



TiO₂ Slide Preparation, Clean-Up, and Triiodide Electrolyte Solution Preparation

Making the TiO₂ Paste

The solar cell activity requires advanced preparation of TiO₂ slides. There are two methods for making the TiO₂ paste. The first one is the method mentioned in Institute for Chemical Education activity kit. The second method was mentioned at a symposium lecture by Haiyan Li and Jun Jiao. The second method was our preferred method. The second method was easier to spread and also seemed to be more durable if reusing the slides. The second method however does use caustic chemicals, needs specialized equipment and should only be performed by someone with a chemistry background.

Method 1:

Materials

- Degussa P25 TiO₂ powder
- Nitric or acetic acid solution (pH of 3-4)
- Large mortar and pestle
- Surfactant or clear dish detergent

Directions

1. Add 6 g of colloidal Degussa P25 TiO₂ powder in a large mortar.
2. Add a total of 9 mL of nitric acid or acetic acid solution (pH of 3-4) in 1 mL increments while grinding with a pestle. Be sure to only add another mL addition after the previous mixing has produced a uniform mixture. This process should approximately take 30 minutes to complete. The finished product should look like thick white paint.
3. Add a drop of surfactant to 1 mL of deionized water.
4. Transfer the TiO₂ paste to a small dropper bottle and add the surfactant and water mixture. The suspension should not be ground or mixed after the surfactant is added.
5. Allow the surfactant to sit for at least 15 minutes before coating the slides.

Method 2

Materials

- Degussa P25 TiO₂ powder
- Centrifuge tube
- Glacial acetic acid
- Anhydrous ethanol

Directions

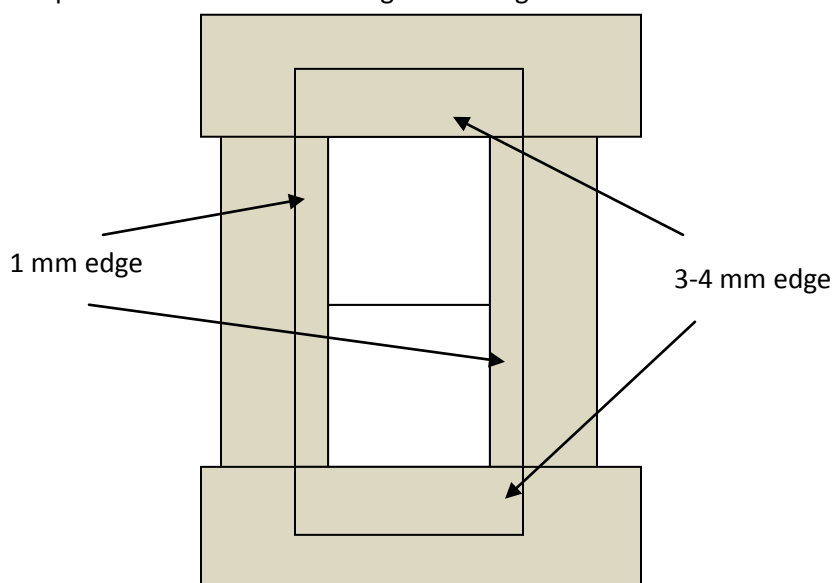
1. Weigh 2.0 g Degussa P25 TiO_2 paste.
2. Add to a 50 mL centrifuge tube.
3. Add 3.0 mL glacial acetic acid and mix with glass rod until uniform.
4. Add 10 mL of anhydrous ethanol.
5. Cap and shake.
6. Sonicate for 3.4 hours.
7. Put paste into a small dropper bottle.

Coating the glass slides

The glass slides will be coated with the previously prepared TiO_2 paste. The coating needs to be on the conductive side of the glass slide.

Directions

1. Clean the glass slide with ethanol and dry using a Kimwipe.
2. Using a multimeter determine which side of the glass slide is conductive. Set the multimeter to measure ohms. When the multimeter reads "1 ." this means there is ultimate resistance and that side is nonconductive. If the multimeter reads something other than "1 ." this is the conductive side of the glass slide. The conductive slide usually reads 10 – 30 ohms. That side will be coated in the TiO_2 paste.
3. Place two glass slides conductive side adjacent to each other up on the work area.
4. Apply scotch tape to two opposite edges of the slide no more than 1 mm from the edge of the slide. The tape should also secure the slide to the table work area. Apply a third and fourth piece of tape to top of the first slide and the bottom of second slide. This piece of tape should be placed 4-5 mm from the edge. See diagram below.



5. Apply a thin line to the edge of the slide near the tape on both slides.
6. Using a glass rod (held horizontally) spread the suspension across the surface of the slide. Try to distribute a uniform coating on the slides by repeating the sweeping motion on the surface of the slides.
7. Allow to dry for 1 minute and then carefully remove the tape from the slides.

Annealing the Glass Slides

There are three ways to anneal the slides either in an oven, with an alcohol burner or on a hotplate. They need to be heated to 450°C so make sure whatever way you are annealing the slides it reaches 450°C. They need to be heated for 15 minutes. If using an alcohol burner, trim the wick and wet with ethanol so that soot is not produced.

While annealing the glass slides it is important to cool them down slowly as the glass can fracture or break.

Cleaning the Glass Slides

The TiO₂ coated slides can be reused after they are cleaned and re-baked. The slides need to be rinsed with anhydrous ethanol. After rinsing they are to be re-baked on a hot plate or in an oven for 10 minutes at 450°

Triiodide Electrolyte Solution Preparation

It is simple to prepare the electrolyte solution if you have the proper chemicals. However it has become increasingly difficult to obtain pure iodine crystals. An alternative that can also be used is a triiodine tincture in alcohol. This is used as a farm animal antiseptic and can be found at most feed stores and can also be found at duboisdistributors.com (item TDINEPT). It is important that it is a **triiodide** tincture and not an iodine and ammonia tincture.

Materials

- Iodine crystals
- Potassium iodide
- Ethylene glycol

Directions (10 mL of solution)

Dissolve 0.127 g of iodine crystals and 0.83 g of potassium iodide in 10 mL of ethylene glycol.

References

Morre, J. (Ed) *Nanocrystalline solar cell kit: recreating photosynthesis*. (4th ed). Madison: ICE Publication

Li. H and J. Jiao. Symposium lecture.