Semiconductor
Lecture 4

Manoj Kr. Das
Associate Professor
Physics Department
J N College, Boko

Zener Diode:

A Zener Diode is also known as break down diode is a heavily doped semiconductor device that is designed to operate in the reverse direction. When the voltage across the terminals of a Zener diode reversed and the potential reaches the Zener voltage or knee voltage the junction break down and the current flows in reverse direction. *This effect is known as Zener effect*. A Zener diode operates like a normal diode when it is forward biased, however when connected in reverse biased mode a small leakage current flows through the diode. As the reverse voltage increases to the predetermined break down voltage, current starts flowing through the diode. The current increases to a maximum after which it is stabilizes and remains constant over a wide range of applied voltage.

Avalanche break down occur at high reverse voltage. When a high value reverse voltage applied to the junction the free electron gains sufficient energy and accelerates at very high velocities. These free electrons moving at high velocity collides other atoms and knocks off more electrons and as a result a large number of electrons generated by increasing diode current rapidly. For avalanche break down Zener voltage must be 6 volts. At the Zener break down region a small increase in voltage results in the rapid increase of the electric current.

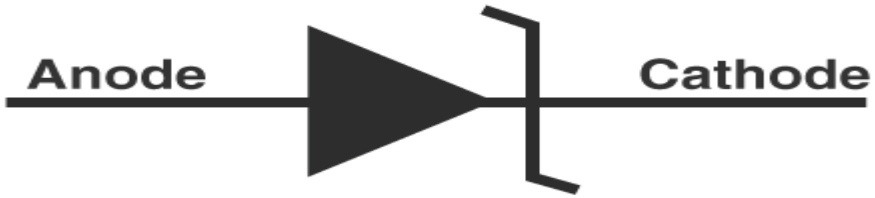

Fig 1

LED (Light Emitting Diode):

The increasing use of digital displays in calculator, watches and all forms of instrumentation has contributed to an extensive use of LED. The two types in common use to perform this function are the light emitting diode (LED) and light crystal diode (LCD).

The LED is a diode that gives off visible or invisible(infrared) light when energized. The recombination requires that the energy possessed by the unbound free electron be transferred to another state. In all semiconductor $p - n$ junctions some of this energy is given off in the form of heat and some in the form of photons. Si and Ge are not used because in the recombination, greater percentage of energy converted into the form of heat.

On the other hand diodes constructed of $GaAs$ emit light in the infrared zone during the recombination process at the $p-n$ junctions. Even though the light is not visible, infrared LED have numerous application where visible light is not a desirable effect. Though other combinations of elements a coherent visible light can be generated. The basic construction of an LED with the standard symbol used for the device. The external metallic conducting surface connected to the p-type material is smaller to permit the emergence of the maximum number of photons of light energy when the device is forward biased. It is also noted that the recombination of the injected carrier due to the forward biased junction result in emitted light at the site of recombination.

There will be some absorption of some package of photon energy in the structure itself, but a very large percentage can leave. It is interesting to note that invisible light has a lower frequency spectrum than visible light. The two quantities are related by

$$\lambda = \frac{c}{f} \rightarrow (iv)$$

Here c is the speed of light, λ is wavelength in meters and f is the frequency in Hertz.

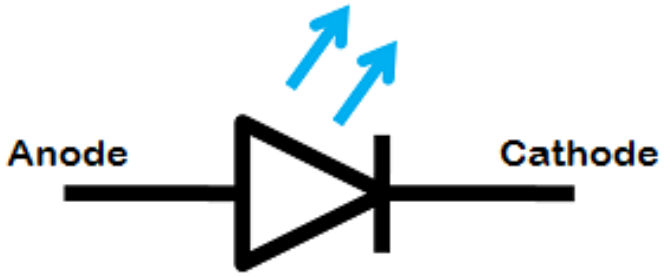

Fig 2

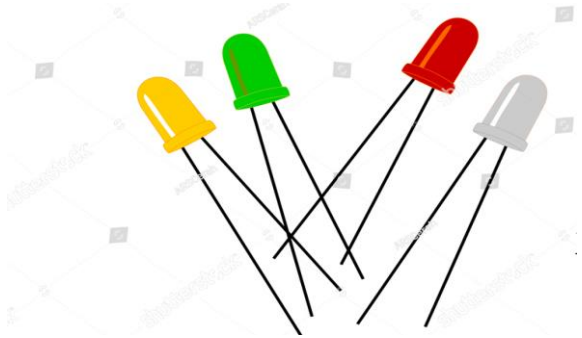

Fig 3

This certainly places $GaAs$ in the wavelength zone typically used in infrared devices. $GaAsP$ with a band gap of $1.9\ eV$ the resulting wavelength is $654\ nm$ which is the centre of red zone making it excellent compound semiconductor for LED production. Therefore in general, the wavelength and frequency of light of a specific colour are directly related to the energy band gap of the material.

Photo Diode:

A photo diode is a semiconductor $p-n$ junction device that converts the light into electrical current. The current is generated when photons are absorbed in photo diode. Larger the intensity of incident light, larger be the change in conductivity of the semiconductor. Therefore by measuring the resistance of the semiconductor one can measure the intensity of the optical signal.

The simplest photo diode is a reversed biased $p-n$ diode. If such an $p-n$ diode is illuminated with light photons having energy $h\nu = E_g$,the electron hole pair generated in the depletion layer or near the junction will be separated by junction field and made to flow across the junction. There would be a change in the reverse saturation current measuring which on illumination can give the values of light intensity.

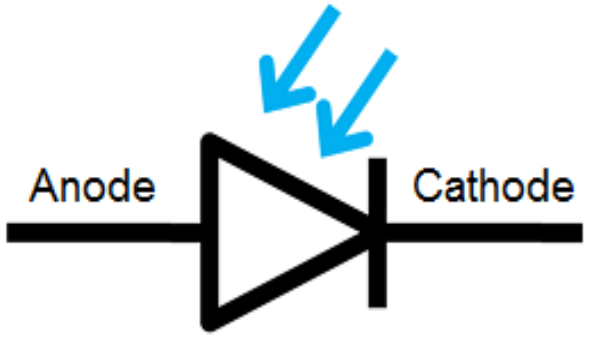

Fig 4

Fig 5

Solar Cell:

The solar cell is branded as a large area photo diode because it converts solar energy into electrical energy, though solar cell works on bright light. When sunlight strikes a solar cell electron in the silicon are ejected which results formation of holes. If this happens in electric field, the field will move electron to the $n - type$ and holes to the $p - type$.

It is the form of photo voltaic cell defined as a device whose electrical characteristic such as current, voltage or resistance vary when exposed to light. Individual solar cell devices are often the electrical building blocks of photovoltaic modules popularly known as solar panel.

The common single junction silicon solar cell can produce a maximum open circuit voltage 0.5 to 0.6 volts approximately. Solar cell are described as being photovoltaic irrespective of the source is sunlight or artificial light.

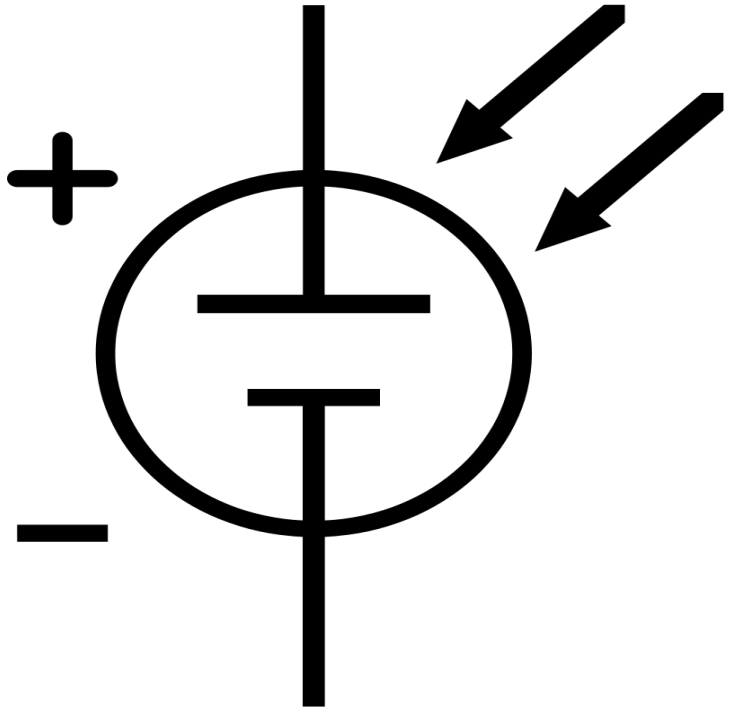

Fig 6

Fig 7