SUBJECT: BASIC ELECTRONICS

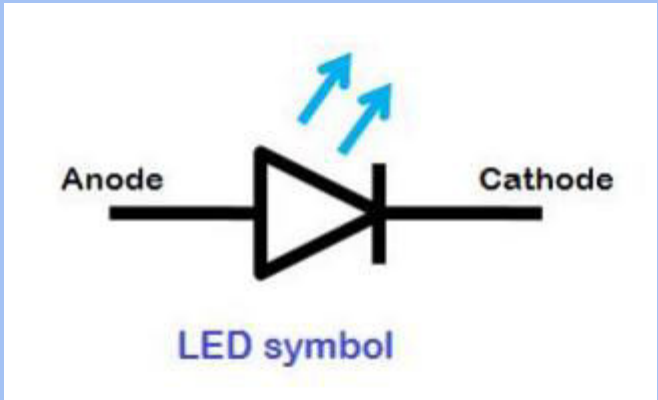
LED - Light Emitting Diode: Introduction,Working, V-I Characteristics

Elementrix Classes

Introduction

- **LED (Light Emitting Diode)** is an optoelectronic device which works on the principle of electro-luminance. Electro-luminance is the property of the material to convert electrical energy into light energy.

- It is specially doped p-n junction diode made up of specific type of semiconductors. When the light emitting diode light is forward biased, then it emits light either visible region or infra-red region.

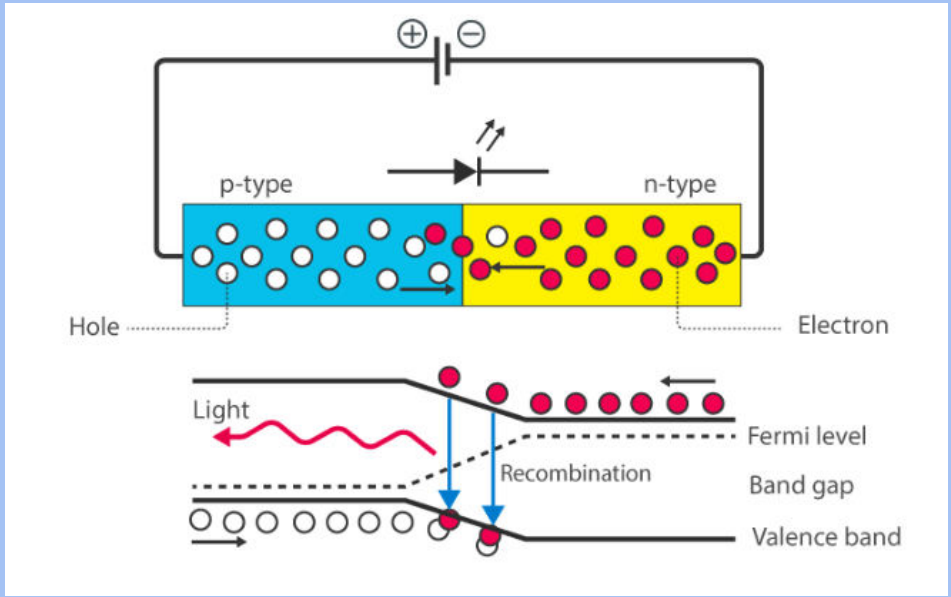


LED symbol

Working Principle of LED:

The light emitting diode works like a normal PN-junction diode. When the diode is forward biased, then the current flows through the diode.

The flow of current in the semiconductors is caused by the both flow of holes in the opposite direction of current and flow of electrons in the direction of the current. Hence there will be recombination due to the flow of these charge carriers.



The recombination indicates that the electrons in the conduction band jump down to the valence band. When the electrons jump from one band to another band the electrons will emit the electromagnetic energy in the form of photons and the photon energy is equal to the forbidden energy gap (E_g).

$$\mathbf{E_g = hf}$$

Where **h** is known as a **Planck constant**, and **f** is the **frequency of the emitted electromagnetic radiation**.

The frequency of radiation is related to the velocity of light as a $f = \frac{c}{\lambda}$

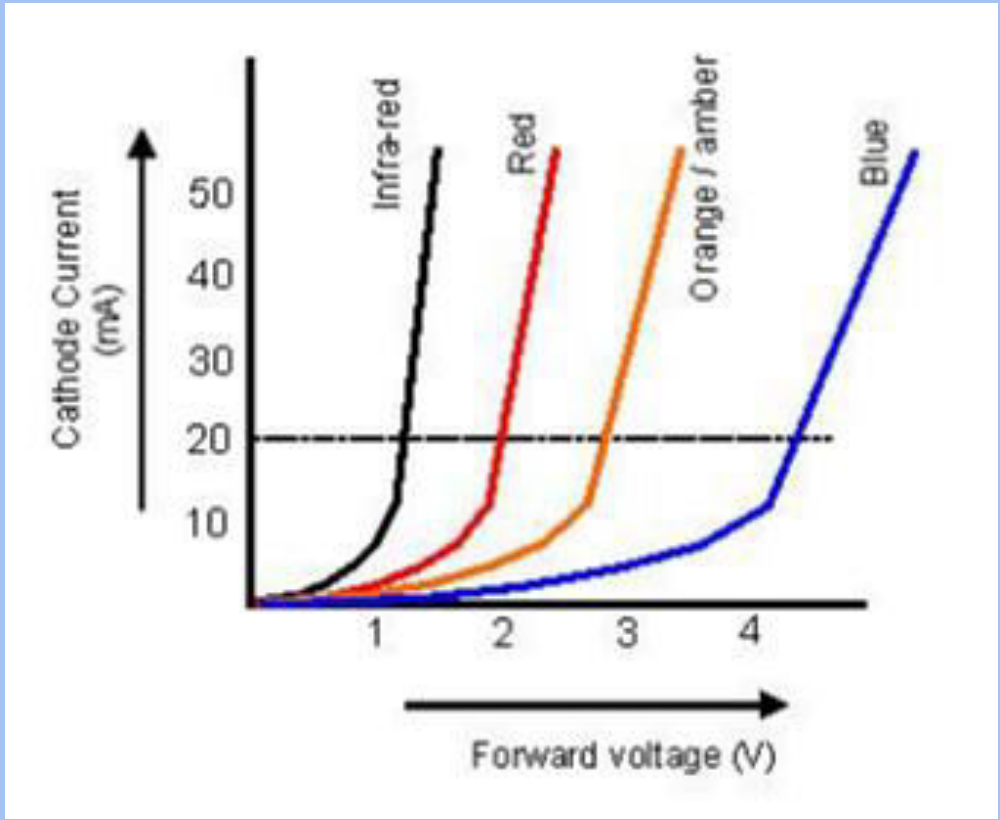
where c is the speed of light λ is denoted as a wavelength of an electromagnetic radiation and the above equation will become as

$$E_g = \frac{hc}{\lambda}$$

From the above equation, we can say that the wavelength of electromagnetic radiation is inversely proportional to the forbidden gap. For LED the wavelength of the emitted photon, lies in the visible or infrared region.

V-I Characteristics of LED

There are different types of light emitting diodes are available in the market and there are different LED characteristics which include the color light, or wavelength radiation, light intensity. The important characteristic of the LED is color.


Cathode Current (mA)
50
40
30
20
10
Infra-red
Red
Orange / amber
Blue
1
2
3
4
Forward voltage (V)

Color LED	Name Color	Wavelength nm = $1x10^{-9}$	Voltage Drop (Forward Voltage)
	White	395 - 530 nm	3 - 5 V
	Ultraviolet	< 400 nm	3.1 - 4.4 V
	Violet	400 - 450 nm	2.8 - 4.0 V
	Blue	450 - 500 nm	2.5 - 3.7 V
	Green	500 - 570 nm	1.9 - 4.0 V
	Yellow	570 - 590 nm	2.1 - 2.2 V
	Orange	590 - 610 nm	2.0 - 2.1 V
	Red	610 - 760 nm	1.6 - 2.0 V
	Infrared	> 760 nm	< 1.9 V

- The following graph shows the approximate curves between the forward voltage and the current. Each curve in the graph indicates the different color.

- The safe forward voltage ratings of most LEDs is from 1V to 3V and forward current ratings is from 200 mA to 100 mA.

- Light emitting diodes emit either visible light or invisible infrared light when forward biased. The LEDs which emit invisible infrared light are used for remote controls.

Materials Used in LEDs

- Silicon or germanium diodes do not emit energy in the form of light. Instead, they emit energy in the form of heat. Thus, silicon or germanium is not used for constructing LEDs.

- The material in an LED is selected in such a way that the wavelength of the released photons falls within the visible portion of the light spectrum.

- Visible LED is a type of LED that emits visible light. These LEDs are mainly used for display or illumination. Invisible LED is a type of LED that emits invisible light (infrared light). These LEDs are mainly used with photosensors such as photodiodes.

Some commonly used LEDs are mentioned below:

- Gallium Arsenide (GaAs) – infrared
- Gallium Arsenide Phosphide (GaAsP) – red to infrared, orange
- Aluminium Gallium Arsenide Phosphide (AlGaAsP) – high-brightness red, orange-red, orange, and yellow
- Gallium Phosphide (GaP) – red, yellow and green
- Aluminium Gallium Phosphide (AlGaP) – green
- Gallium Nitride (GaN) – green, emerald green
- Gallium Indium Nitride (GaInN) – near ultraviolet, bluish-green and blue
- Zinc Selenide (ZnSe) – blue
- Aluminium Gallium Nitride (AlGaN) – ultraviolet

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