

Solar power



How solar panels work (photovoltaics)

- Solar energy is absorbed by electrons which then escape the matrix of molecules in silicon and are free, able to form a current
- Because silicon molecules share electrons, when one leaves, another can fill its space, another can then leave its place and move into this new gap, and the "hole" can be passed down the line, functioning as a positive ion. Hence "holes".
- One side of the panel is doped +p and one is doped +n (or any way of imposing opposite poles) encouraging the 'holes' and electrons to flow in one direction
- This current is captured.
- But, the hole-electron pairs which form need to be released, which requires energy. Room-temperature thermal energy works in silicon panels, but isn't enough in more ecologically friendly ones.

How solar panels are made

- Silicon wafer rods are doped on one side with boron and the other with phosphorus to make them +p and +n. This is done by exposing them to a vapour of the doping material. (The 'doping' material is naturally extra in electrons or negative ions.)
- The electrode to capture the current is applied as a liquid, divers ways.
- The rods are sawn into cell sizes and cleaned up.
- Then busbar is welded as anode to the front and any conductor to the back.
- Voltage is achieved by increasing the number of cells in series until the desired voltage is reached, and current by the number of cells in parallel. This amount are fitted into a "solar panel". Nowadays, most solar panels are designed to feed into mains electricity not 'live off-grid', so they usually match grid V & I measurements.

Ecology's problems: brief explanation

- Simply: life is made up of a very limited range of carbon-based chemicals. Anything else cannot be incorporated into life. So, all plastics, most inorganic chemistry, anything life did not evolve with (unlike say granite or limestone) cannot be processed by a lifeform. This wouldn't matter, except that now the amount of materials in the world that harm, cannot support or poison life is now getting past the point where life (all lifeforms as a whole) can handle it. We are at or past the tipping point. It won't affect us for a long time: it's already past that point in a lot of countries near the equator due to global warming, and to those 'third world' countries we use to extract natural resources at artificially low prices (otherwise capitalism would collapse as mathematically we need to balance out inflation, to pay down debt, with artificially introduced deflation), eg Congo. It'll be a century or more before it affects the first world, if it does. (Plenty of sources for this in economics.)

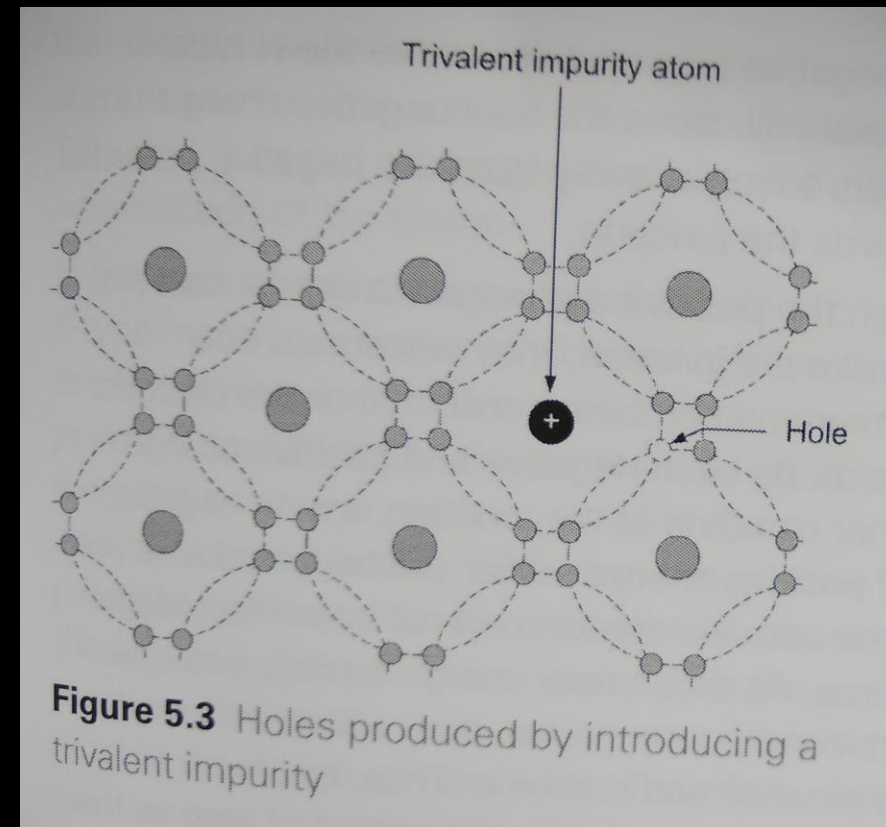
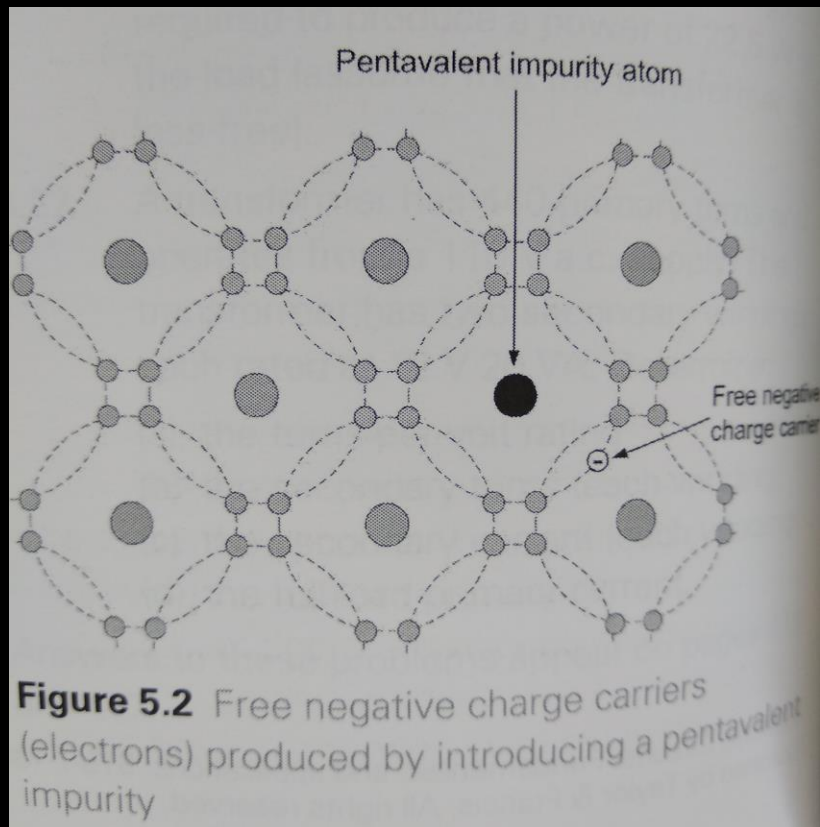
Problems with solar panels and how they are addressed 1

- Use of extremely poisonous vapours and materials in manufacture. Exposure of workers and disposal at end of life.
- Limited amounts of these materials.
- Costly
- Whilst long-lived by engineering standards, still expire.
- Cannot absorb all the energy in sunlight
- Generate unreliable amounts of electricity anywhere with cloud cover
- Keeping polluting electrical power generation on standby to ramp up and down to fill in the gaps in demand is far more polluting than just generating electricity from polluting sources.
- Incorporating the electricity supplied into the grid

How problems are addressed 2

- Problems like exposing workers and the environment to pollution are mainly dealt with by making and disposing of them in poorer parts of the world using more powerless and ignorant workers and corrupt, bribable governments.
- Problems with poisonous, unrecyclable materials increase cost and cost is dealt with using more inefficient products with a shorter lifespan. Solutions for cost and pollution tend to solve one at the expense of the other.
- Cheaper PV cells use thin PV films on glass, plastic or metal
- Attempts to use carbon as an organic and readily-available material. "Organic electronics" uses organic carbon-based chemistry on molecules or polymers. For PSCSO the carbon molecules have their central sphere of electrons and oval orbiting ones tweaked to have fewer electrons describing an orbit which involves both the inner and outer electron shells. This allows them to absorb energy by rising to the outer shell and release it by falling to the inner orbit shell. The main problem is the energy involved in this change of state is 2.5-5 eV instead of 1.5-3eV so room temperature heat is not enough and outside energy must be applied to return them to their unenergetic state so they can capture the sun's energy all over again.

Four covalent electrons in the valence shell, showing how additional electrons can be introduced by a pentavalent (five-electron) foreign atom ('p-type doping') and lost to an a trivalent one ('n-type doping'). Picture from Mike Tooley "Electronic Circuits".



Organic carbon conductivity improvements

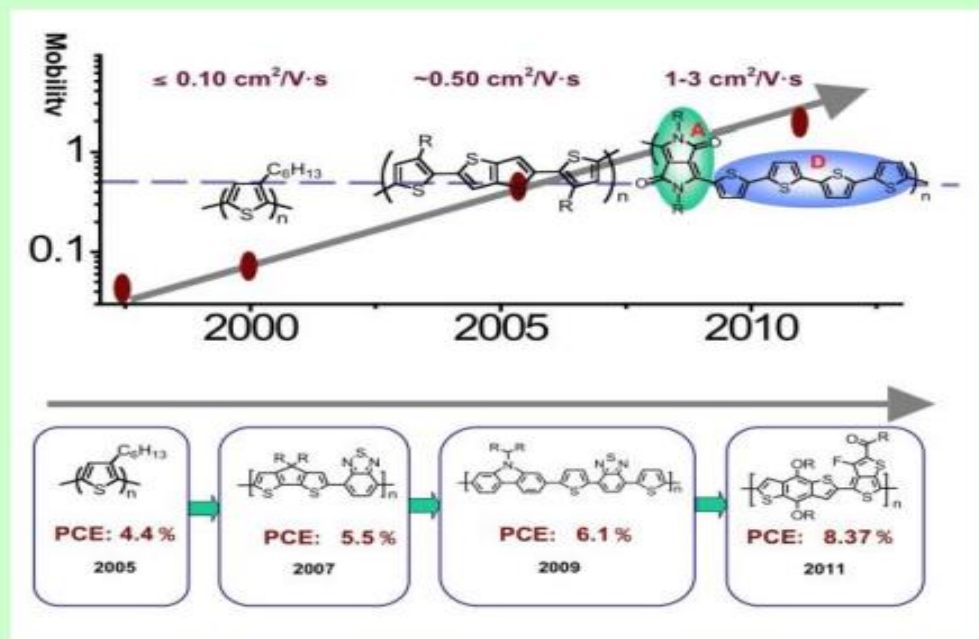
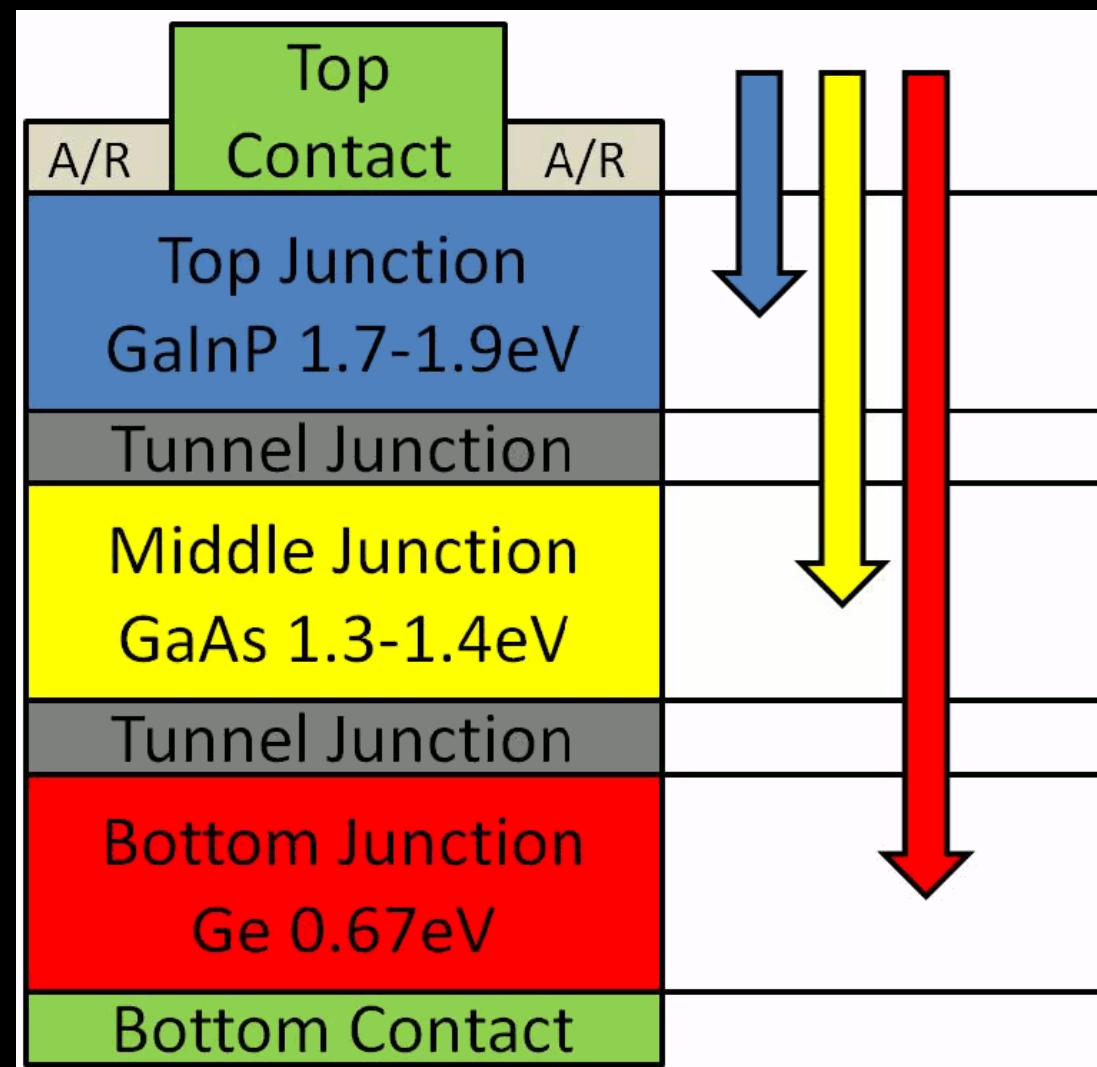
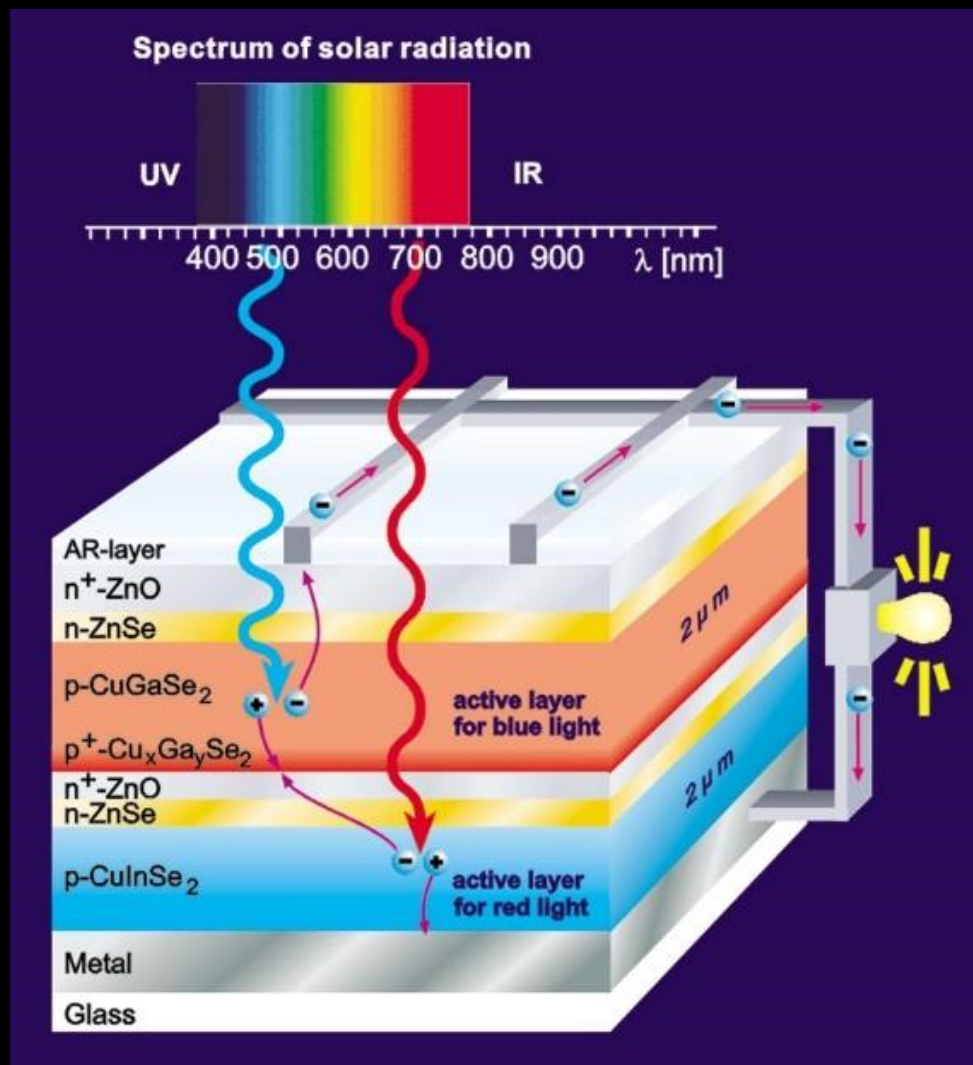


Figure 2. Improved electronic performance in devices made with organic polymer materials, 2000-present. Top: Continued research on polymer materials has led to a steady increase in charge-carrier mobilities in organic field effect transistors (OFETs) (top) and increased photoconversion efficiencies (PCEs) for organic solar cells (bottom). Source: Lixiang Wang.

Commercial use

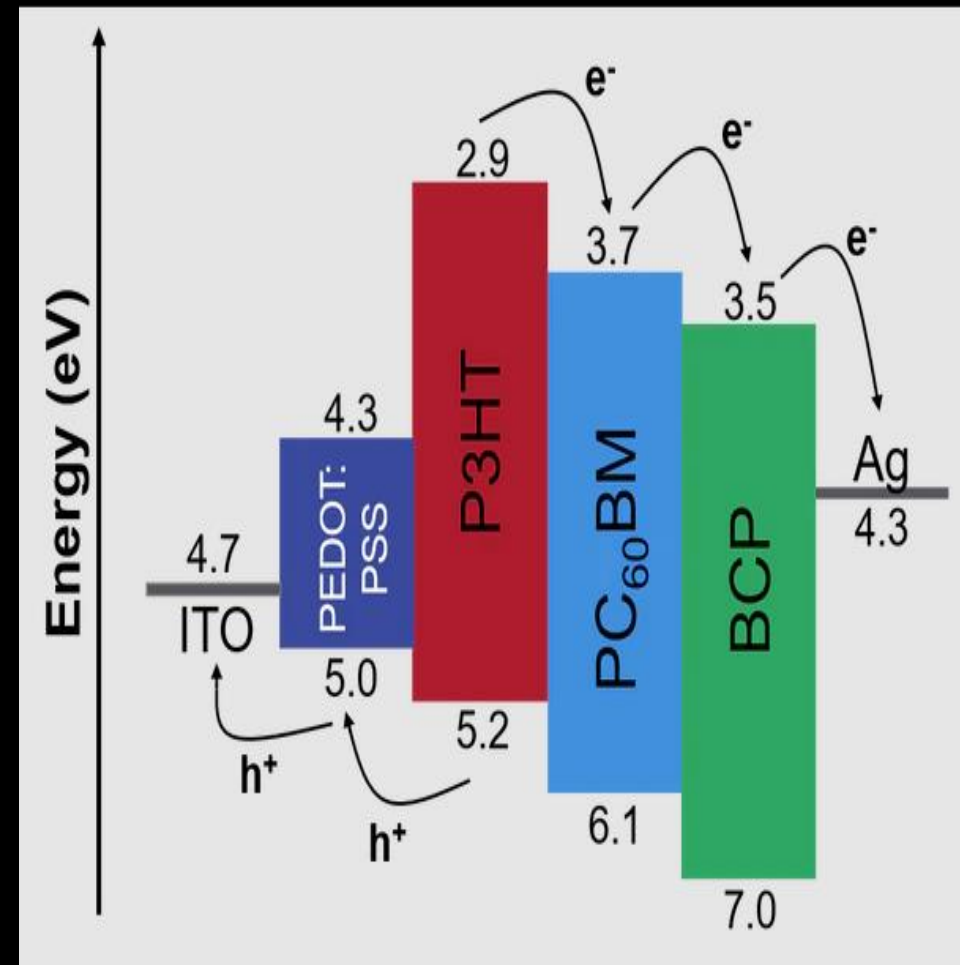
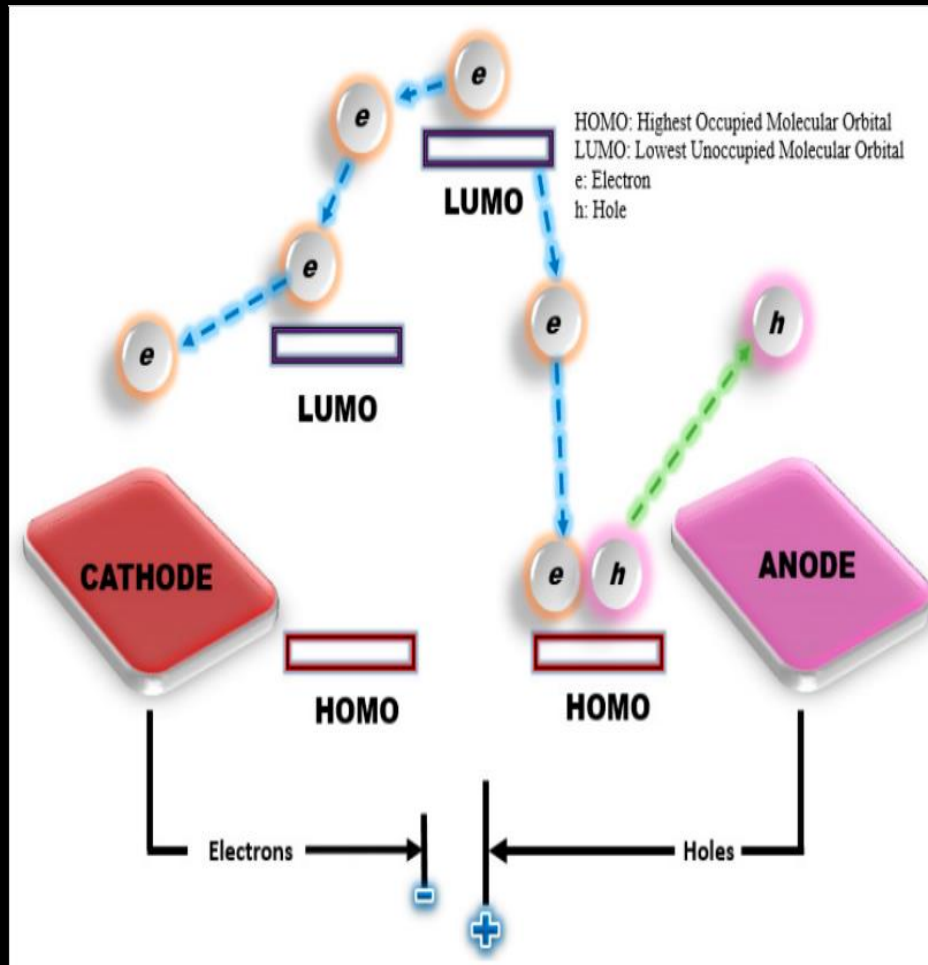
- Two main problems are 1) it's DC and 2) it doesn't capture much energy. The unpredictable/unreliable flow problem is solved with batteries or state-level, government-chosen solutions such as smart grids (Germany) or bypassing grids and trying to make households electricity independent with mini panels (Uganda, French Polynesia). That's not an engineering question but a governance question. (Where the will exists, the funding will supply the engineering solution. State-level solutions aren't going to be built by commerce on the off-chance the government might approve them.)
- At power plants, step-up transformers also convert the DC to AC as well, with some loss of power. Batteries to even out supply are being incorporated in most new planning applications (source: Private Eye).
- Increasing the sunlight used has generated many fascinating solutions. The two main ones are multijunction panels and increasing the amount of sunlight that a panel receives.
- Multijunction panels consist of layers of cells, which absorb energy from lower and lower levels of energy in photons as they go down. So, the top one can absorb energy high energy photons, medium level energy photons are too weak to trigger its chemical reactions and they get passed down to the middle cell. The middle cell reacts exposed to medium level energy photons, but passes the low energy ones down to the bottom layer. Panels are made with any number of layers. The big problem is, more expensive and more poisonous chemistry.
- Concentrating Photovoltaics (CPV) focuses sunlight on the cell. From whitewashed embrasures to Fresnell lenses (thin equivalent of a convex lens), these are widely used in developing countries and commercial use. They are usually combined with making the solar panels track the sun across the sky. The problems with this are the increased cost, especially maintenance, of moving the solar panels throughout the day. If this is not done, the whole point is lost because the cell can only gain if the sun comes through the lens. Parabolic mirrors are also used.

Multijunction cells

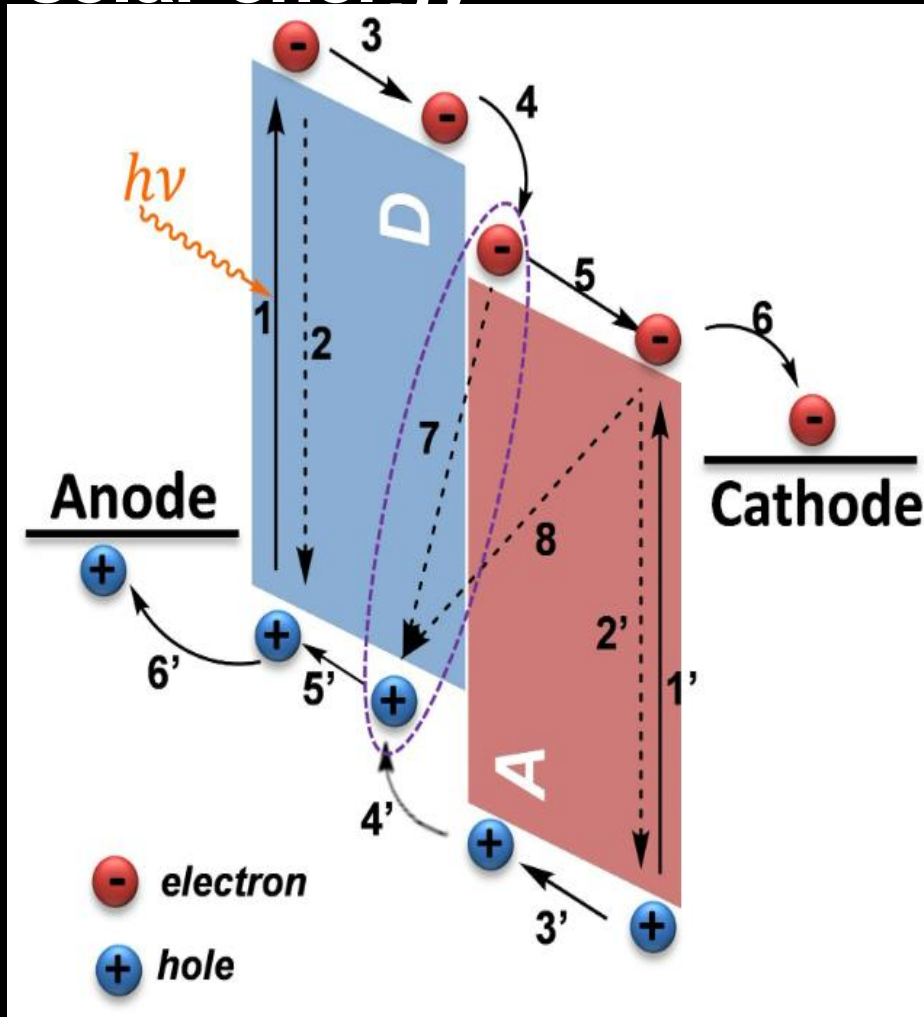


Organic Photovoltaics

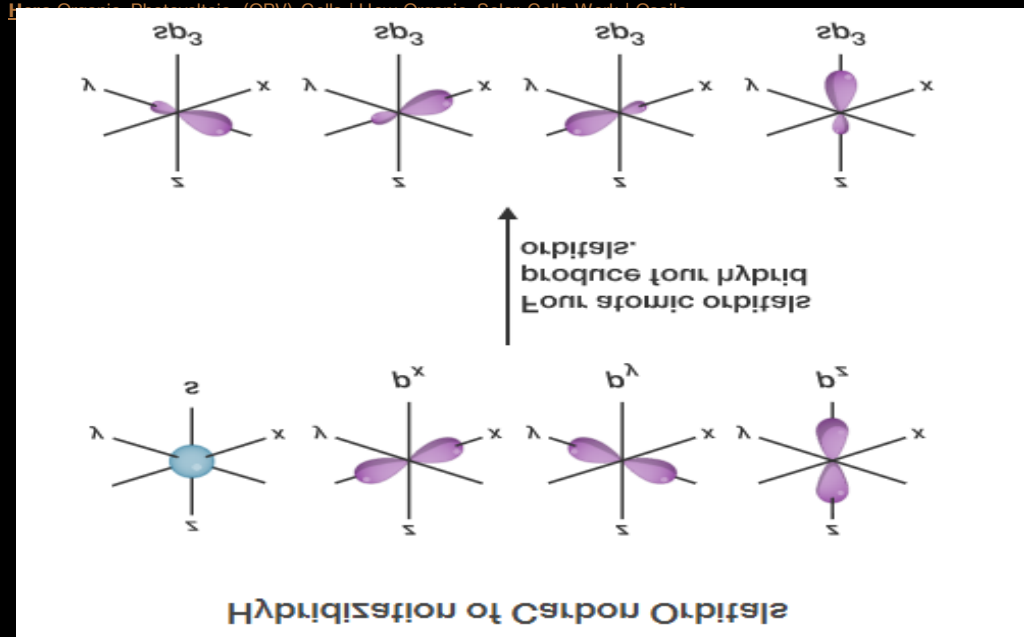
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Conjugating carbon to enabled band gap bridging by solar energy



Electrons move from the highest occupied molecular orbital (HOMO [sic]) to the unoccupied orbitals at lower energies called lowest unoccupied molecular orbital (LUMO). The band or energy gap between these is too high to be bridged by visible light spectrum energy but can become so when carbon atoms are conjugated with hybrid orbitals its energy is enough for the gap to be jumped [Hybridization of Carbon - Course](#)



Other facts

- Solar can be used to warm water directly, when it is a very cheap and efficient way to heat a house (radiators) and water. In cold climates, because the water would freeze in winter, antifreeze (equivalent) feeds a heat exchanger which heats the water. In commercial use, some power stations use solar to heat water to steam which drives conventional generators (CSP).