improved

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mechanical properties in coating. Our approach is to also use such particles as the source of surface roughness that promotes enhanced repellency.

## Testing

As part of the research and development of Solar Sharc® by who are where has testing been carried out?

Development Partners:

- TWI Cambridge UK
- Crest (Centre for Renewable Energy Systems Technology) Loughborough University (UK)

Test Partners:

- TWI Cambridge UK
- INES CEA France
- Crest (Centre for Renewable Energy Systems Technology)
- ARTIC (Advanced Resin and Coating Technologies Innovation Centre) London South Bank University
- Fraunhofer-Center für Silizium-Photovoltaik CSP

## Nano Safety

What is Nanoscience and nanotechnologies?

The application and growth of Nanoscience and Nanotechnologies is now being used across multiple industries. This disruptive technology provides a plethora of potential solutions to historical industrial challenges. Using nature as a guide, novel structural hierarchies can be assembled using the latest advances in functional materials design. This new "soft chemistry" approach allows materials, and particularly coatings to be tailored to the application, leading to enhanced materials with functional capability and specific properties.

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## What is the Environmental Impact?

As with any new disruptive technology the management of the potential environmental impact is of critical importance. The management not only addresses this fundamental issue but facilitates the wider adoption and future growth of novel bespoke materials which will have a far-reaching impact on multiple sectors.

## Safety Public Bodies

Ethical issues faced by nanotechnology are common with most emerging technologies. There are several public bodies involved in the development of new practices, procedures, standards, regulations and legislation for new materials and new working practices. The properties of these nanoparticles and chemicals used in SolarSharc® have been investigated through a detailed literature review and we will continually engage with nanomaterial safety practices and relevant public bodies.

## Is SolarSharc® technology is in compliance?

- SolarSharc® is safe: nanoparticles are chemically bound into the coating matrix.
- SolarSharc® follows best nanomaterial safety practices.
- SolarSharc® is in continuing engagement with relevant public bodies to assure and maintain standards.

## Research and Development

### What's your approach?

Continuing research & development is the foundation that underpins Solar Sharc®. We have adopted a collaborative approach to R&D by engaging and working with key enterprises. Ingenuity, invention and a unique materials by design pathway has facilitated the creation of Solar Sharc®.

### What is Materials By Design?

The fundamentals that underpin the materials by design ethos are:

- Materials with new functions, features, capabilities and processing.
- Association of dissimilar materials.
- Adoption of processing techniques.
- Optimisation of process parameters.

## MOQ (Minimum Order Quantities)

What is the minimum volume of Solar Sharc® I can order?

Solar Sharc® is a new technology, its manufacturing process is complex requiring the functionalisation of nano particles and integration into a film forming matrix. Accordingly, to make Solar Sharc® commercially viable the minimum order requirement is 10 Litres. Detailed below is an example of the coverage attainable based on 10 Litres of Solar Sharc®

Panel Watt Peak Capacity	Length	Width	SQ Metres	No Modules	Total SQ Metres	No Litres Required
330	2	1	2	720	1440	10.0

In this example we show the coverage based on 50 Litres of Solar Sharc®

Panel Watt Peak Capacity	Length	Width	SQ Metres	No Modules	Total SQ Metres	No Litres Required
330	2	1	2	3600	7200	50.0

What is the maximum volume of Solar Sharc® I can order?

Currently the maximum order is 1000 Litres of Solar Sharc® however, we do have supply chain capability to scale up for specific customer requirements.

What is your expected lead time?

Orders for 10 to 50 Litres our standard lead time is Seven weeks. For larger orders this will be increased, and we will confirm as part of our quotation process. We do retain smaller SKU's (stock kept units) so in certain instances we can ship volumes of 10 Litres with a shorter lead in time.

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## What does Solar Sharc® cost?

This information is commercially sensitive. If you would like a quotation, please complete the RFQ (Request For Quotation Document) and we would be happy to provide you with a full quotation in confidence.

## Do you provide samples? I would like to carry out a trial first

We do provide a samples kit comprising of 125ml of Solar Sharc® and the following items:

Item No.	Description of Goods	HS Code	Country of Origin	QTY	Packed in Box No.
1	Microwipe Cloth	63071010	UK	1	1
2	Powder Free Latex Gloves XL	40151900	UK	1	1
3	Panorama Paper Face Mask	48185000	UK	1	1
4	Terumo Sterile LUER Slip Syringe 30MI	90183110	UK	1	1
5	Solar Sharc® Buytl Acetate Mixture	32089011	UK	1	1

Due to the high demand for samples kits we do levy a charge for the sample and ask the shipping costs are met by the customer. Please note that we only ship by Air Freight and the sample kit is packed to comply with DG (Dangerous Goods) requirements.

## How much does the Sample Kit cost?

The cost of the sample kit is £99.00 + VAT (where applicable) but excludes the cost of airfreight shipping, Dangerous Goods certification & any importation duty.

## I would like a Sample Kit what is the process?

Please complete the RFS (Request For Sample) application form and return to it to us. We will then provide full a quotation with pro-forma invoice. Please allow 7 days for a response. This allows our shipping company to identify the most competitive logistics quotation.



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Can you Air Freight to any country?

Yes, in most cases. However, some countries do have restrictions that make air freight non-viable. We will be able to advise at the point of quotation.

Are there any other restrictions?

Yes, we can only ship to a commercial address not residential. We can only process the sample order once we have received full cleared payment in accordance with the terms of our Pro-forma invoice.

I would like to view the MSDS (Material Safety Data Sheet)

The MSDS for Solar Sharc® is available to download from the Solar Sharc® web site

I would like to view the TDS (Technical Data Sheet)

The TDS for Solar Sharc® is available to download from the Solar Sharc® web site

## **Where can I find more information on Solar Sharc®?**

Please visit our website [www.solarsharc.com](http://www.solarsharc.com) for more information on Solar Sharc®

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