Photoconductivity and photovoltaic:

If a semiconductor is exposed to the radiations, its conductivity increases.The energy supplied by the incident light is used to ionize the covalent bonds in the semiconductor. Due to this the covalent bonds break and electron-hole pairs are generated, on top of those which are thermally generated. Due to the increase in electron-hole pairs the resistance of the material decreases and its conductivity increases. Hence such devices are called photoconductors or photo resistors. This phenomenon is known as photoconductivity

The principle of operation of photoconductor is shown in the Fig. 1.

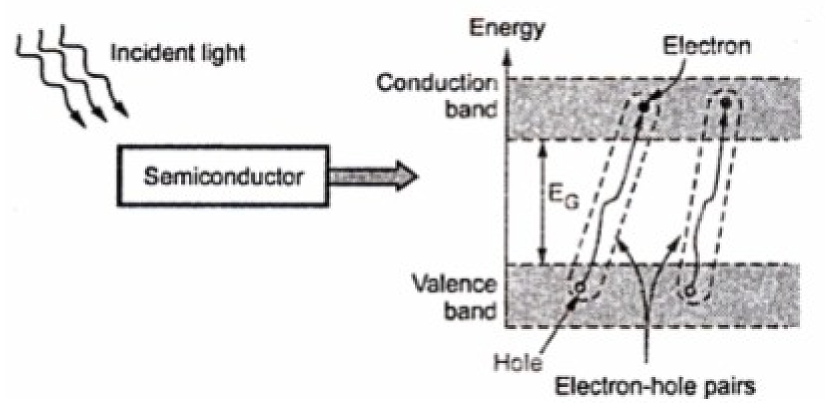

Fig. 1 Principle of photo excitation on semiconductors

Certain crystalline semiconductors, such as silicon, germanium, lead sulfide, and cadmium sulfide, and the related semimetal selenium, are strongly photoconductive. Normally, semiconductors are relatively poor electrical conductors because they have only a small number of electrons that are free to move under a voltage. Most of the electrons are bound to their atomic lattice in the set of energy states called the valence band. But if external energy is provided, some electrons are raised to the conduction band, where they can move and carry current. Photoconductivity ensues when the material is bombarded with photons of sufficient energy to raise electrons across the band gap, a forbidden region between the valence and conduction bands. In cadmium sulfide this energy is 2.42 electron volts (eV), corresponding to a photon of wavelength 512 nanometers (1 nm = 10^{-9} meter), which is visible green light. In lead sulfide the gap energy is 0.41 eV, making this material sensitive to infrared light.

APPLICATIONS:

- As the current ceases when the light is removed, photoconductive materials form the basis of light-controlled electrical switches.
- These materials are also used to detect infrared radiation in military applications such as guiding missiles to heat-producing targets.

- Photoconductivity has broad commercial application in the process of photocopying, or xerography, which originally used selenium but now relies on photoconductive polymers.

ADVANTAGES:

- High sensitivity.
- Low cost.
- Long Life.
- High dissipation capability.
- High voltage capability (100 to 300 volts).
- High ‘dark to ‘light’ resistance ratio (1000 : 1).
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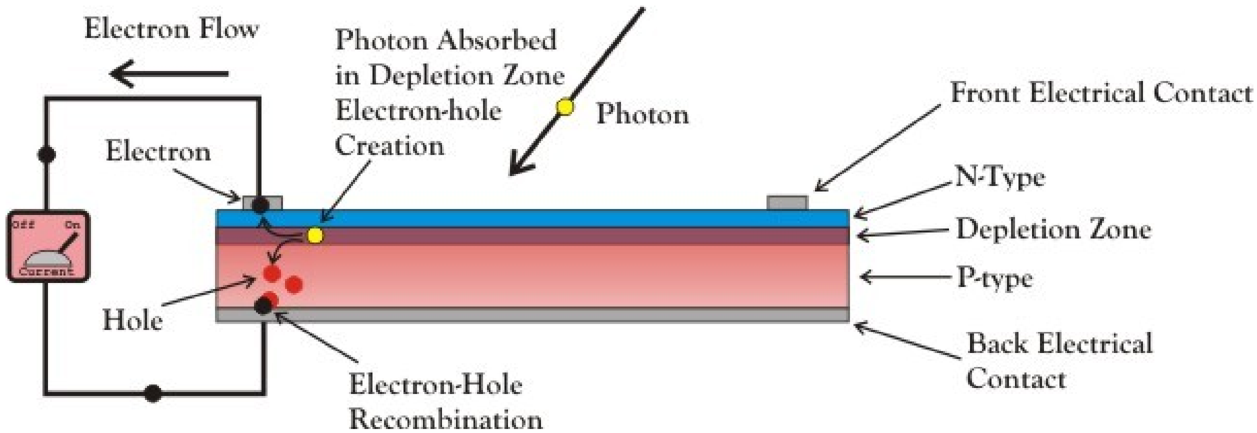
PHOTOVOLTAIC CELLS:
When a pair of electrodes is immersed in an electrolyte & light is allowed to incident on one of them, a potential difference is created between the electrodes this phenomenon is called photovoltaic effect. Devices based on this effect are known as photovoltaic cells. In a photovoltaic cells light energy is used to create a potential difference the potential difference so developed is directly proportional to the frequency & intensity of incident light.

SOLAR CELLS:

A solar cells or solar battery is basically a P–N junction diode which converts solar energy into electrical energy. It is also called a solar energy converter and is simply a photo diode operated zero bias voltage.

CONSTRUCTION:

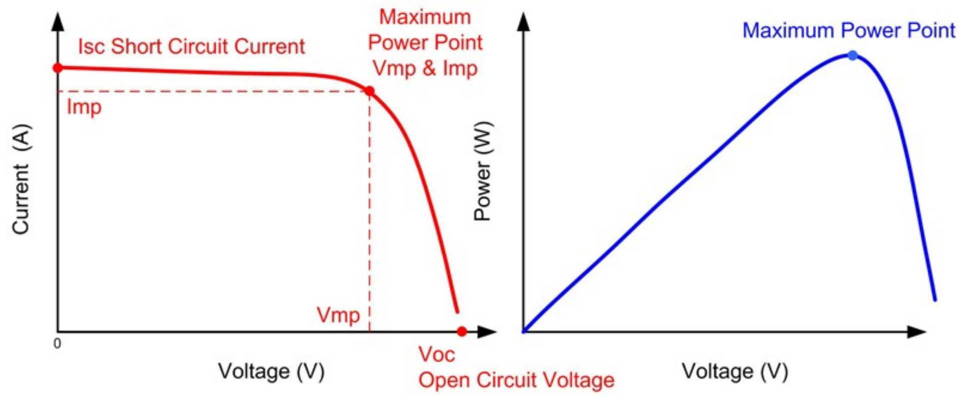


A solar cell consists of a P–N junction diode generally made of Ge or Si. It may also be constructed with many other semi conducting materials like GaAs, indium arsenide and cadmium arsenide. The P–N diode so formed is packed in a can with glass windows on top so that light may fall upon P & N type materials. The thickness of P region of is kept very small so that electrons generated in this region can deffuse to the junction before the recombination takes place. Thickness of N region is also kept small to allow holes generated near the surface to diffuse to the junctions before they recombine. A heavy doping of P and N regions is recommended to obtain a large photo voltage. A nickel plated ring is provided around the P layer which acts as the positive output terminal. A metal contact at the bottom serves as the negative output terminal.

WORKING:

The working of solar cells may be understood with reference of figure When light is allowed to fall on a P-N junction diode, photons collide with valence electrons and impart them sufficient energy enabling them to leave there parent atoms. Thus electrons hole pairs are generated in both the P and the N sides of the junctions . These electrons and holes reach the depletion region W by diffusion and are then separated by a strong barrier field existing between there. However the minority carriers, electrons in the p-side , slide down the barrier potential to reach the Inside and the holes in the N-side move to P-side. Their flow constitutes the minority current which is directly proportional to the illumination and also depends on the surface area being exposed light.The accumulation of electrons and holes on the two sides of the jnction gives rise to an open circuit voltage V_{oc} which is a function of illumination. The open circuit voltage produced for a silicon solar cells is typically 0.6 volt & the short circuit current is about 40 m A / cm^2 in bright noon day sun light power conversion efficiency of about 15% are obtained with a thin N diffused layer into a P wafer. Many such cells are interconnected to provide large quantities of electrical power. Solar panels providing 5watt at 12 volt have been built to operate 24 hrs a day by recharging the batteries during day light hrs.

CHARACTERISTICS:



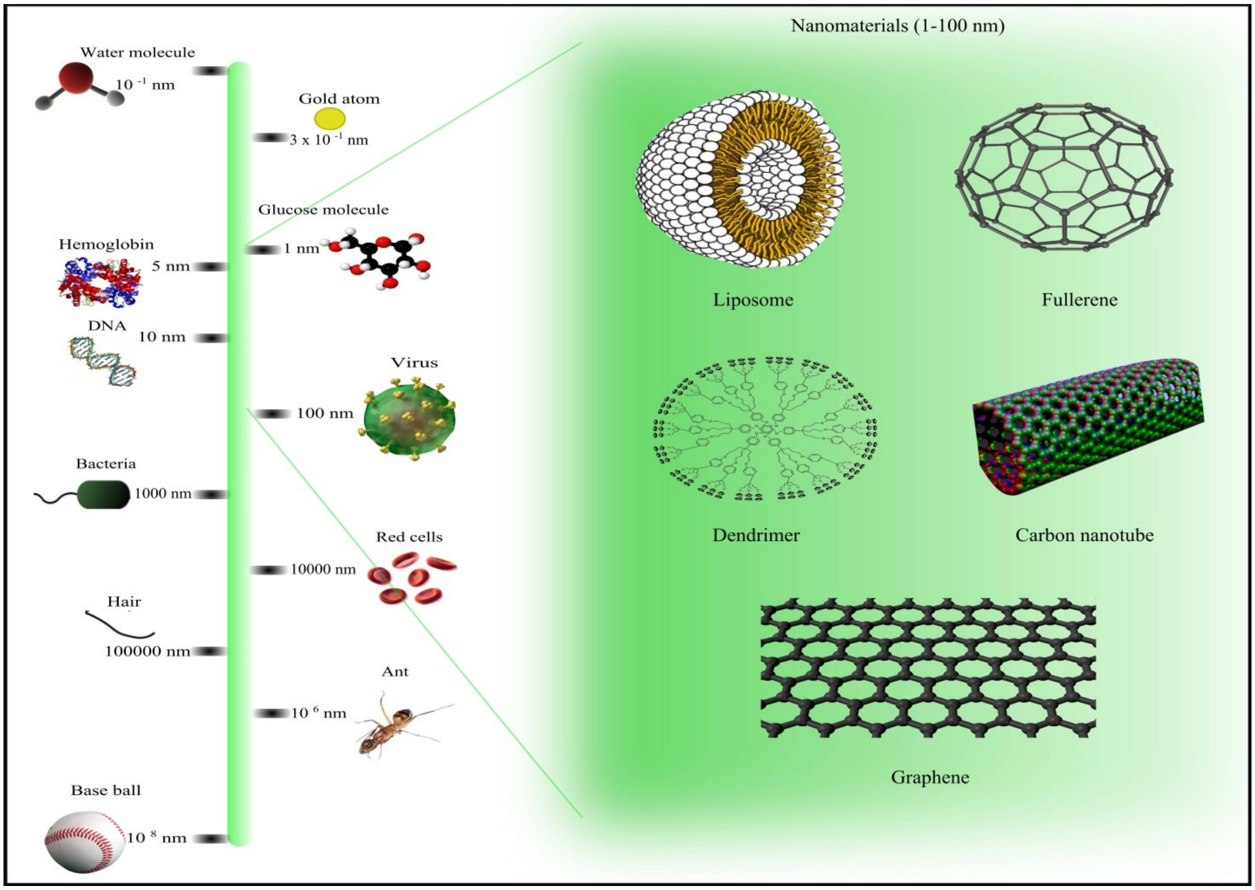
Typical V- I characteristics of a solar cell corresponding to different levels of illuminations are shown in the figure. It may be seen that for 100 m W/cm^2 illuminations the open circuit voltage is about 0.57 volt while the short circuit current is 50 m A. maximum power output is however obtained when the cell is operated at the knee of the curve.

USES:

Solar cells are used extensively in satellites and space vehicles to supply power to electronic and other equipment or to charge storage batteries they are receiving attentions even for terrestrial electric power generation. for it, it is planned to orbit big panels of solar cells outside the earth atmosphere for converting solar energy into electrical energy.

NANOSCIENCE

A nanometer (nm) is one billionth (10^{-9}) of a meter. Nano science can be defined as the science of objects and phenomena occurring at the scale of 1 to 100 nm. Nano science is the study of phenomena and manipulation of materials at atomic, molecular and macromolecular scales, where properties manipulation of materials at atomic, molecular and macromolecular scales, where properties differ significantly from those at a larger scale; and nanotechnologies is the design, characterization, production and application of structures, devices and systems by controlling shape and size at the nanometer scale.



PRINCIPLE

The behavior of matter changes significantly when the surface area to volume ratio increases so dramatically. Classical physics no longer control the behavior of the material which is now under the control of quantum laws. This fact gives the Nano-structured material new abilities and properties that may be more favorable than the ones of the bulk material version. A good example is that some polymers, although being insulators in the bulk form, they become semiconductors at the Nano scale.

APPLICATIONS

Energy: Nanotechnology can improve the existing technology of fuel cells in order to increase their life cycle and reduce the cost of catalysts. Solar cells will also increase their energy conversion efficiency by reducing cost. The production of fuel could also become more effective by making extraction and processing more economical.

Medicine: Nanoparticles can be developed in order to deliver drugs to diseased cells. New bio-compatible materials are produced that can be used to make medical implants. Stents are also developed to prevent artery blockage.

Industry: Vehicle manufacturers can use the new light and extremely strong materials (eg. carbon nanotubes) to build faster and safer cars. The same technology applies in aerospace as well. The textile industry can benefit from the development of Nano fibers. Clothing made of Nano fibers is stain-repellent and can be washed at very low temperature. Another great application has to do with the embedded wearable electronics. Nanotechnology could also revolutionize the food industry by improving the conservation, processing, and packaging procedures. Other applications include bacteria identification and Nano encapsulation of bioactive food compounds in order to keep them in a safe anti-microbial environment.

Communication and Electronics: The advances in nanotechnology will reduce the weight and power consumption of electronic devices. Data processing speed will increase, and new portable devices will be available soon. This will revolutionize the world of communication and data transfer.

Consumer Goods: Other goods of every-day use that could be developed include anti-reflective sunglasses, new generation cosmetics, easy-to-use ceramics and glasses, etc.