1. **Dye-Sensitised PV Cells (DSC's)** (Photochemical PV)

   → This type of PV cells resembles natural photosynthesis in that:

   1. an organic dye is used to absorb light and produce a flow of e-s
   2. it uses multiple layers to enhance both absorption and collection efficiencies

→ Titanium Dioxide (TiO₂) powder (nanometer sized particles) are deposited onto a conductive glass by a process similar to painting

→ TiO₂ powder (titania) is a white powder used in sunscreen and foods

→ TiO₂ is also a cheap large-bandgap semiconductor; 3.2 eV

   → This high E₆ limits harvesting of sunlight photons to about 4% of sunlight radiation

→ the deposited TiO₂ layer forms a nanoporous "sponge"

→ the glass plate with the TiO₂ "sponge" is dipped in the dye:

   Used dyes:
   1. red ruthenium containing dye
      → an inorganic dye used in paints
   2. anthocyanin containing dye
      → a green chlorophyll derivative

→ A single layer of dye molecules attaches by adsorption to each nano-particle of TiO₂

Show Fig 2.34
Figure 2.34 A dye-sensitised solar cell.

Figure 2.35 Innovative and flexible: dye-sensitised solar cells in Australia (Dyesol).
Fig. 4.2 Operation of the dye-sensitized nanocrystalline TiO₂ solar cell. Light is absorbed by the dye molecule (sensitizer) and the resulting excited electron is "injected" into the TiO₂. The electrons then diffuse within the porous TiO₂ structure and are collected at the back contact (conductive transparent glass). The resulting positive charge on the dye is compensated by the mediator, which itself is reduced after the electron has passed through the external load. The redox mediator in the electrolyte goes through cyclic oxidation and reduction as the process continues.
The dye acts as the primary absorber of sunlight.

An iodide, $\text{I}^-$, containing electrolyte liquid is then placed on the film, to percolate into the pores of the membrane.

Then a counter electrode of conductive glass coated with a thin layer of Pt or C is placed on top.

The TiO$_2$ side is illuminated by sunlight.

**How does it work?**

Light entering the cell is absorbed by the dye coating the TiO$_2$ nano-particles.

This creates excitation e$^-$s in the dye that are injected into the CB of the TiO$_2$, causing the dye to oxidize.

The e$^-$s efficiently diffuse through the TiO$_2$ to the electrical contact.

The e$^-$s then pass to/through the attached electrical load.

The e$^-$s then re-enter the cell via the counter electrode.

The e$^-$s then restore the oxidized dye to its original unoxidized state with the help of the electrolyte.

$\text{I}_2 \rightarrow 2\text{I}^- + \text{e}^- \rightarrow$ reduction process

Recombination does occur, but not with holes, but instead with the oxidized dye.

DSC's are wide bandwidth PV devices analogous to photosynthesis in plants.
Example images of DSC’s: