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Dye Sensitized Solar Cell (DSSC):

Facilitator Guide: This is a guide for a facilitator in a museum floor setting, where a visitor spends less than 5 minutes.

Please read the complete Titanium Dioxide Raspberry Solar Cell Guide at <http://mrsec.wisc.edu/Edetc/nanolab/TiO2/index.html#Introduction> before following these steps.

Keep all the materials for the visitor to make a solar cell ready on the table. If you do not want to purchase the kit mentioned on the website see the **materials_list.pdf** document to find vendors where you can assemble your own kit.

Materials:

1. Nanocrystalline Titanium Dioxide (TiO₂) coated conducting glass (this can be prepared anywhere from a month to a few hours ahead of time using instructions from the *UW-MRSEC* website). See **troubleshooting_solarcell.pdf** for help.
2. Raspberry juice diluted with distilled water in petri dishes. Each petri dish can accommodate about 2-3 people at any given time. Estimate the number of dishes based on the number people you will be guiding through the activity at any given time.
3. Note that this activity can be done with many other juices. *For example at the MRS Spring Meeting student mixer, students were challenged to find the most effective 'dye'. They used beer, white and red wine as well as blackberry, strawberry and raspberry juice.*
4. Ethanol in wash bottles
5. Kim wipes (or any residue free lab quality dry wipes)
6. Distilled water in wash bottles
7. Triiodide solution for electrolyte
8. Binder clips
9. FTO/ITO clean conducting glass slides (same number as the TiO₂ coated ones)
10. Soft lead Pencils for making the 'graphite' coating (the *MRSEC website* uses soot from a candle to make the graphite coating; you can easily substitute a No.2 pencil for it).
11. Multi-meters and wires with alligator clips.
12. Goose-neck lamps if out-door sunshine is not available (you can use an old fashioned overhead projector if you have one).
13. Gloves

Steps for a successful assembly of the DSSC:

1. Have the visitor choose a dye or juice for making their solar cell. Give them a pair of gloves to work with. Though there is no danger from any of the chemicals used in the activity, raspberry juice can stain fingers.
2. Place the TiO₂ coated slide face down in the petri-dish containing the liquid. The efficiency of the solar cell is directly proportional to the time the TiO₂ is in the dye (upto a maximum of 15 minutes). A working solar cell can be observed if the TiO₂ soaks for as little as 2-3 minutes.

Role of TiO₂: Nanocrystalline TiO₂ acts as a scaffold so the dye molecules can bond to its 'rough' surface. The longer the TiO₂ soaks in the dye, the greater the number of dye molecules available for charge generation. This is called the anode or the working electrode.

3. While the TiO₂ glass slide is soaking, have the visitor take one of the uncoated FTO/ITO conducting glass slides. Clean it-- first with distilled water and then with ethanol. Wipe dry with a Kim-wipe. Take care not to touch the conductive side with your hands and hold the slide by the sides.
4. Check the two sides of the FTO/ITO slide for the conductivity with the resistance setting on the multimeter.

The following steps 5 and 6 should be performed in as little time as possible (1-2 minutes) in order to avoid exposing the dye coated TiO₂ to air/light!

5. Coat the conductive side of this slide with the pencil, take care to cover the entire surface of the slide with a uniform coating. This will be the graphite/carbon electrode (negative) for the solar cell.

Role of Carbon/Graphite: The coating of carbon/graphite acts as the counter or the negative electrode.

6. Gently, holding the sides, take the TiO₂ coated slide out of the liquid dye. Wash the TiO₂ side first with water and then with ethanol. Gently pat dry with a kim-wipe. Take care not to rub the kim-wipe on the TiO₂. The color of the TiO₂ will now appear to be purple if you have used raspberry juice.
7. Assemble the solar cell as follows: Place the TiO₂ side facing the graphite coated glass slide as shown in the video on the UW-MRSEC website. Put binder clips on the flush side as shown.

8. Place 2 drops of the triiodide solution (liquid electrolyte) at the seams of the slide assembly.

Role of Electrolyte: Iodine, is the electrolyte that helps the charge transfer process. As the light is converted to electricity by the 'dye', it loses an electron and acquires a positive charge; the electrolyte donates its electron to the dye and regenerates it so that the cycle can be repeated again.

9. Alternately clip and unclip the binder clips so that all of the iodine is pulled in between the two slides through capillary action.

10. Now the DSSC is ready to be tested. Connect the wires from the multimeter: negative terminal to the carbon coated electrode and the positive terminal to the TiO₂ coated slide.

In order to test the DSSC, either the voltage generated or the current generated can be measured. The multimeter should be set to either of the two.