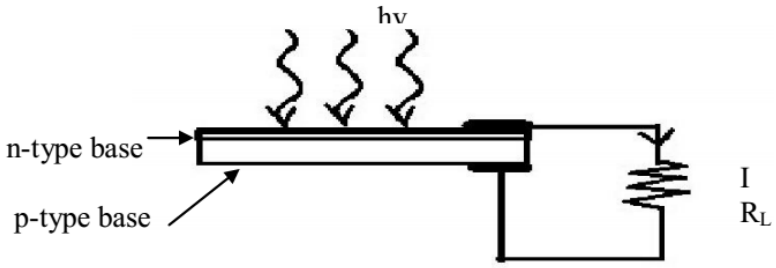
Email (البريد الالكتروني للتدريسي)

Solar cells

These cells converts the sun's light energy to electrical energy .power from solar light (peak at ~ 500 nm) is ~ 100 mW/cm for 100 % efficiency.

The cell is a photodiode has a p-n junction diffused close to a flat surface, so that a much light as possible can reach the junction. The surface area is ~ 1 cm^2, and often large arrays of several thousand cells are used.



[The solar cell]

The depletion area is very narrow. The active area is very large. The diode is operated in the photovoltaic mode without bias.

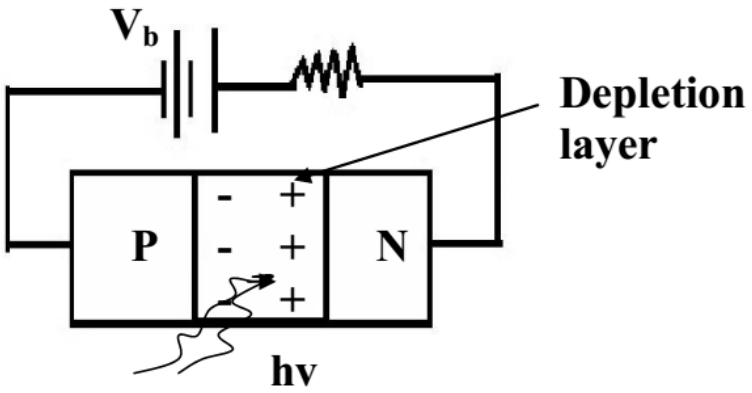
Photons of adequate energy create electron-hole pairs. Current is created and directed through a very low resistance to obtain maximum power transfer.

If the radiation power falling on the cell is w then the overall efficiency (ε) of the cell is :

$$\varepsilon = \frac{P}{W}$$ where P Is the power produced in the external load ($P = I_M^2 R_L$) . The cell efficiency reaches 75% in space, while it reaches 20% on the earth.

Junction photodiodes

In these quantum detectors, two neutral materials, doped to be p- and n – type, which are to be brought together to form a junction.



An n-type S.c. has an excess of electron carriers. A p-type has excess holes.

If they join together, electrons and holes move because of:

(1) Both electrons and holes will move from areas of high concentration to areas of low concentration this called 'diffusion' .

(2) Under the influence of an electric field, both electrons and holes will move, but in opposite directions because their charge is – ve and + ve respectively.

The diffusion of electrons and holes across the junction led to the formation of a depletion layer by neutralization of holes the p – region and free electrons in the n- region.

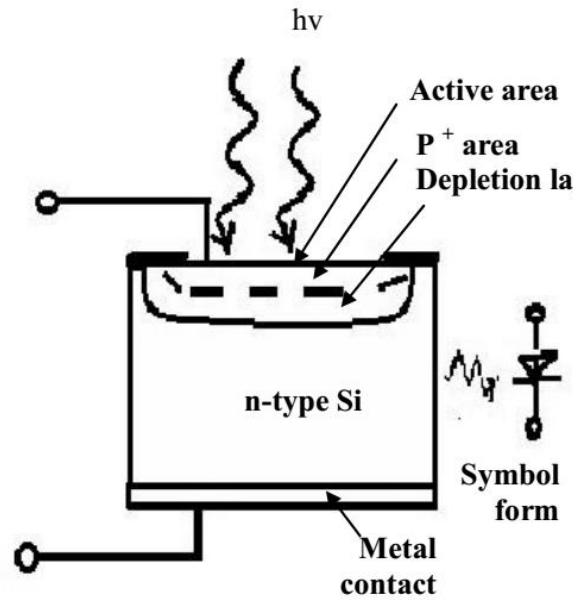
The diffusion continues till a potential barrier (an internal space – charge field) is developed in the depletion layer and prevent further diffusion (migration of the carriers).

The potential barrier is either decreased using a forward biasing or increased using a reverse biasing , i .e . Applying an external voltage.

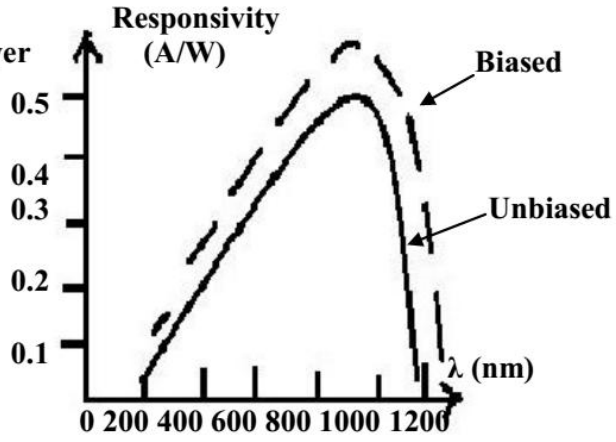
Photons absorbed near the p-n junction produce hole – electron pairs. In the photoconduction mode, a reverse bias across the junction is applied, and the produced pairs (from photons) greatly increase the conductance.

The current produced by the bias and free carriers is proportional to the light intensity over a wide range.
Si , Ge , InAs junction detectors are normally used .

Silicion photodiodes : are the most common junction detectors , their spectral response covers the visible and near IR range , and their linearity and dynamic range is excellent .
Photons pass through the thin top layer to generate electrons and holes near the junction. The junction is a region depleted of current carriers.
The junction drives holes into the p- material and the electrons into the n material. This results in a voltage difference between the two regions, and if they are connected by external circuit, a current flows.
Wide spectral response-
(UV to near IR)
(280- 1100 nm)
-λ at peak response = 950 nm
- responsivity at peak = 0.55 A/W
-Rise time:
$\approx$ 9 ns for small areas (~ 5 mm^2)
$\approx$ 230 ns for large areas (~ 100 mm^2)
-NEP at peak $\approx$ (1-6) x10^{-13} $W/Hz^{1/2}$



[Pn junction Si photodiode structure]



[Spectral response of Si photodiode]

The near IR junction include Ge and InAs .
The use of Ge instead of Si, the spectral sensitivity is extended to 1800 nm (1.8 μm). The detectivity D* vs λ is: