Materials and Procedure

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|  | Materials needed   * Conductive (tin dioxide (Sn02)  coated) transparent glass * Colloidal titanium dioxide powder  (Ti02) * Surfactant - dish detergent * Acetyl acetone * Heat source ~450C (most propane BBQs work) * Iodide electrolyte solution * Pestle and Mortar, to mix and mash TiO2 and leafs * Binder Clips * Thin tape * Tweezers or forceps * #2 pencil, or carbon rod or candle * Multimeter, capable of measuring  volts, ohms, and amps * Wire with alligator clips * Ethanol * Gradated Cylinder (25 ml) * Small glass jars * Blackberries * Fresh lawn grass   I. Making the Ti02 Suspension  1. Measure 6g of Ti02  2. Add 0.2 mL of acetyl acetone to 1  mL of water.  3. Mix the Ti02 powder with the acetic acid solution while grinding.   4. Add about 15 mL of water in 1 ml  increments while continuing to grind.  5. Add more water if necessary.  6. Add a small drop of a surfactant, like clear dish detergent, with 1 mL of water.   7. Store in dropper bottle, carefully not to mix up the solution, as to form bubbles.  8. Allow the bottle to sit for about 30 minutes before using.        II. Counter Electrode Carbon Coating   1. Take one Sn02 coated glass plate. Use a multimeter to figure out which side is the conductive side. You will want  to apply the carbon on the conductive side.   2. Light candle, and hold glass closely to the candle flame with tweezers.   This allows the soot (carbon) to build up on the glass, you need to move the glass around so that it  is evenly coated.   3. Alternatively cover with carbon from a pencil or carbon rod.  4. This serves as a catalyst for the triiodide to iodide reaction.   5. If you choose you can try to anneal the carbon when you anneal the Ti02 coated plate.     III. Deposition of the Ti02 Film  1. Obtain and clean one Sn02 coated glass plate, rising in ethanol to clean, and dry with soft tissue.  2. Use a multimeter to check for the conductive side of the glass plate.   4. Tape down the Ti02 plate conductive side up with two strips of tape, masking only about 1 mm.  5. Tape down with one more strip of tape the the end, masking 4 to 6 mm of the glass. The masked area will be used to  attach clamps for the electrical connection.  6. (The thickness of the tape allows for a 40-50 micron thick Ti02.)  7. Place about one drop (5 microliters per square centimeter) of the Ti02 suspension.   8. Quickly slide a clean glass stirring rod horizontally over the plate, back and forth over the  plate, do this until the surface   looks uniform and even, if this doesn't  work, whip off the Ti02 with a damp cloth, and repeat step 7.  9. Allow the plate to dry for a few minutes.   10. Anneal the Ti02 film by placing  the conductive glass on a ring stand under a Bunsen burner for 10-15  minutes.  Or for home, place on aluminum foil and set in BBQ on high for about 15-20 minutes.   11. Allow to cool SLOWLY to room temperature as to avoid cracking.  12. Store these is an enclosed place to avoid getting dirty.   (I quickly turned the Ti02 dropper  upside down to avoid getting the top bubbles in the drop)                              IV. Preparing the Chlorophyll Dyes  Warning, Do not use plastic cups!   1. Grind fresh leaves with about 20+ ml of acetone. Continue doing this until the acetone is a dark green.  2. Use a coffee filter to filter this into light proof bottle.   3. Place several pieces of leaves in the bottle.  4. Place the Ti02 coated glass plate, that has been annealed, in the bottle. Add additional acetone to the bottle, if needed,   till it covers  the glass plate. Allow to react for 24 hours.         Preparing the Anthocyanin Dye  1. Crush 5-6 fresh berries in about 4-5 ml of deionized water.  2. Filter solution into light proof bottle.  3. Place Ti02 coated plate into filtered juice.   4. Allow to soak for about 10-15 minutes  5. If white is still visible place in juice for another 5 minutes.  6. When done wash film gently in water, then in alcohol.  7. Blot dry   8. If it won't be used right away place back in juice.    Assembling Cell   1. Remove the Ti02 coated plate from the dye, blot dry.  2. Carefully place the counter electrode on the other side of it, so that the Ti02 side faces the carbon side of the  counter electrode, leaving the non-Ti02 area exposed, this will be your area to clamp an electrical clamp too.  3. Attach binder clips to the edges.  4. Place one or two drops of iodide electrolyte at one end.   5. Alternately open and close each clamp and help allow the electrolyte to move uniformly in the cell.  Testing a Cell   1. Attach alligator clips to each hang over, the Ti02 side will be the - and the counter electrode side will be the +.  2. Attach clips to multimeter (a device used to measure current, resistance and voltage)   3. Set multimeter to Volts DC and move cell around till you get the high number, record that number.  4. Set multimeter to Current DC and move cell around till you get the highest number, record that number.   5. Set multimeter to resistance, cover the cell so it is dark, and record this resistance. (The resistance measurement  is made to help diagnose any cell faults.) |