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Technical Information

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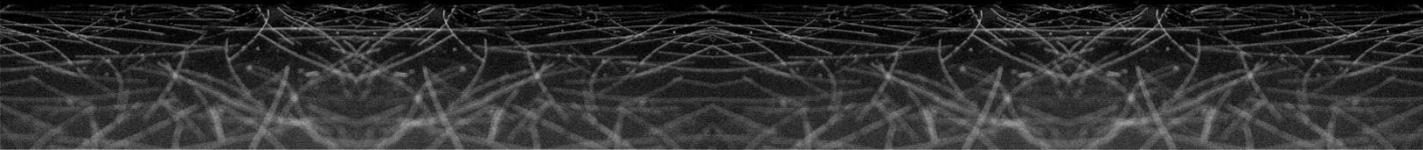
ECOS®

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March 2019

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Conductive  
Functionalization



**ECOS®**

silver nanowire technology

## 1 DESCRIPTION

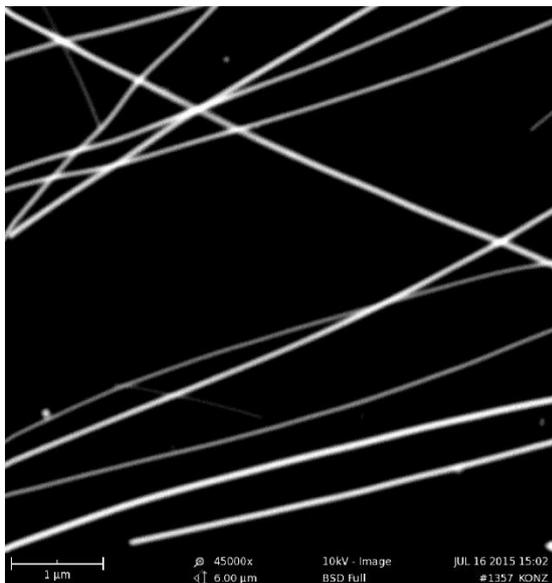
The ECOS® technology is designed for the conductive functionalization of a material or a product. ECOS® is based on silver nanowires with diameters of around 40 - 50 nm and lengths of 10 - 40 µm. Resulting from these size dimensions electrical conductivity can be achieved at very low loading levels.

Applications of products equipped with ECOS® are numerous and widely diversified due to the wide range of conductivity values that can be achieved. The high flexibility of silver nanowires allows functionalization of every kind of coatable surface. Consequently, the ECOS® technology can be used to create conductive transparent surfaces, conductive fibers and textiles and conductive curved substrates to name just a few. Depending on the amount of silver, surface resistances down to a few  $\Omega/\square$  and up to the antistatic region can be reached. End applications such as organic photovoltaics, touch sensors and low e textiles shall be exemplarily mentioned.

RAS AG provides silver nanowires in different formulations and preformulations to meet the customers' needs. Accordingly, you can obtain silver nanowires in form of a concentrate or as ready-to-use coatings for a wide variety of substrates. Additional information for use and application of ECOS® can be requested at our laboratory.

## 2 TECHNICAL DATA

ECOS® silver nanowires are provided as stabilized dispersions that prevent aggregation of the well-defined nanostructures. The following Figure shows a SEM image of silver nanowires and important technical parameters.



**diameter:** 30-50 nm

**length:** 10-40 µm

**physical state:** dispersion

**color:** metallic grey, iridescent

**pH:** 4-7

Figure 1. SEM image of ECOS® silver nanowires

Use ECOS® products safely. Always read the label and product information before use!

### 3 AVAILABLE FORMULATIONS AND PREFORMULATIONS

product	silver content	description
<b>ECOS® HC</b>	4.0 wt%	silver nanowire concentrate dispersed in ethylene glycol
<b>ECOS® Epoxy</b>	0,2 wt%	Epoxy formulation for coatings with high abrasion stability, 3 component system
<b>SURFLINK®</b>	-	surface activator in combination with ECOS® HC

*Prices are available on request*

**ECOS® HC:** stable viscous dispersion of silver nanowires in ethylene glycol including stabilizing agents. ECOS® HC can be diluted with water and short-chain alcohols (2-Propanol, Ethanol) in any ratio. ECOS® HC can be used in a diluted form as a transparent conductive coating for a wide variety of substrates or as additive in lacquers and inks.

**ECOS® Epoxy:** Epoxy formulation for coatings with high abrasion stability. The 3 component system combines antistatic properties with transparency and excellent mechanical and chemical resistance. The coating can be applied on variety of substrates with common coating techniques.

**SURFLINK:** SURFLINK is used as a surface activator in combination with ECOS® HC. SURFLINK improves the conductivity when used in combination with ECOS® products. After mixing ECOS® products it is recommended to use the formulation fresh, at least within 24 hours to obtain the best possible results.

### 4 APPLICATION METHODS

Coating Process
<ul style="list-style-type: none"> <li>• Roll to Roll (R2R)</li> <li>• Slot Die on Sheet</li> <li>• Spin Coating</li> <li>• flood coating</li> <li>• <i>under development</i></li> <li>• Inkjet Printing</li> <li>• Offset Printing</li> <li>• Gravure Printing</li> </ul>

Substrates
<ul style="list-style-type: none"> <li>• PET</li> <li>• Glas</li> <li>• PC</li> <li>• PMMA</li> <li>• Textile Fibers</li> <li>• Fabrics</li> <li>• .....</li> </ul>

Application
<ul style="list-style-type: none"> <li>• ESD</li> <li>• Touchscreen</li> <li>• OLED</li> <li>• OPV</li> <li>• Conductive Textiles</li> <li>• .....</li> </ul>

coating technique	recommended product
slot dye coating, bar coating	ECOS HC + SURFLINK
R2R	ECOS® HC + SURFLINK
spin coating	ECOS® HC + SURFLINK
flood coating	ECOS® HC + SURFLINK

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## 5 APPLICATION INSTRUCTIONS / RECOMMENDATIONS

### 5.1. HANDLING AND STABILITY

Before handling ECOS® products please study the materials safety data sheet. Further, careful attention must be paid to precautions necessary for handling chemicals.

Please store ECOS® formulations and preformulations cool and dark. For ECOS® ready-to-use formulations, a sedimentation during shipping and storage (after days - weeks) can occur and is normal. Gentle stirring or shaking until a homogeneous dispersion is obtained is recommended prior to use. Please avoid the use of strong mechanical force and ultrasound dispersers, since high shear rates lead to deformation and breaking of ECOS® silver nanowires.

### 5.2. MISCIBILITY

ECOS® HC can be diluted with water and short-chain alcohol (2-Propanol, Ethanol) at any ratio. Please avoid the use of strong mechanical force and ultrasound dispersers during diluting ECOS® silver nanowires.

ECOS® Epoxy is a ready-to-use formulation, a dilution is not recommended.

ECOS® products are not compatible with some organic solvents, especially acetone and ethyl acetate.

### 5.3. CURING

After coating, for ECOS® HC curing temperatures in the range of 140 - 150°C are recommended. Temperatures below 140°C can cause a loose in performance. Please avoid temperatures above 250°C.

For ECOS® Epoxy a curing temperature of 110°C (at least 5 min) is recommended.

### 5.4. COMBINATION WITH ADDITIVES

If you want to add your own additives (binders, thickeners etc.) ECOS® HC as conductive additive is recommended. Ideally additives compatible with aqueous systems are used. The stability of the obtained nanowire dispersion should be controlled after the addition of the additives. Coagulation or precipitations of solids should not occur within days and if so should be redispersible by shaking or gentle stirring. Furthermore, the binder to silver content must be adjusted to avoid the formation of an insulation layer on the silver nanowire network.

The ECOS® technology is not a one-size-fits-all solution. We rather customize each solution to give your product exactly the qualities and properties you want for your specific needs and manufacturing processes. Our product development experts and testing laboratories will help you to choose among our many product options to find – or develop – the right solution for you.

## 6 PROCESSING INFORMATION ECOS® AND SURFLINK

Best results with respect to conductivity and performance can be achieved by combining ECOS® products such as ECOS® HC with SURFLINK. Please note and proceed as follows:

- Please study the MSDS of ECOS® and SURFLINK carefully.
- Please wear protective equipment (safety glasses, gloves, lab coat).
- Please prepare the formulations freshly before use. Prepare only the amount that you need for the experiments, since the dispersion loses performance after a certain time.
- For the preparation of the formulation please first disperse ECOS® HC with water by shaking or gentle stirring until a homogeneous dispersion is obtained. Please avoid strong mechanical force or ultrasound.
- Afterwards, mix the dispersion with SURFLINK (recipe is available on request). A low viscous coating formulation (< 10 mPas) is obtained. After mixing, the formulation is stable for only 24 hours!
- Depending on the wet film thickness on a substrate, different surface conductivities can be obtained. Typical wet film thicknesses are 4 - 40 µm. Please cure the wet film at 150°C for 3 minutes.

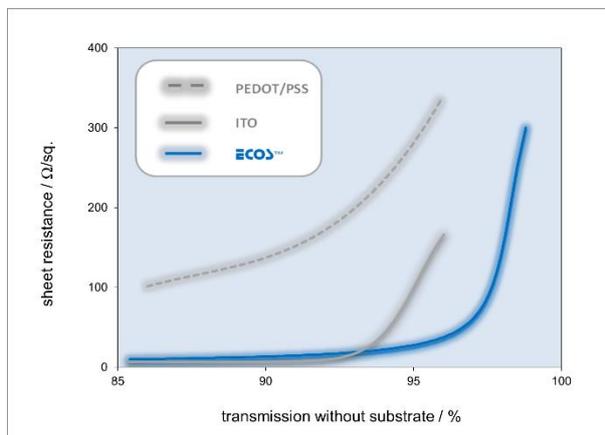
In the following table, typical results are shown when coating the formulation (0.2 wt% silver) on PES films at different wet film thicknesses:

wet film thickness	surface resistance
12 µm	< 100 Ω/□
24 µm	< 50 Ω/□
40 µm	< 30 Ω/□

The sheet resistance vs. transmission characteristic is shown in Figure 2. For the curve

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the formulation ECOS® HC, water and SURFLINK has been used following the procedure described above.



**Figure 2.** Sheet resistance vs. transmission characteristic of ECOS® in comparison with other conductive materials.

Textiles and fibers can be coated with the formulation ECOS® HC + SURFLINK, for example by using a dip and squeeze method.

## 7 HANDLING PRECAUTIONS

When handling this product, due attention should be paid to the information and details in the material safety data sheet. Furthermore, all precautions necessary for handling chemicals must receive careful attention.

Avoid contact with skin, eyes and clothing. When using do not eat, drink, or smoke.

Please use chemical resistant disposable gloves and eye protection.

Wash off affected skin with plenty of water. Remove contaminated clothing and wash off affected cloth with plenty of water.

## 8 AVAILABLE PACKAGING

product	available package
ECOS® HC	0,5 kg, 1 kg, 5 kg
ECOS® Epoxy	1 kg, 5 kg, 25 kg
SURFLINK	1 kg, 5 kg, 25 kg, 200 kg

## 9 DISCLAIMER

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## 10 CONTACT DATA

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