



Organic light emitting diodes for display technology

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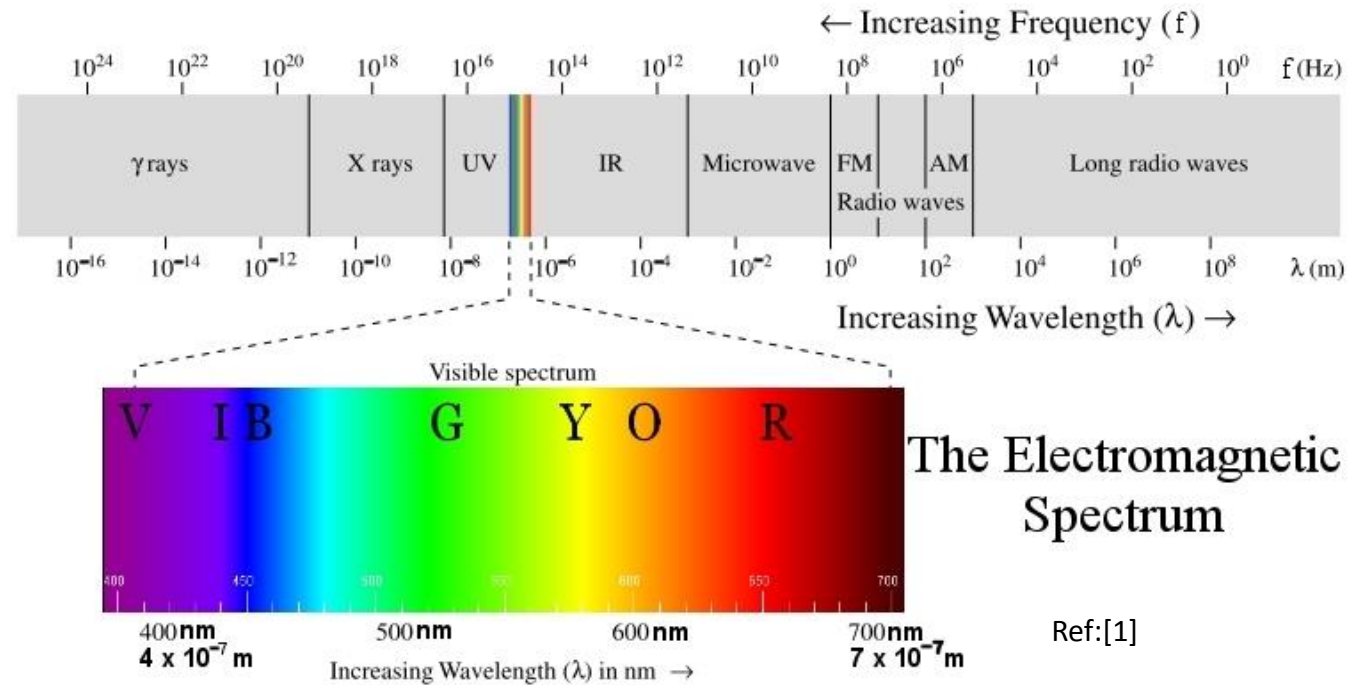
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What's Light

Light:

Visible part of EM spectra .



- **Thermoluminescence:**

luminescence produced due to the re-emission of previously absorbed energy.

- **Electroluminescence:**

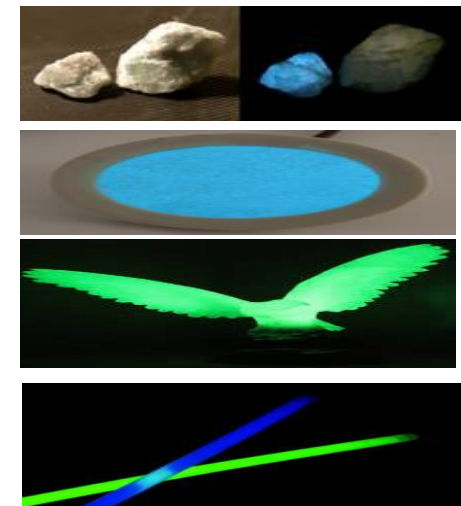
luminescence produced electrically, especially by the application of a voltage.

- **Photoluminescence:**

luminescence produced due to the absorption of EM radiation.

- **Chemiluminescence:**

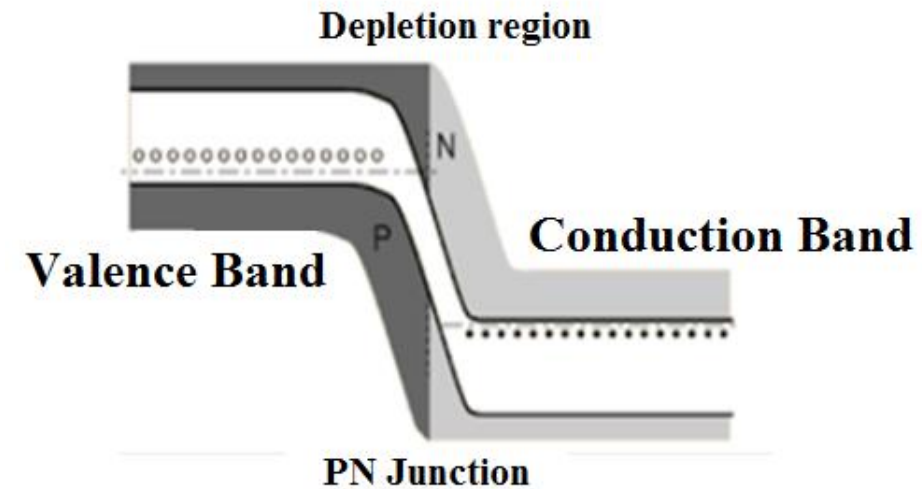
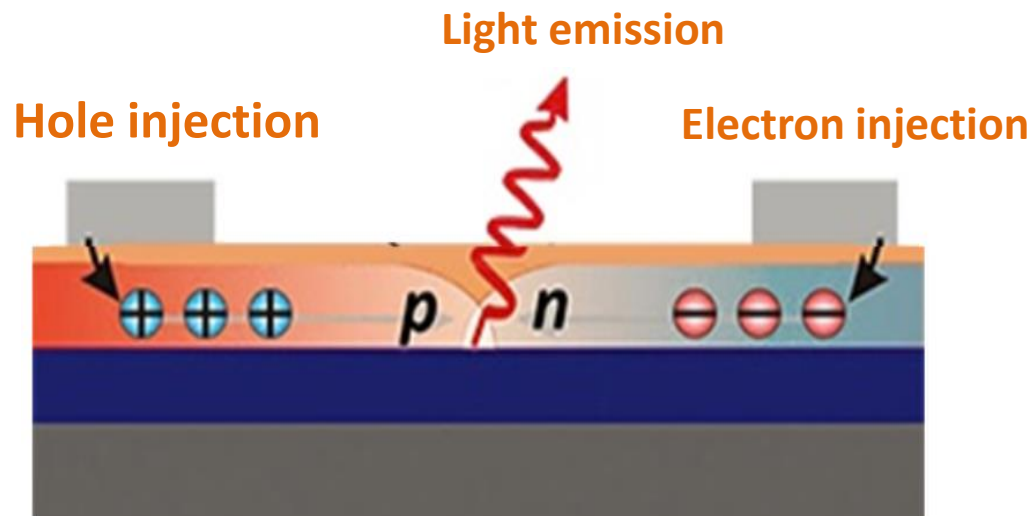
luminescence produced due to energy released during a chemical reaction of a substance.





What is an LED(Light Emitting Diode)? & How it works?

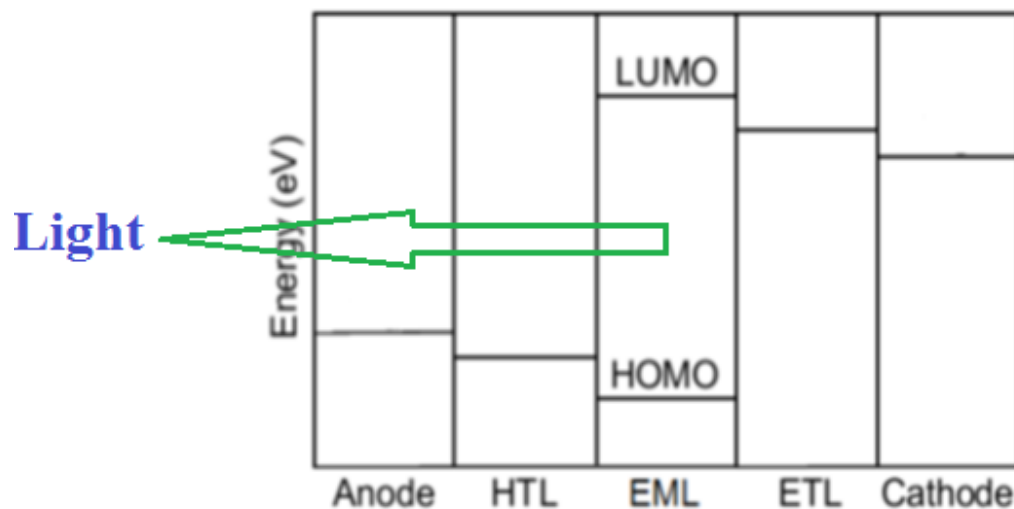
- Two-lead semiconductor light source.
- Current flows (forward Bias) - the free Negative electrons are drawn to the positive electrode. The holes move the other way.
- The holes exist at a lower energy level than the free electrons. When electrons fall into holes, it losses energy .
- This energy is emitted in a form of a photon, which causes **light**.





Organic Semiconductors

- In Organic semiconductors the emission of light occurs in organic(Carbon based) semiconducting layers.
- The organic semiconductors are used in Organic LEDs (OLED).



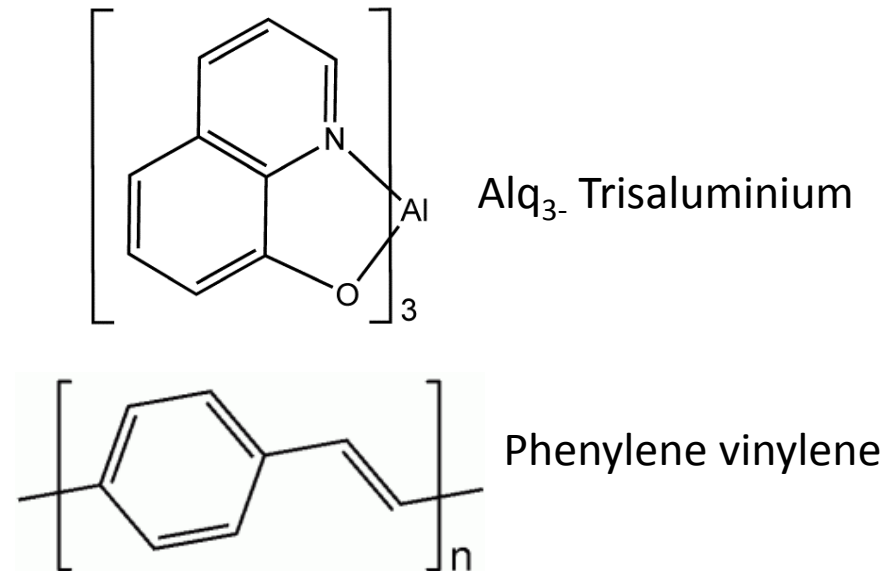
HTL:Hole transporting layer

ETL:Electron transporting

EML:Emissive layer (EML).

LUMO : lowest unoccupied molecular orbital

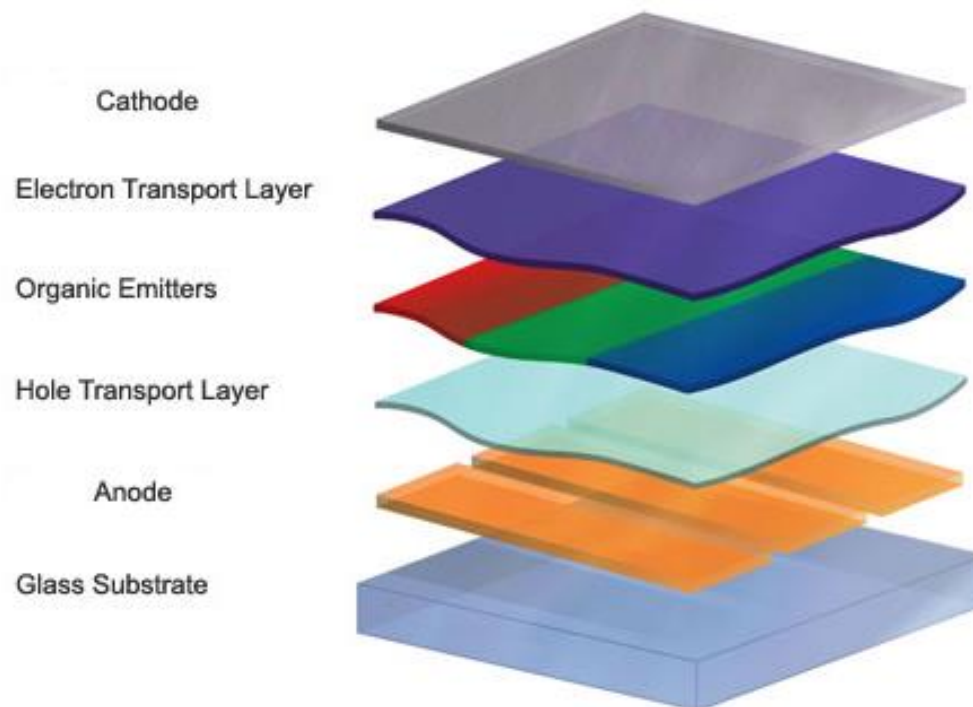
HOMO: highest occupied molecular orbital



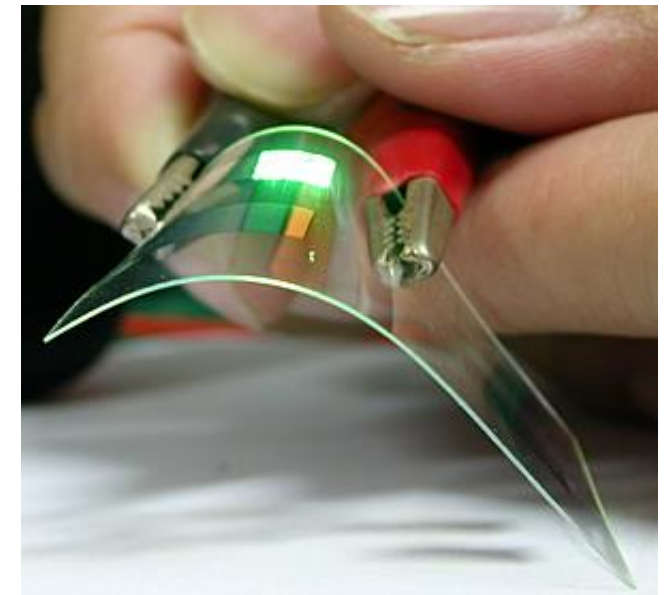


What's OLED

- An OLED is an electronic device made by placing a series of organic thin films between two conductors.
- A device that is 100 to 500 nanometers thick or about 200 times smaller than a human hair.



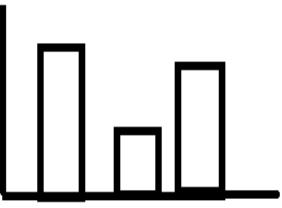
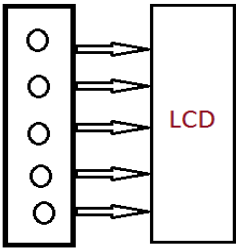


Structure of OLED





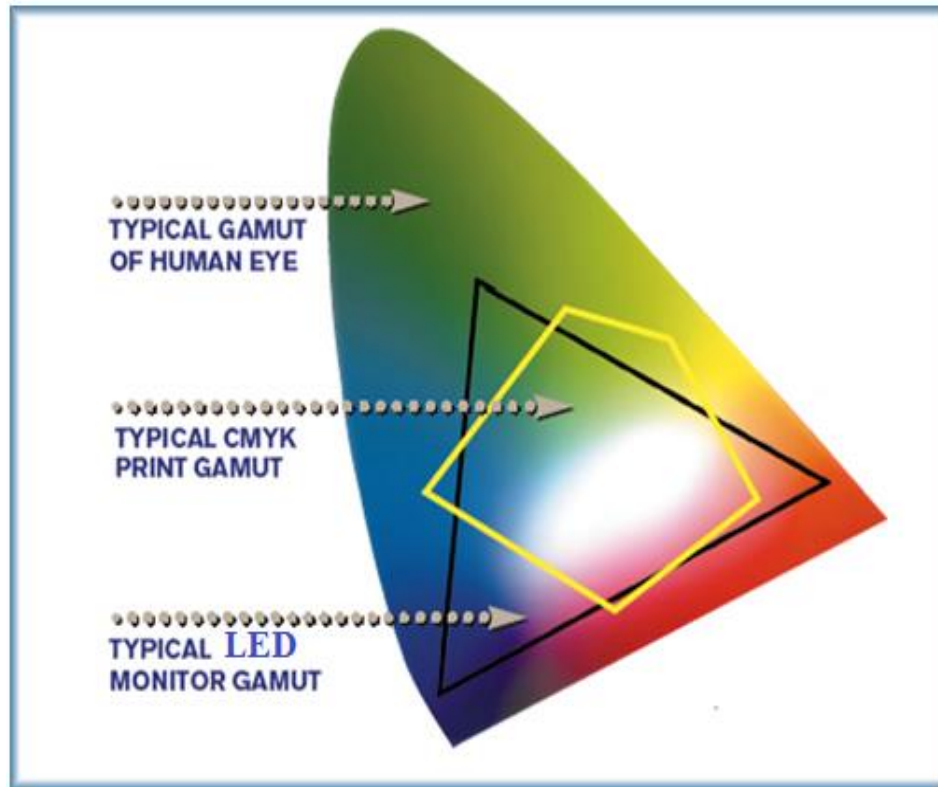
Electro optic comparison of LED & OLED

	OLED	LED
Efficiency (utilization)	100%	50%
Maximum Brightness		
Display	 <p>Pixels active- when needed</p>	 <p>Active always – waste of energy</p>
Color Gamut	Big Range	Smaller than OLED

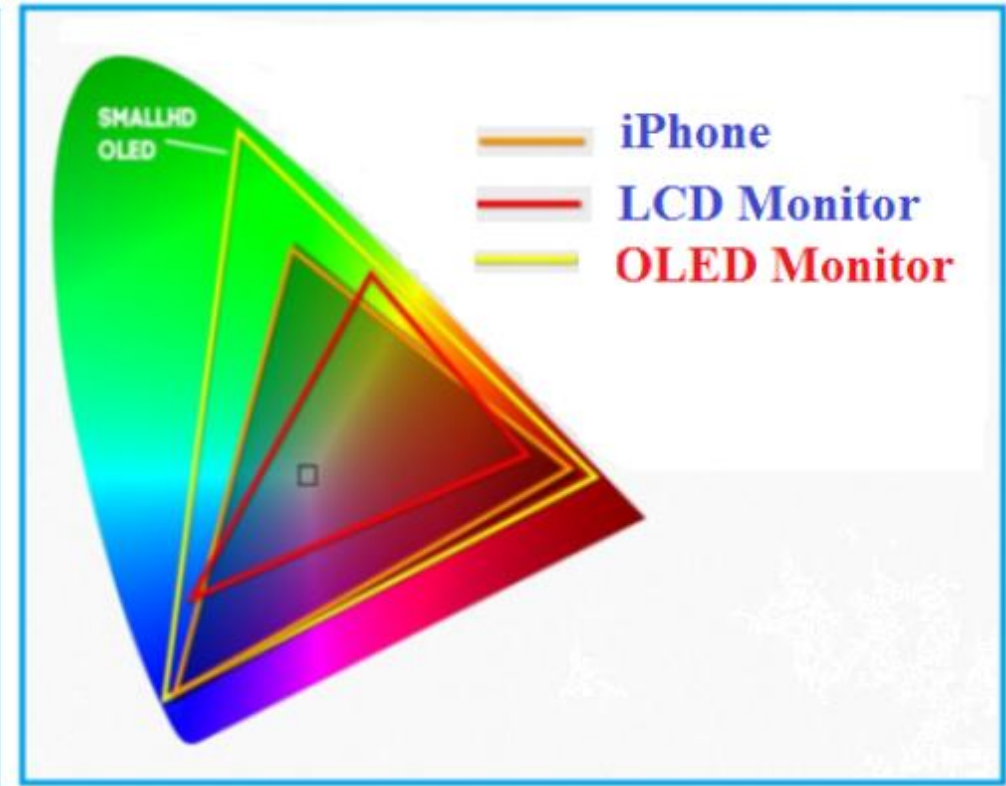


Color Gamuts

The Color Gamut is the range of colors that a display can produce.



LED



OLED

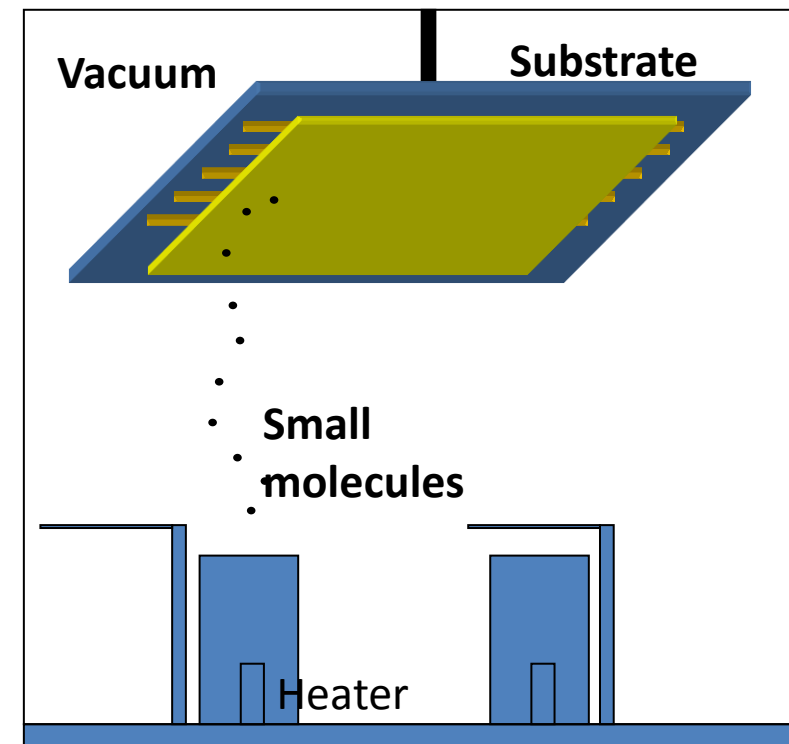
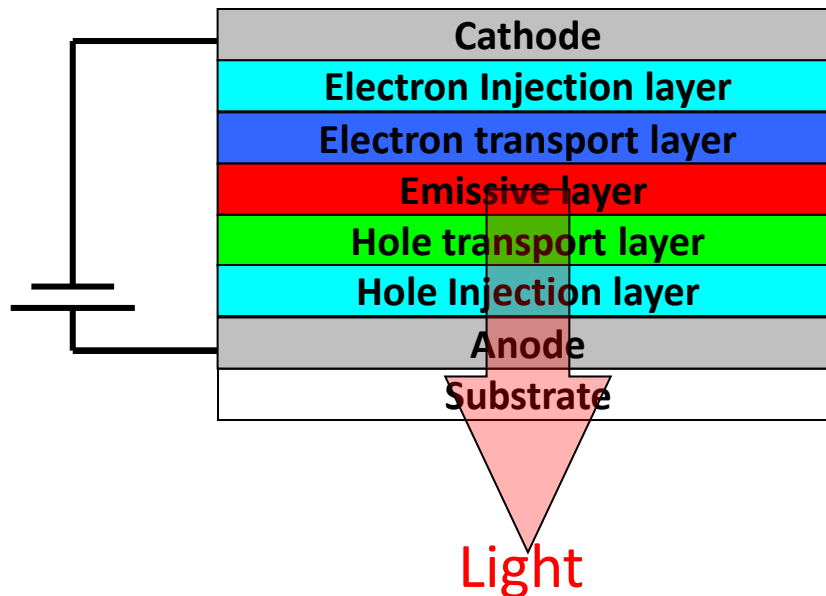


Branches of OLEDs

There are two Principle Branches

1. Small molecular OLEDs:

- Electrons injected from cathode, Holes injected from anode.
- Transport and radiative recombination of electron hole pairs at emissive layer .

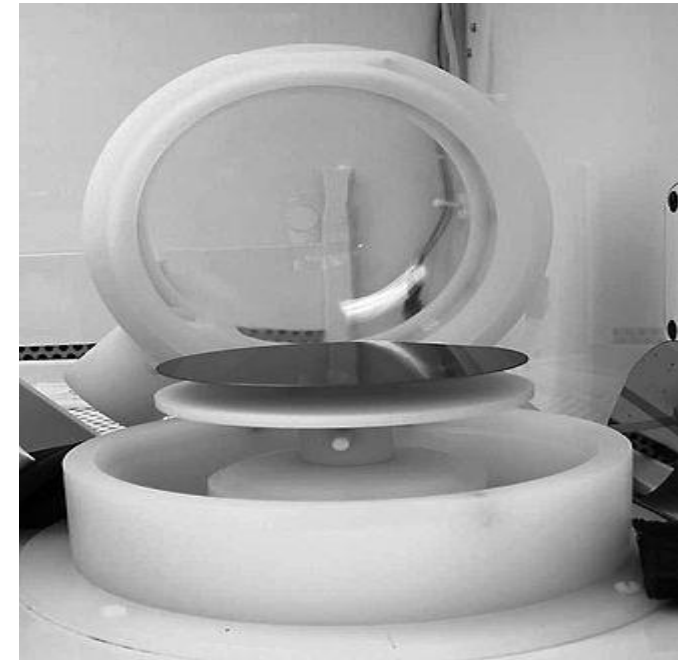
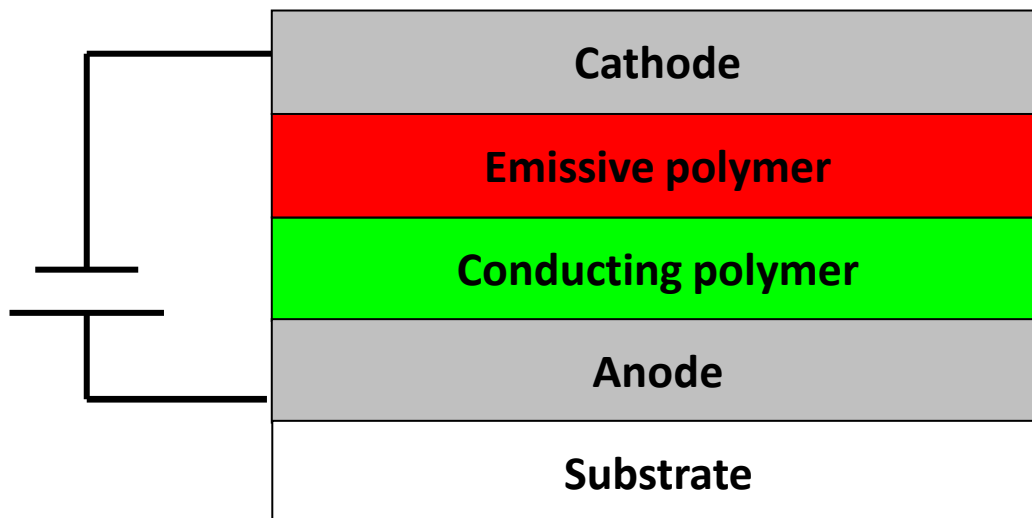




Branches of OLEDs

2. Polymer light-emitting diodes :

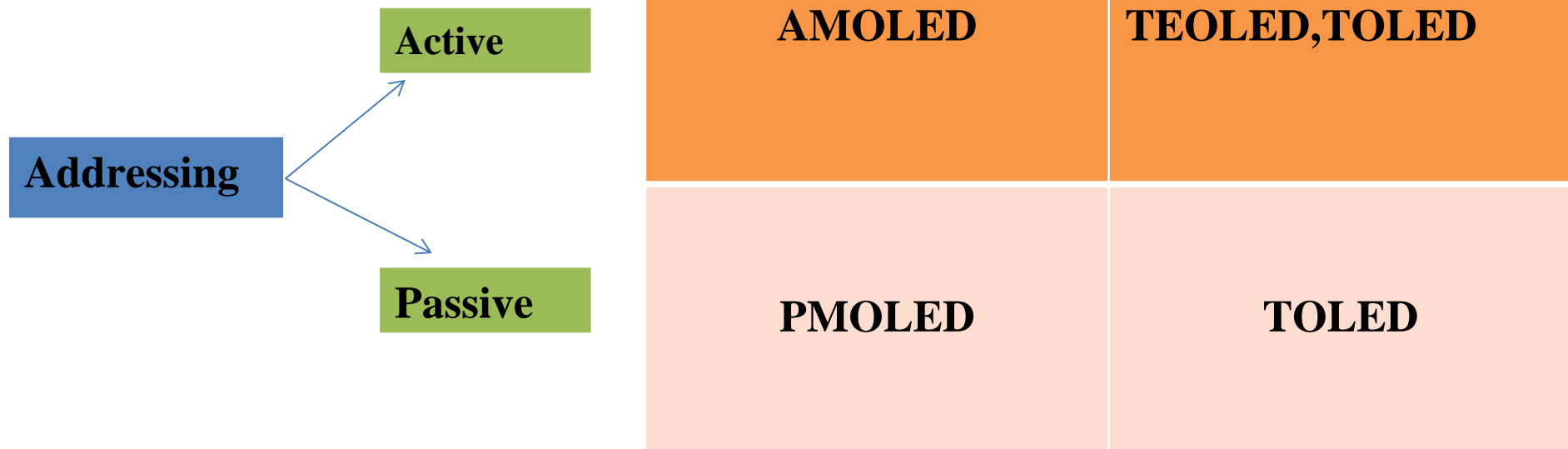
- Polymer light-emitting diodes (PLED), also light-emitting polymers (LEP), involve an electroluminescent conductive polymer that emits light when connected to an external voltage.



WS-400 spin coater used to apply photoresist to the surface of a silicon wafer.



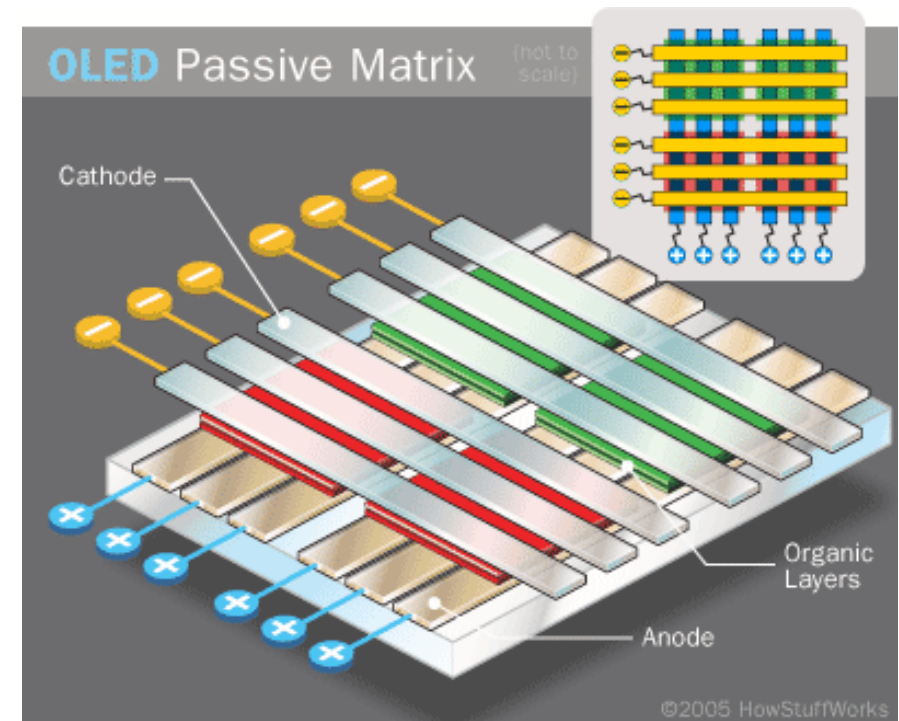
Types of OLED





Passive-Matrix OLED (PMOLED)

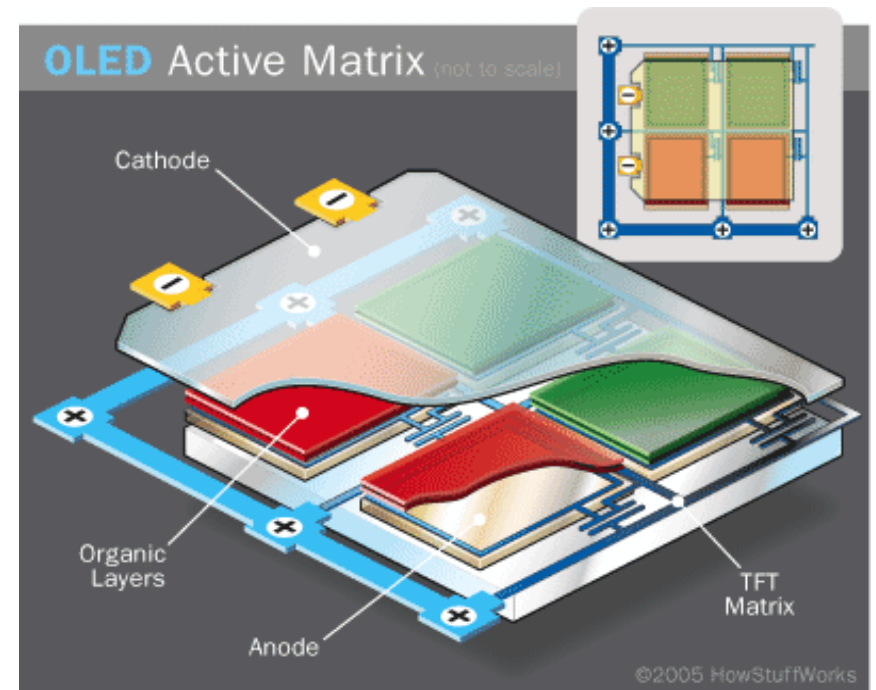
- Perpendicular cathode/anode strip orientation.
- Light emitted at intersection (pixels)
- External circuitry
Turns on/off pixels
- Large power consumption
Used on 1-3 inch screens





Active-Matrix OLED (AMOLED)

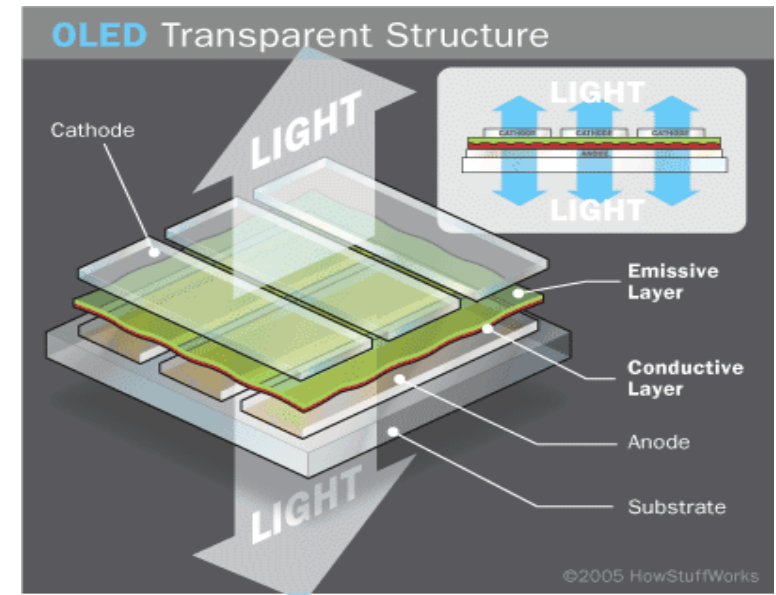
- Layers of cathode, anode, organic molecules.
- Thin Film Transistor matrix (TFT) on top of anode.
Internal circuitry to determine which pixels to turn on/off
- Less power consumed than PMOLED.
Used for larger displays





Transparent OLED (TOLED)

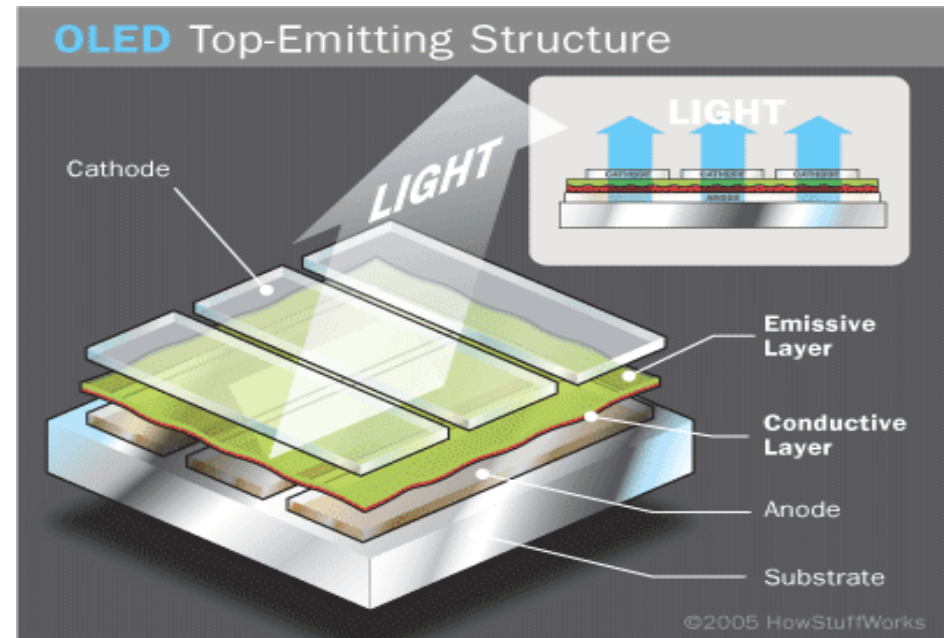
- Transparent substrate, cathode and anode
- Bi-direction light emission
- Passive or Active Matrix OLED
- Useful for heads-up display.
Eg: Transparent projector screen glasses





Top-emitting OLED (TEOLED)

- Non-transparent or reflective substrate
- Transparent Cathode
- Used with Active Matrix Device
Eg: Smart card displays









Flexible - OLED

- Deposition of the organic layer onto the substrate using a method derived from inkjet printing.
- Used in the production of rollable displays, electronic paper, or bendable displays.





Comparison Study

Source of light	Thermal	Fluorescent	LED	OLED
Usage	 Not used for displays	 / Plasma TV	 / LED Back Lighting	 / Display Pixels
Over all Efficiency	2%	15%	22%	84%
Black level/ contrast	0 -- ∞	0 -- ∞	1/1000 / 1000	0 -- ∞
Resolution in dpi	--	40	300-800	1000
Refresh rate		60fms	120fms	LED < OLED
Viewing angle	Lambertian	Lambertian	Non- Lambertian	Lambertian



OLED TVs ,Tablets, Mobile phones





Devices with OLED





Case Study

Devices	Companies	OLED
Mobile phones	Samsung, Motorola, LG....	YES
Televisions	Panasonic ,LG....	YES
Digital Cameras	Sony, Canon, Olympus...	YES
Tablets	Samsung, Dell, Fujitsu...	YES
Wearable Devices	LG, Samsung, Acer....	YES
OLED Lamps	Acuity, LG..	YES
Other Devices(binoculars, Car audio Systems, remote Controllers...)	Sony...	YES



Drawbacks of OLED

- Lifespan
- Large quantity production of large-size screens is not available.
- Water can easily damage OLED.
- Sunlight Effect: Another disadvantage of OLED display is that they are hard to see in direct sunlight.
- Expensive.



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Thank you