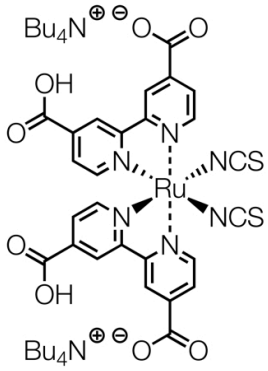
Solaronix SA
Rue de l'Ouriette 129
CH-1170 Aubonne
Switzerland

www.solaronix.com
T +41 21 821 22 80
F +41 21 821 22 89
info@solaronix.com

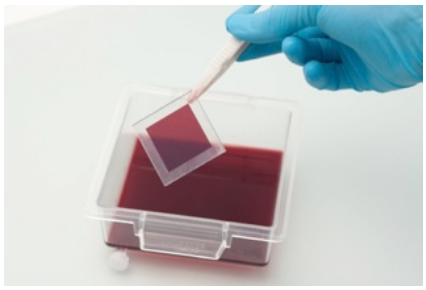
Ruthenizer 535-bisTBA

High Performance Ruthenium Photo-Sensitizer for Dye Solar Cell Application



For industry or researchers who manufacture or study Dye Solar Cells, Ruthenizer 535-bisTBA is a high performance ruthenium dye which very efficiently sensitizes wide band-gap semi-conductors like titanium dioxide.

Unlike lower quality supplies, Ruthenizer 535-bisTBA is ready to use and doesn't require extra purification. Our product is high quality and tested in real solar cells.



Characteristics

Aspect	dark purple powder
Synonyms	N719
Chemical Name	*cis*-diisothiocyanato-bis(2,2'-bipyridyl-4,4'-dicarboxylato) ruthenium(II) bis(tetrabutylammonium)
Molecular Formula	$C_{58}H_{86}O_8N_8S_2Ru$
Formula Weight	1188.6 g/mol
CAS Number	207347-46-4
HS Code	7110.4900
Absorption λ(max)	535 nm (1.47); 395 nm (1.43); 312 nm (4.91) ($\varepsilon/10^4$ M^{-1} cm^{-1})
Emission λ(max)	750 nm (EtOH, rt.)
HOMO Level	-5.34 eV
LUMO Level	-3.43 eV
Solubility	EtOH, MeOH, AcCN, DMF, basic H_2O

Retail Quantities

100 mg	ref.	21612
200 mg	ref.	21622
500 mg	ref.	21652
1 g	ref.	21613
2 g	ref.	21623
5 g	ref.	21653
10 g	ref.	21614
20 g	ref.	21624
50 g	ref.	21654
100 g	ref.	21615

Pricing on product page:
solx.ch/ru535tba

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, Ruthenizer 535-bisTBA is also available in bulk for industrial purpose. Please inquire.

USAGE

Ruthenizer 535-bisTBA is known to very efficiently photosensitize very efficiently titanium dioxide (titania) in the visible spectrum up to a wavelength of ~750 nm. This compound is commonly referred as N719 in the literature. It is so far one of the best pigment for Dye Solar Cells and has become an industry standard.

Ruthenizer 535-bisTBA is used to prepare staining solutions in which metal-oxide semi-conductor electrodes will be immersed. The dye naturally adsorbs on the semiconductor, resulting in a colored electrode bearing a sensitizing layer of dye molecules.

Staining Procedure For Titania Electrodes

Weight the amount of dry powder necessary to make a 0.5 mM ethanol solution of the required volume. Make sure the volume is sufficient to completely immerse the electrode(s).

The addition of chenodeoxycholic acid (10 fold) in the staining solution yields a significant performance boost.

Place the dye powder in a sealable container and add the required volume of ethanol. Absolute ethanol is good, but not strictly necessary. Alternatively, methanol can be equally employed with this dye.

Stir the mixture in a sealed vessel at room temperature (e.g. a glass bottle with stir bar). The solution rapidly turns dark purple although most of the solid is yet to be dissolved. Coarse grains can take awhile to dissolve, so prolong stirring until no traces of solid are visible.

If necessary, briefly sonicate the solution to help dissolution. Beware that excessive sonication is potentially harmful to the dye molecules.

Position the titania electrodes in a flat-bottomed, sealable container, side by side, with titania layers facing up. This is important in order to prevent scratching the fragile titania surface.

Pour a freshly prepared dye solution into the container and fully immerse the electrodes. Too little liquid won't allow the titania surface to adsorb enough dye and the electrodes may appear unevenly colored.

For best results fire the titania electrodes just before staining so that they don't pick up ambient moisture. It is best to put them in the staining bath while still warm, 50-60°C. Such mesoporous titania electrodes are easily polluted by volatile substances.

Seal the container with a lid and wait for the titania surface to get entirely stained. This takes several hours and can be conveniently left overnight. Make sure to avoid excessive light exposure during the staining process. Dye molecules are very light sensitive in solution, and even more so when adsorbed on titania and dry.

Remove the stained electrodes with plastic tweezers (to avoid metal traces pollution). Rinse thoroughly with ethanol to remove any excess dye which could otherwise cause a detrimental build up of dye molecule. Discard the rinsing waste.

Staining solutions can be reused several times, provided the concentration is sufficient. However, dye solutions are not suitable for long term storage. Dye oxidation and precipitation may occur over time. It is preferable to store the dried dye powder in its original container and prepare solutions when needed.

Completely dry the electrodes with an inert gas flow or with a brief blow of a hair-drier from a reasonable distance. Make sure to assemble the solar cells immediately. Stained electrodes are fragile, keep them in a sealed environment away from light until you are ready for assembly.

A properly stained titania electrode should look quite dark (especially if opaque) and purple (in any case), otherwise it will result in poor cell performance.

Common Pitfalls

A white or faded coloration indicates poor staining, the entire surface of the electrode visibly didn't get colored. Try to increase the dye concentration or lengthen the staining time. If the problem persists, use recommend staining conditions for troubleshooting, change solvent, or check for moisture in the solution.

It could also indicate the structure of the titania electrode is not porous enough. Investigate possible titania issues such as firing process, poor porosity, or large particle size.

A brownish stained electrode indicates the dye has been oxidized, it's no longer purple. Discard the staining solution for a fresh one if it has changed color as well. Also, avoid exposing freshly stained electrodes to ambient atmos-

phere or moisture of too long, dye molecules adsorbed on the titania can be easily oxidized, especially when exposed to light.

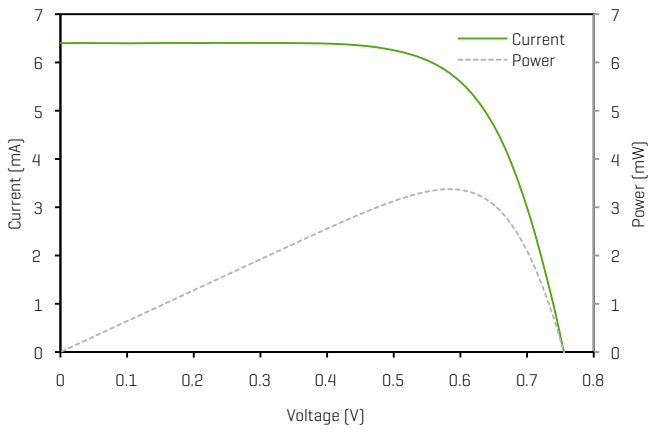
Staining the electrodes for too long will severely reduce solar cell performance due to dye molecule buildup. Consider using a lower concentration, or shorten the staining time if possible.

EXAMPLE

A Dye Solar Cell Sensitized with Ruthenizer 535-bisTBA

A 36 mm^2 titania photo-anode was prepared with 2 prints of Ti–Nanoxide T/SP and 1 print of Ti–Nanoxide R/SP on a piece of TCO22–7 glass substrate. The electrode was treated with $TiCl_4$, and stained in a solution of Ruthenizer 535–bisTBA using the procedure described above 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}	755 mV
J_{sc}	17.78 mA/cm^2
FF	0.70
Eff.	9.4 %

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 exposure.

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 leaving the container open unnecessarily.

Safety

Ruthenizer 535-bisTBA is for research and development use only and is intended to be manipulated by knowledgeable personnel. Ensure good ventilation of the workplace, and wear suitable protective equipment.

Signal word: Danger

For a complete description of safety measures, please refer to the Material Safety Datasheet (MSDS) of Ruthenizer 535–bisTBA.

solaronix.com/msds/

RELATED PRODUCTS

Cited in This Document

- Chenodeoxycholic Acid, staining additive.
- TCO22–7, FTO coated glass substrates.
- Ti–Nanoxide T/SP, screen-printable titania nanoparticle paste.
- Ti–Nanoxide R/SP, screen-printable reflective titania paste.
- Platisol T/SP, screen-printable platinum precursor paste.
- Iodolyte HI–30, very high performance electrolyte.
- Meltonix 1170-60, hot-melt sealing films.
- Solixon, continuous illumination solar simulators.

Consider Also

- Ruthenizer 535, protonated analogue to Ruthenizer 535–bisTBA
- Ruthenizer 620–1H3TBA, panchromatic ruthenium dye
- Ruthenizer 520–DN, amphiphilic ruthenium dye
- Labware: Staining Boxes, Plastic Tweezers

REFERENCES

Articles About N719

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

- Chem. Commun. 2003, 1456-1457 [doi:10.1039/b302566g]
- Inorg. Chem. 1999, 38, 6298-6305 [doi:10.1021/ic990916a]
- Inorganica Chimica Acta 2009, 362, 5155-5162 [doi:10.1016/j.ica.2009.09.001]
- J. Phys. Chem. B 2003, 107, 14244-14248 [doi:10.1021/jp035483i]
- Nature Materials 2009, 8, 665-671 [doi:10.1038/nmat2475]
- Thermochimica Acta 2000, 348, 105-114 [doi:10.1016/S0040-6031(99)00486-4]
- J. Phys. Chem. C, 2011, 115 (17), pp 8825–8831 [doi:10.1021/jp111949a]

People Using Ruthenizer 535–bisTBA

A random selection of publications using Ruthenizer 535–bisTBA:

- Metrohm: Autolab Application Note PV01, PV02, PV03.
- Chang et al. Nanoscale Research Letters 2012, 7:688
- Chem. Commun., 2011,47, 1809-1811 [doi:10.1039/C0CC03312J]
- Phys. Chem. Chem. Phys., 2011,13, 19298-19301 [doi:10.1039/C1CP22819F]
- Scripta Materialia 62, 2010, 223–226 [doi:10.1016/j.scriptamat.2009.11.001]

Do you use this product? Would you like your article to appear here? Please let us know at materials@solaronix.com.

Find Out More

Visit the Ruthenizer 535–bisTBA product page for more information: solx.ch/ru535tba

How to Order

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

Feedback

Do you have any comments or suggestions? Help us improve this document, contact us at materials@solaronix.com