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# Electricity from sunlight?

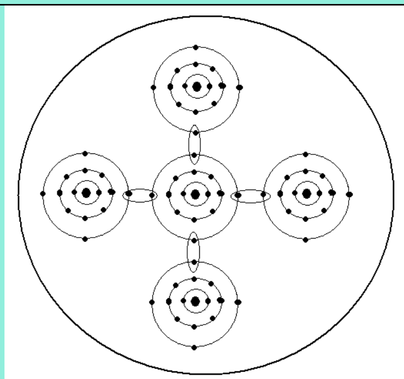
Albert Einstein is celebrated for the Theory of Relativity but the Nobel Prize he got for his later work on the **Photoelectric effect**, says S.Ananthanarayanan.

When ordinary light strikes certain materials, electrons get knocked out and a current can be made to flow. This can be used to measure the brightness of the light, as in photographers' light-meters, or charge a battery or run an appliance.

Einstein used the newly developed 'quantum theory' to explain this phenomenon, as caused by the energy of photons, or the 'particles' of light.

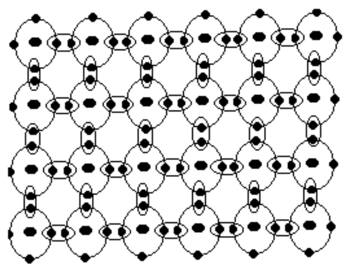
**Silicon and semiconductors**

The atom of Silicon, a favourite photoelectric metal, has fourteen electrons, of which four are in the outer shell. As the most stable condition is to have eight electrons in the outer shell, the silicon crystal has adjacent atoms 'holding hands', to mutually achieve eight electrons each.

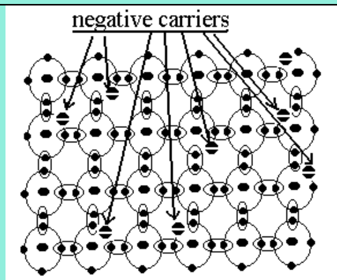


Now, if the crystal has a slight impurity of phosphorus, which has five outer shell electrons, the occasional phosphourus atom can stand in for silicon in the lattice, but this 'extra' electron is left not securely bound, and 'free' to move from atom to atom. The result is to make the crystal like a conductor, a semiconductor.

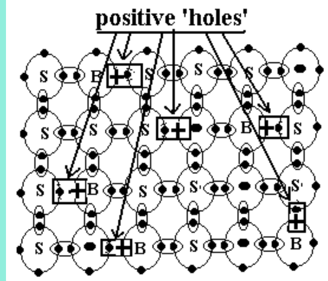
If the impurity were of boron, which has three outer shell electrons, then it is a 'lack of an electron', or a 'hole' or positive placeholder, which is 'free'. And again, the crystal is a semiconductor.



Silicon atoms share electrons




Silicon doped with phosphorus

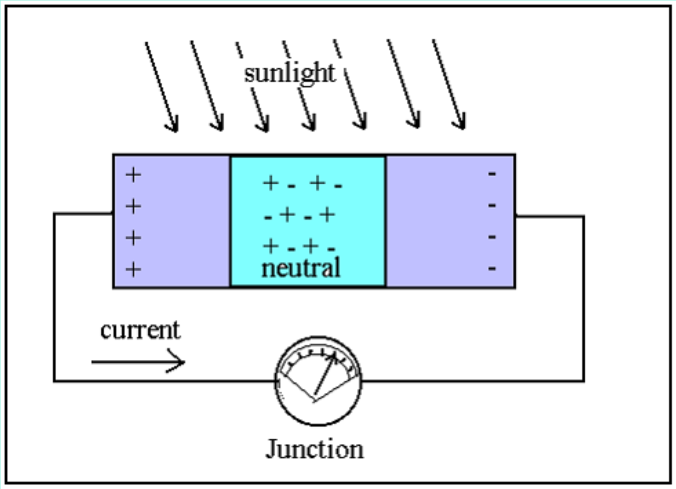



Silicon doped with boron

Now if these two kinds of semiconductor are brought together, then some of the ‘free electrons and ‘holes’ rush and meet at the junction, leaving a net positive or negative charge behind and a neutral meeting place in the middle.

**The photocell is ready**

As the phosphorus side is positively charged and the boron side is negative, a current could flow if the two sides were connected. All it takes is that some light fall on the cell to knock free a ‘hole’ and an electron, and the field pushes the electron through the wire, to show up in a meter, run an appliance, or charge a battery! The more the light, the stronger the current.




**Cost is the drawback**

Photoelectric cells are useful for small power, in remote places and the like, but are not economic. While sheets of silicon single crystals are prohibitively costly, other, alternate materials are all tradeoffs between cost and efficiency. It is an area of feverish research, but large-scale generation of power with photocells is still out of reach.

**Molecular photocells are the answer?**

Scientists at Cambridge University and the Max Planck Institute in Germany report a new, self-assembling, organic solar cell, which may overcome the cost hurdle. Combining two kinds of carbon-based molecules, the device converts 34% of incident blue-green light to electricity. The molecular components even organize themselves into the layered structure necessary for efficiency.

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A mixture of the organic substances separates into microscopically thin film, predominantly of one kind, above a film of the other. One side conducts electrons and the other side conducts ‘holes’. When the organic molecules absorb light and spit out an electron, leaving behind a positive 'hole', a current flows, just like in the usual photo-voltaic cell.

This offers the possibility of easily manufactured and assembled photocells on a large scale.