Preparation and testing of a dye sensitized solar cell (DSSC)
Prof. Maciej Zalas, Adam Mickiewicz University in Poznan (Poland),
Resident Visiting Scientist of SmartMatLab Centre

[The steps in italics are to be carried out by the laboratory technician]

**Paste preparation**

1. *(For each student group)* Prepare 15 cm$^3$ of water in a beaker. Add one drop of concentrated HNO$_3$ (65-69%. Safety: gloves, googles). Take 2 cm$^3$ of this solution and mix it with 6.5 cm$^3$ of ethanol.
2. *(For each student group)* Prepare 1.5 g TiO$_2$ in a small beaker (50-100 cm$^3$)
3. Pour the solution from step 1 into the beaker containing TiO$_2$.
4. Stir with a glass rod to obtain a stable suspension.

**Working electrode preparation**

1. Wash two FTO substrates with ethanol and dry them with a hairdryer.
2. Put both plates on the clean bench, conducting side up (having identified it by resistance measurement with a tester)
3. Use the scotch tape to cover the outer side of the FTO plate

![Scotch tape on FTO plate](image)

4. Drop a few drops of TiO$_2$ paste (using a Pasteur pipet) on the top of the FTO plates.

![TiO2 paste on FTO plate](image)

5. Spread the paste over the plate using a glass rod, moving it from up to down.

![Paste spread over FTO plate](image)

6. Gently remove the scotch tape.

![Scotch tape removed](image)
7. Using tweezers put the FTO plates on the hot plate (T ≥ 300 °C) and leave them there for 10-15 minutes.
8. Using tweezers remove the FTO plates from the hot plate and let them cool down on wood, cork or heat resistant paper support (not ceramic to avoid thermal shock).

The above procedure allows to prepare two working electrodes (or a pair number of them); to prepare a single electrode (or an odd number of electrodes) without wasting a plate, just put one of the FTO plates upside down and wash it after removing the scotch tape (in this case the titania has been deposited on normal glass).

For the current experiment, each group will have to prepare 3 working electrodes.

**Sensitizer solution preparation**

1. Put a few berries (if out of season, defrosted ones can be used, too :-) ) into the mortar and grind them with addition of 2 cm³ of water.

2. Put a few sour cherries (if out of season, defrosted ones can be used, too :-) ) into the mortar and grind them with addition of 2 cm³ of water.

3. Prepare forest fruit or hibiscus tea using only 50 cm³ of boiling water for a standard tea bag.

[As alternatives to points 1-3, you can use forest fruit juice and/or sour cherry juice and/or beet juice]
Sensitizer adsorption onto the titania surface

1. Put a different sensitizer solution in each of the available Petri dishes.
2. In the case of fruit pulp (i.e. semisolid) sensitizers put the titania-covered surface face DOWN.
3. In the case of juice or tea (i.e. liquid) sensitizers put the titania-covered surface face UP, and take care that the solution level is well over the plate.
4. After 10-15 minutes remove plates from sensitizing mixture, rinse with water and ethanol, and dry the with a hairdryer.

Counter electrode preparation

1. Wash three FTO substrates with ethanol and dry them with a hairdryer.
2. Light a small candle. (safety: make sure to keep it far away from ethanol!)
3. Using tweezers (safety: gloves, googles, etc.) put the glass plate OVER the flame with the FTO side face down, until it is covered by ashes (leave a small area of glass uncovered by ashes for electric contact).
4. Remove the FTO plates from the flame and leave them to cool down on wood, cork or heat resistant paper support (not ceramic to avoid thermal shock).

Electrolyte preparation

A commercial I$_3^-$/I$^-$ electrolyte solution is already available.

[Should it be prepared, dissolve ~1 g KI and ~0.5 g I$_2$ in 50 cm$^3$ of ethylene glycol]

Assembling the cell

1. Assemble one working electrode with one counter electrode (sandwich-style) and clip them with a binder clip, leaving the uncovered surfaces out of the sandwich.
2. Drop a few drops of electrolyte on the upper edge of the cell and let it flow down between the two electrodes.

3. Clip the upper side of the cell with another binder clip.

4. Repeat with the remaining two pairs of electrodes.

**Testing the cell**

Under illumination measure the potential difference between the two electrodes for each cell using the tester.

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<th>Cell #</th>
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