Build your own solar cell

At this station you can find build your own solar cell using the semiconductor titanium dioxide TiO_2, an aqueous solution of EDTA and a platinum-coated razor foil.
Carry out the experiment, note down your observations and answer the questions.

Compact solar cell

Fig.1 Equipment needed for building the cell

You need:
1 photoelectrode*,
2 pieces of filter paper,
EDTA-solution, *c* = 0,5 mol/L
pipette,
2 razor foils,
glass plate,
2 paper clips,
2 cables, 2 alligator clips,
multimeter, motor

Fig.2 Compact cell ready for use

* The photoelectrode consists of a plate of conductive glass which is coated with a thin layer of the semiconductor titanium dioxide. The titanium dioxide layer is not very stable, so don´t touch it with your fingers.

Procedure and observations:

Building the cell
Carefully place 2 layers of filter paper onto the titanium dioxide surface (without touching the surface with your fingers). Pipette two drops of EDTA solution onto the filter paper. Cover the filter paper with the razor foils, so that the foils have contact with each other and some part of the razor foils sticks out of the cell. The razors foils serve as counter electrode. In order to fix the compact cell, press the glass plate on top of the razor foils and hold the cell with the paper clips together as shown in Fig.2.

Using the cell
Connect the cell with a multimeter using the cables and the alligator clips. Attach one alligator clip to the uncoated glass strip of the photoelectrode and connect the electrode with the negative pole. Attach the other alligator clip to the piece of razor foil which sticks out and connect this with the positive pole of a multimeter.

a) Irradiate the cell (from the "white" side) with a strong lamp (Ultravitalux lamp, OSRAM, 300W) from a distance of 10-15 cm.
Note the maximum voltage U [V] generated by the cell: _____ V
Place a piece of cardboard between the lamp and the cell and observe the voltage: _____ V
Repeat this intermittent irradiation:

b) Measure the electric current I [A] generated by the cell
during irradiation: _____ mA and in darkness: _____ mA

c) Irradiate the cell for 90 sec and connect the cables with an electric motor.

d) Try out other light sources: sunlight (with open windows!), torch, projector, differently coloured lamps / lights.

☞ **Questions:**

1) Explain the statement: "The photoelectrode is photosensitive."

2) When does the cell produce an electric current?

3) Look at the scheme of the compact solar cell (Fig.3) and name the kinds of materials (metals, semiconductors, etc.) that are used for this cell. Describe which kind of charge carriers are involved in which part of the cell.

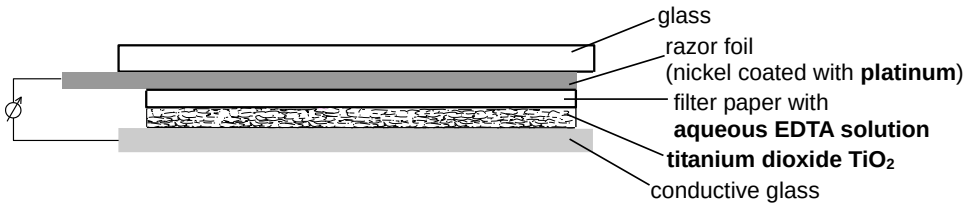

Fig.3: Scheme of the compact solar cell (cross section)

4) The photoactive part in the compact solar cell is the photoelectrode with the semiconductor TiO_2. Explain why it makes sense to use a semiconductor rather than a metal.

5) On the basis of your observations and your knowledge from Station 2 make a hypothesis on the lifetime of the cell.

6) *question for experts*
The filter paper is moistened with an aqueous EDTA solution. EDTA stands for the chemical ethylene diamine tetraacetic acid. This is a compound that is oxidized easily. Every electron that leaves the photoelectrode and moves through the outer circuit leaves an electron deficit ("hole") in the semiconductor. This hole is filled by an electron from the EDTA solution.
a) Draw a sketch that visualises this piece of information.
b) If an oxidation takes place, there must be a reduction somewhere in the system as well. Neither the titanium dioxide nor the platinum coated razor foil change. Look at the name of EDTA again and develop an idea about the place where the reduction must be taking place.

7) In the experiment you could start an electric motor by irradiating your solar cell. Compare the processes taking place here with those taking place when you start a motor using a battery (galvanic cell).

Words: *titanium dioxide*: Titandioxid; *platinum:* Platin; *coated:* beschichtet; *razor foil:* Rasierscherfolie; *conductive glass*: leitfähiges Glas; *to pipette:* pipettieren; *counter electrode:* Gegenelektrode; *to irradiate:* bestrahlen; *intermittent:* intervallweise; *photosensitive*: photosensibel; *cross section*: Querschnitt; *to moisten*: anfeuchten.