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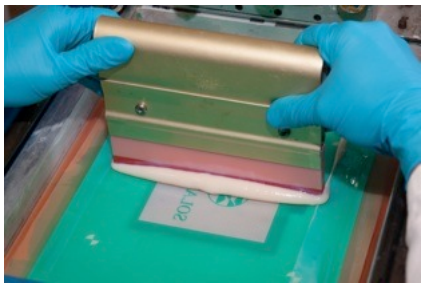
Ti-Nanoxide R/SP

Screen-Printing Reflective Titanium Dioxide Paste

For industry or researchers and industries who manufacture or study Dye Solar Cells, Ti-Nanoxide R/SP is a screen-printing paste which provides an opaque light scattering titania after sintering.

Unlike other titania that is supplied in powder form, Ti-Nanoxide R/SP is ready to be printed and doesn't require any processing before use. Our product is high quality and tested in real solar cells.



Characteristics

Intended for	screen-printing, slot-coating (doctor blade)
Aspect	white viscous paste
Resulting Layer	opaque
Particle Size	> 100 nm
Concentration	~18% wt.
Medium	terpineol, organic binders
Surface Area	~15 m^2/g (after firing)
HS Code	2823.0000

Retail Quantities

10 g	ref.	14811
20 g	ref.	14821
50 g	ref.	14851
100 g	ref.	14812
200 g	ref.	14822
500 g	ref.	14842
1 kg	ref.	14813

Pricing on product page:
solx.ch/tinanorsp

How to Order

Please visit our webshop at shop.solaronix.com, or send us an e-mail or fax indicating your desired products.

Bulk Supply

In addition to the retail quantities listed above, Ti-Nanoxide R/SP is also available in bulk for industrial purpose. Inquiries are welcome.

The research leading to this product has received funding from the European Union Seventh Framework Programme (FP7/2007- 2013) under grant agreement n° 227192, FP7-ENERGY-2008-FET, Project SOLHYDROMICS.

USAGE

Ti-Nanoxide R/SP is a screen printing paste that is transformed into an opaque light scattering film of TiO_2 by firing at 450-500°C. This scattering layer **does not** adsorb sensitizing dye molecules but rather reflects transmitted light back towards the sensitized TiO_2. e.g. Ti-Nanoxide T/SP, Ti-Nanoxide HT/SP, or Ti-Nanoxide MC/SP.

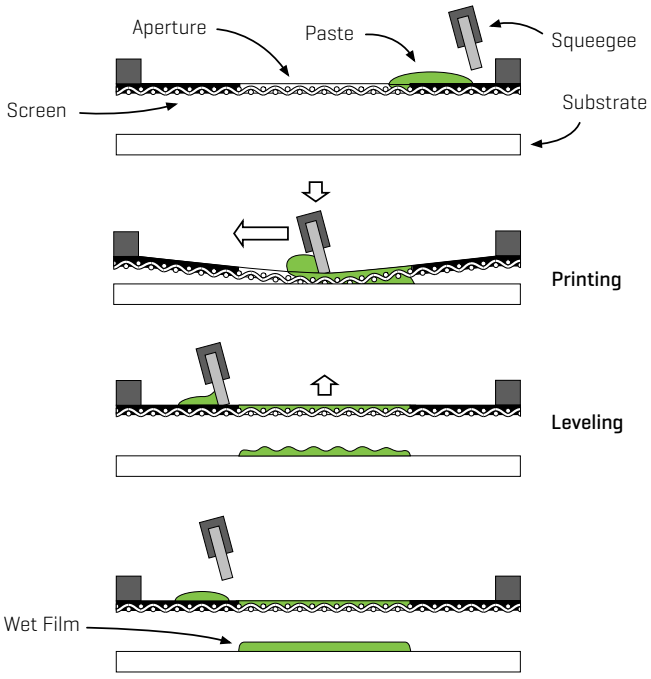
Printing Procedure For Titania Electrodes

Stir the paste well before using for an even deposition. Place an excess of paste at the top of the screen and use it to wet the squeegee.

Place the squeegee behind the paste and press down with enough pressure to bring the screen into contact with the substrate and bend the soft part of the squeegee.

With a smooth movement, and maintaining even pressure, pull the squeegee from the top to the bottom of the screen. The paste is forced through the fine mesh of the printable area of the screen and deposited onto the substrate.

Make sure to use enough Ti-Nanoxide R/SP to complete your deposition in one pass.



Schematic representation of the screen-printing process

The diameter of the threads and the thread count of the mesh dictates how much of the paste is deposited onto the conductive glass substrate

A 61-64 mesh (61 threads/cm, 64 µm thread diameter) leads to 4 µm thick layers after firing. A 43-80 mesh yields an 8 µm thick layer after firing.

The thickness of this scattering layer must be limited to 4 µm or less for three important reasons. First, the mass transport of ions is limited in this scattering layer because the porosity is lower. This mass transport limitation represents an internal resistance in the cell which leads to decreased fill factor and lower overall power conversion efficiency. Second, this layer is screen-printed on top of the transparent TiO_2 and can result in an overall TiO_2 layer thickness greater than the 12-16 µm adhesion limit. Finally, the Ti-Nanoxide R/SP layer is opaque at 4 µm, additional material is superfluous.

To improve adhesion and obtain a more aesthetically pleasing layer, let the paste self level for several minutes before drying or firing.

The Ti-Nanoxide R/SP is commonly used as a reflective layer printed on top of transparent TiO_2 layer(s). It is necessary to dry the previously printed transparent layer(s) between each successive printing. Simply warm the substrate to 120°C and wait for the solvent to evaporate completely, about 5 minutes. Allow the substrate to return to room temperature before the next print.

Sintering Procedure For Titania Electrodes

It is necessary to fire the titania layer to remove the organic screen printing vehicle and to enhance electron transport. Heat the substrate to 475°C with a slow temperature ramp, ca. 30°C per minute. Maintain 475°C for at least 30 minutes to ensure complete combustion and removal of the organic content. Turn off the heat source and let the substrate cool to < 100°C. Attempting to move the substrates while the temperature is >200°C may result in thermal shock and shattering.

It is best to fire the titania electrodes just before staining so they don't adsorb ambient moisture. Submerse them in the staining bath while still warm, around 50-60°C. Mesoporous titania electrodes are easily contaminated by volatile substances.

Common Pitfalls

The Ti-Nanoxide R/SP is meant to bring an opaque reflective layer onto a pre-existing transparent TiO_2 layer. Only a transparent layer, e.g. Ti-Nanoxide T/SP, Ti-Nanoxide HT/SP, or Ti-Nanoxide MC/SP, offers the high specific surface area to obtain a dye-load that is sufficient for stained electrodes to appear well colored. Using Ti-Nanoxide R/SP alone will result in a titania layer which adsorbs little to no dye, resulting in a poor coloration and very poor cell performance.

A cracked or flaked off titania layer indicates poor adhesion. Try decreasing the thickness of your printed titania layer(s). Typically you should be able to stack printed layers up to 12 microns thick without problems.

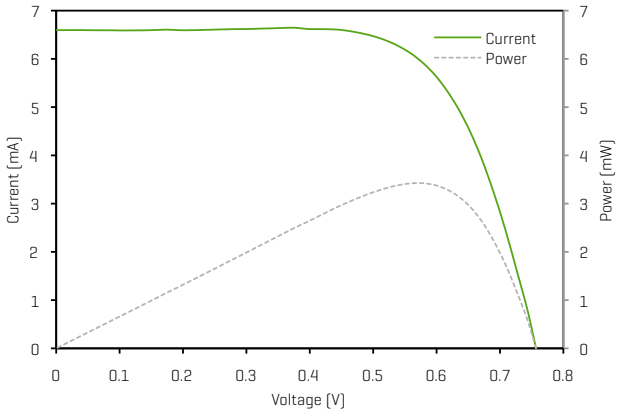
A yellow titania layer indicates insufficient firing or contamination. Try to fire the electrode again at high temperatures (450-500°C).

EXAMPLE

A Dye Solar Cell using Ti-Nanoxide R/SP

A 36 mm^2 titania photo-anode was prepared with 3 printed layers of Ti–Nanoxide T/SP and 1 printed layer of Ti–Nanoxide R/SP on a TCO22–7 glass substrate that was pre-treated with $TiCl_4$. The electrode was fired at 475°C and post treated with $TiCl_4$. After cooling to about 60°C the electrode was stained in a solution of Ruthenizer 535–bisTBA with chenodeoxycholic acid (1:10)as a co-adsorbent. A platinum coated cathode was prepared on another TCO22-7 substrate with a layer of Platisol T. The two electrodes were laminated together using Meltonix 1170–60, and the solar cell was filled with Iodolyte HI–30 through a hole in the cathode. The filling hole was then sealed with Meltonix 1170-60 and a thin glass circle of 6 mm diameter.

The resulting solar cell was placed under 1 sun illumination using a Solaronix Solixon Class-A solar simulator, and equipped with an adequate mask to avoid over-illumination, yielding the following current-voltage curve and tabulated results.



V_{oc}	757 mV	**FF**	0.68
J_{sc}	18.33 mA/cm^2	**Eff.**	9.5 %

STORAGE AND SAFETY

Storage

Store the product in its original container, upright and tightly sealed. Keep in a dry place at room temperature, away from light.

The product is not known to suffer from degradation when stored properly. Consider filling the container with inert gas for very long term storage.

While in use, avoid to keep the container open unnecessarily.

Safety

Ti-Nanoxide R/SP is for research and development use only and is intended to be manipulated by adequately trained personnel. Ensure good ventilation of the workplace, and wear suitable protective equipment.

Signal word: Warning

For a complete description of safety measures, please refer to the Material Safety Datasheet (MSDS) of Ti-Nanoxide R/SP.

solaronix.com/msds/

RELATED PRODUCTS

Cited in This Document

- Ti Nanoxide T/SP, screen-printable titania nanoparticles paste.
- TCO22-7, 7 ohm/sq. FTO coated glass substrates.
- Chenodeoxycholic Acid, staining additive.
- Ruthenizer 535-bisTBA, ruthenium photo-sensitizer.
- Platisol T, platinum precursor paint.
- Iodolyte HI-30, very high performance electrolyte.
- Meltonix 1170-60, hot-melt sealing films.
- Solixon, continuous illumination solar simulators

Consider Also

- Ti-Nanoxide T/SP, transparent titania paste.
- Ti-Nanoxide HT/SP, highly transparent titania paste.
- Ti-Nanoxide D/SP, opaque titania paste.
- Ti-Nanoxide MC/SP, high porosity titania paste.
- Labware: Staining Boxes, Plastic Tweezers.

REFERENCES

Articles About Titania Films

For further reading, have a look at the following articles:

- Inorganica Chimica Acta, 2008, 361, 677-683 [doi:10.1016/j.ica.2007.05.017]
- Applied Energy 2012, 92, 224-233 [doi:10.1016/j.apenergy.2011.10.038]
- Materials Chemistry and Physics, 2012, 136, 1060–1066 [doi:10.1016/j.matchemphys.2012.08.051]

People Using Ti-Nanoxide R/SP

A selection of publications using Ti-Nanoxide R/SP:

- Electrochemica Acta 2013, 107, 488–493 [doi:10.1016/j.electacta.2013.06.023]
- Journal of Power Source, 2013, 239, 122-127 [doi:10.1016/j.powsour.2013.03.079]
- Solar Energy Materials & Solar Cells 2013, 117, 9-14 [doi:10.1016/j.solmat.2013.05.012]

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