



جامعة مولاي إسماعيل
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FACULTÉ DES SCIENCES

Course Optoelectronic

Parcours électronique S6 2025-2026

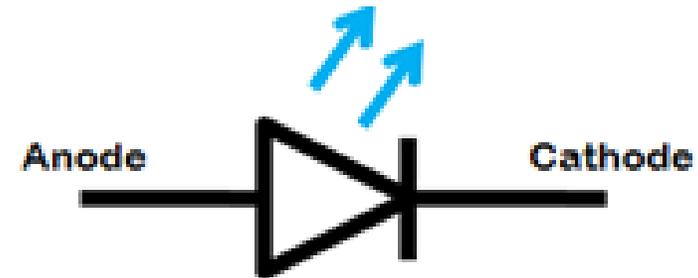
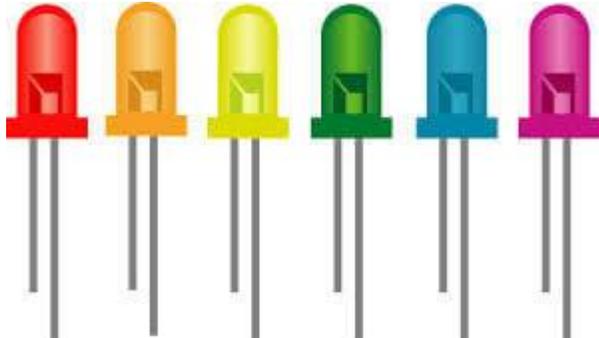
Pr. Omar EL OUTASSI

Chapitre 5: : Light-emitting diodes

- The basic idea of LED
- Structure of LED
- Classification of LED
- Working principle and characteristics of LED
- Specifications of LED
- Applications of LED

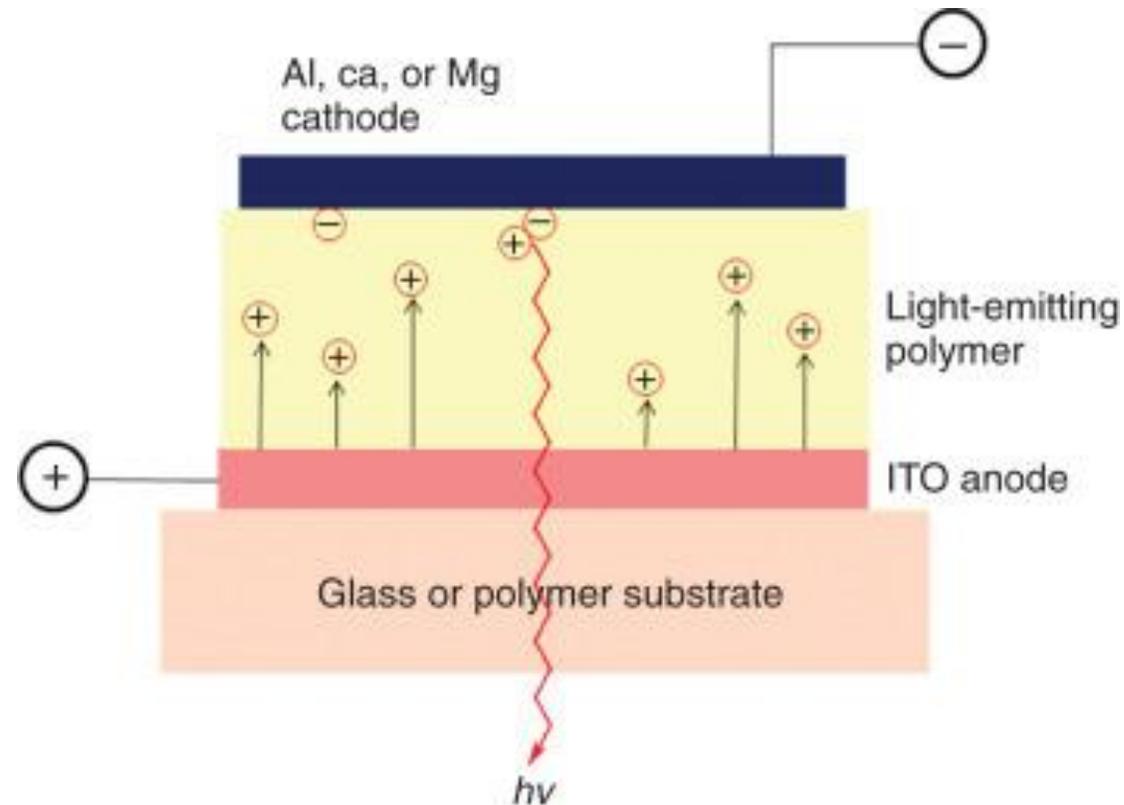
Basic Idea of LED

- **Definition:** An LED (Light Emitting Diode) is a semiconductor device that converts electrical energy directly into light.



Basic Idea of LED

- **Key Principle:** The fundamental concept is **electroluminescence**, where light is produced when an electric current passes through a specific type of material.



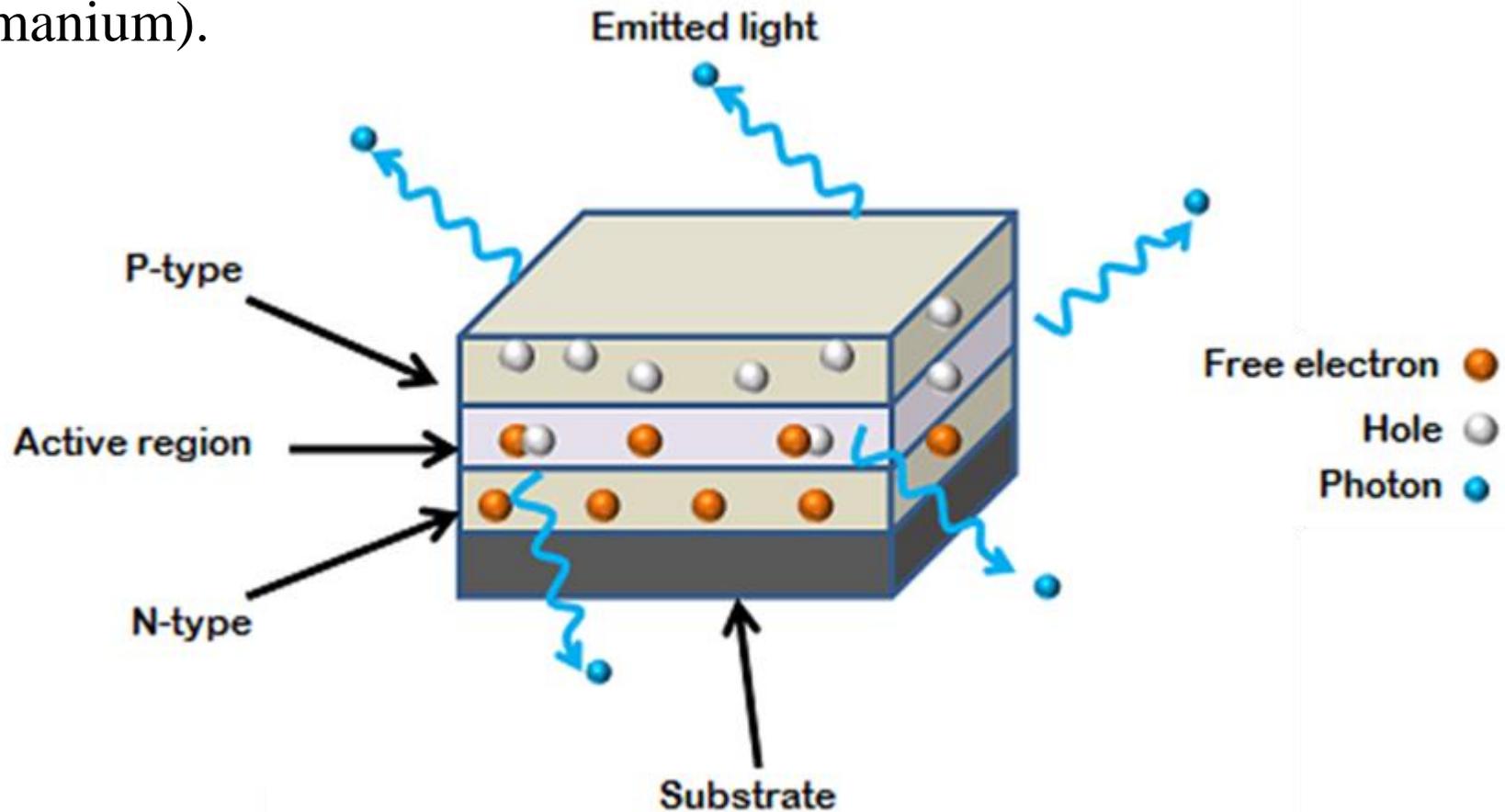
Basic Idea of LED

- **Efficiency:** LEDs are highly efficient light sources because they produce very little heat compared to traditional incandescent bulbs, which waste most energy as heat.
- **Solid-State Lighting:** As solid-state components, LEDs are durable, compact, and have a long operational life.

Light sources	Illumination Efficiency (lm / W)	Lifetime (hours)
Incandescent	15-20	1000
Tungsten Halogen	12-35	2000-4000
Mercury Vapor Lamps	40-60	12000
Compact Fluorescent Lamp	40-70	6000-12000
Fluorescent Lamp	50-100	10000-16000
Induction Lamp	60-80	60000-100000
High Pressure Sodium	80-100	12000-16000
LED	80-160	50000-100000

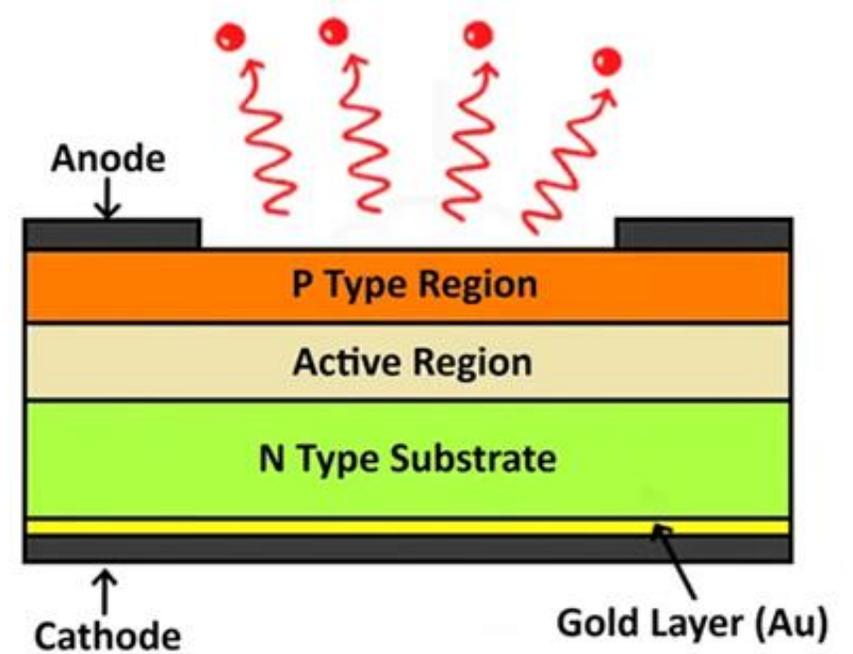
Structure of LED

A LED is built around a P-N junction made of special semiconductor compounds (not silicon or germanium).



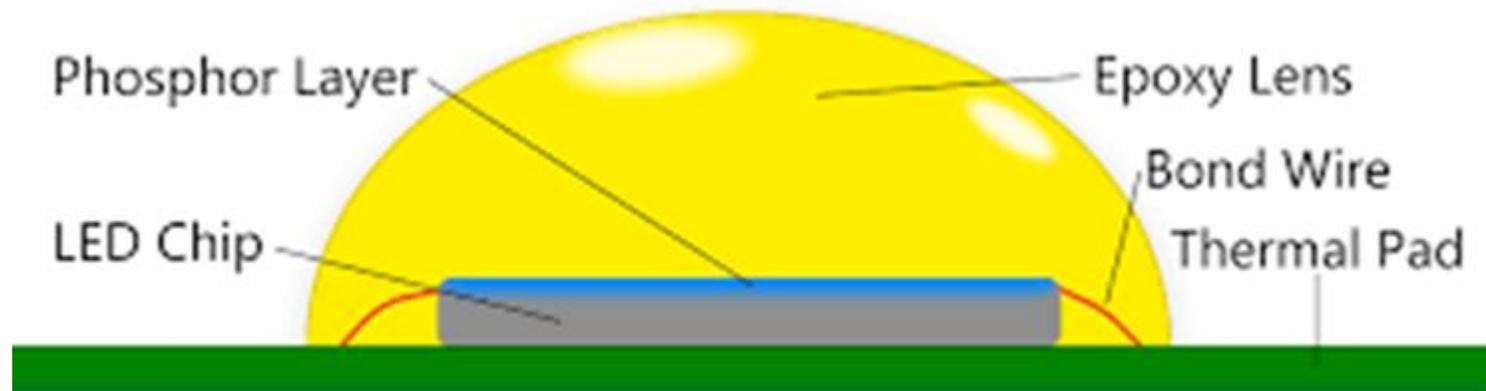
Structure of LED

- **P-type Semiconductor:** A layer doped with impurities to create a surplus of **holes** (positive charge carriers).
- **N-type Semiconductor:** A layer doped with impurities to create a surplus of **electrons** (negative charge carriers).
- **Active/Depletion Region:** A narrow region between the P and N layers where the electrons and holes recombine.
- **Anode and Cathode:** The positive (anode, typically a longer lead) and negative (cathode, typically a shorter lead) terminals for electrical connection.



Structure of LED

- **Encapsulation/Lens:** A transparent epoxy resin shell that protects the internal structure and often acts as a lens to focus or diffuse the light.
- **Reflective Cup:** A feature often placed below the semiconductor chip to direct more light upwards, increasing brightness.



Classification of LED

LEDs are classified based on their material, power, and application.

➤ By Color/Wavelength

(Material):

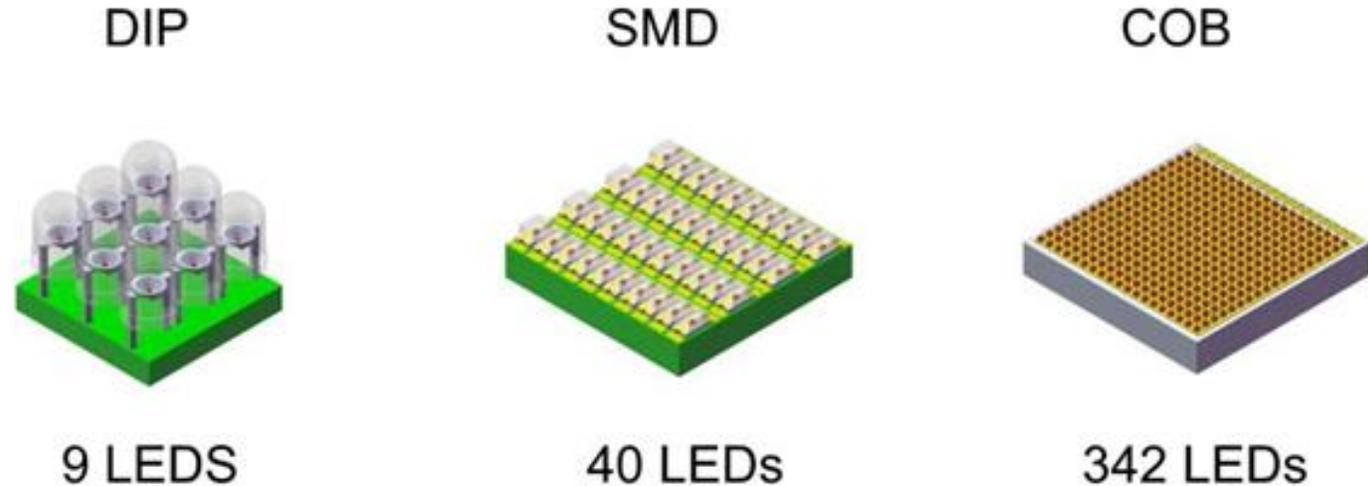
- Visible LEDs:
- Invisible LEDs:
- White LEDs:

Color LED	Name Color	Wavelength nm = 1×10^{-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

Classification of LED

LEDs are classified based on their material, power, and application.

➤ By Type/Packaging:



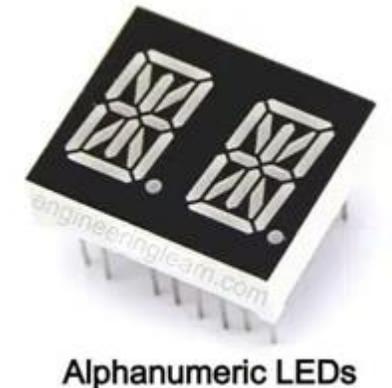
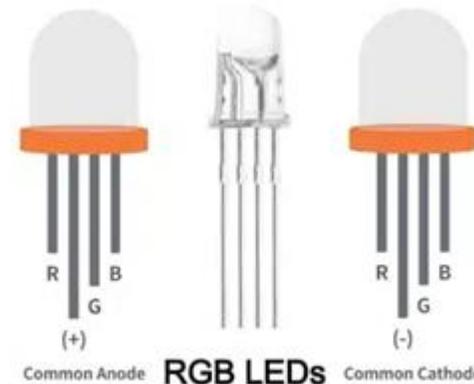
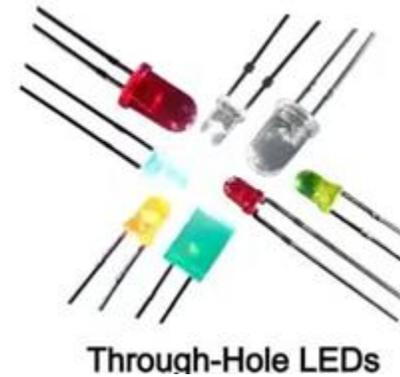
- **Miniature (DIP) LEDs: SMD (Surface Mounted Device) LEDs: COB (Chip on Board) LEDs:.**
- **High-Power LEDs:**

Classification of LED

LEDs are classified based on their material, power, and application.

➤ By Function:

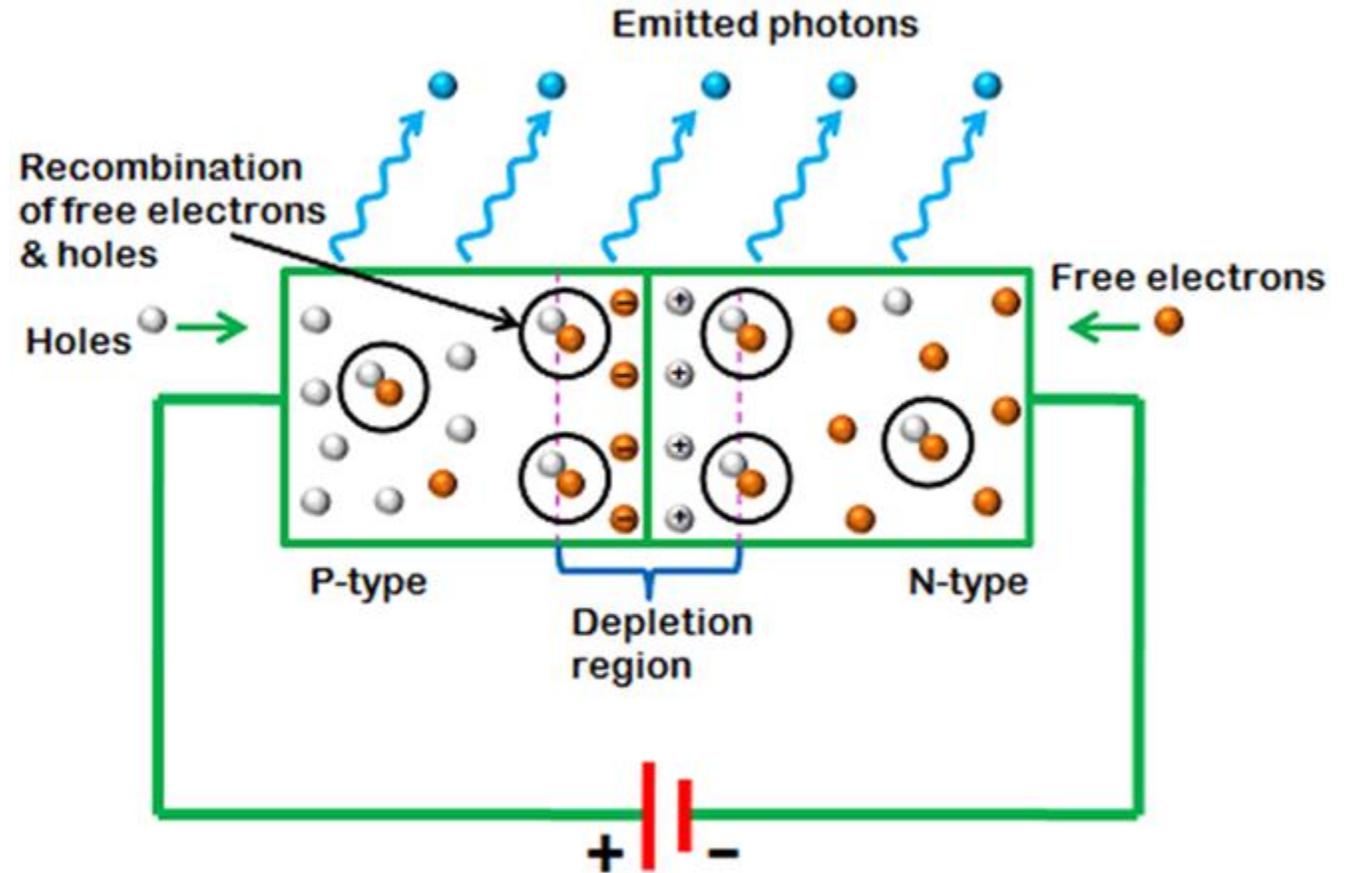
- **RGB LEDs:** Contain red, green, and blue emitters in one package to produce various colors by mixing them.
- **Flashing LEDs:** Have an integrated circuit for built-in flashing.



Working Principle and Characteristics of LED

➤ Working Principle

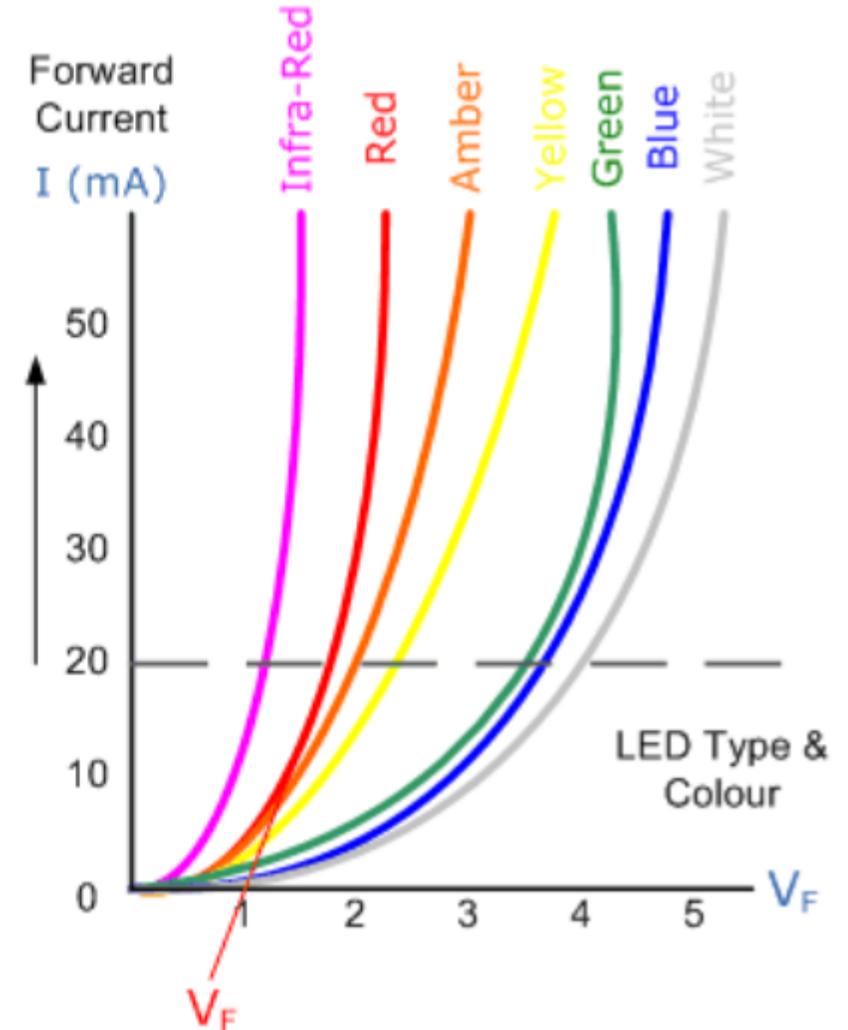
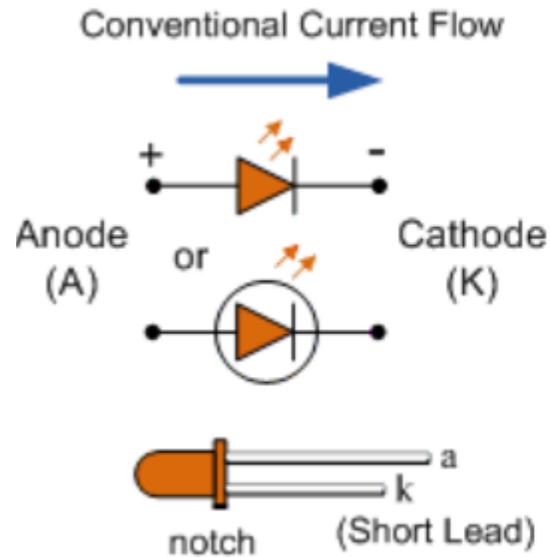
- **Forward Bias:**
- **Recombination:**
- **Photon Emission:**
- **Electroluminescence:**



Working Principle and Characteristics of LED

➤ Characteristics

- **Monochromatic Light:**
- **Directional:**
- **Fast Switching:**
- **Current Dependent:**



Specifications of LED

Key specifications help in selecting the right LED for an application.

- **Forward Voltage (V_F):** The typical voltage drop across the LED when forward-biased. This varies by color (e.g., ~1.9V for Red, ~3.3V for Blue/White).
- **Forward Current (I_F):** The recommended operating current, typically ranging from a few mA (indicator LEDs) to hundreds of mA or more (high-power LEDs).
- **Wavelength (λ):** Determines the color of the emitted light, measured in nanometers (nm).
- **Luminous Flux/Brightness:** Total light output, measured in lumens (lm), or intensity in candelas (cd).
- **Luminous Efficacy:** The efficiency of converting electrical power to light, measured in lumens per watt (lm/W).
- **Beam Angle:** The angle at which light is emitted.

Specifications of LED

Voltage Available	12 V DC
Nominal Power	3 W
Average Lumens	260 Lm
Material:	Plastic + PC
LED Chip	Epistar SMD
Life Span:	50,000 Hours
Luminous Efficacy	80-90 lm/W
Beam Angle	120° Degrees
Working temperature	-25 ~ +55°C
Protect Class	IP50
Power Factor	>95%
CRI	Ra ≥80
Light Color	2700K or 6400K
Socket	E27 or B22

Applications of LED

Due to their efficiency and versatility, LEDs are used in numerous applications.

➤ **General Illumination:**

- Residential and commercial lighting (bulbs, downlights, panel lights).
- Street lights and outdoor area lighting.
- Horticultural grow lights.



Applications of LED

Due to their efficiency and versatility, LEDs are used in numerous applications.



➤ Displays and Indicators:

- Status indicators on electronic devices.
- Large area stadium and dynamic message signs.
- Televisions (backlighting) and computer monitors.
- Alphanumeric displays (seven-segment displays, dot matrix).

Applications of LED

Due to their efficiency and versatility, LEDs are used in numerous applications.

➤ **Automotive:**

- Headlights, brake lights, and turn signals.

➤ **Specialized Uses:**

- Optical fiber communication (using infrared LEDs).
- Medical devices (surgical lights, therapy).
- Alarm and security systems.
- Remote controls.



End chapter 5

[Video](#)

<https://www.youtube.com/watch?v=Yxt72aDjFgY>