UNIT IV

Organic Light Emitting Diodes

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INTRODUCTION

- Organic light emitting diode(OLED).
- Emerging Technology for displays in devices.
- Main principle behind OLED technology is electroluminescence.
- Offers brighter, thinner, high contrast, flexible displays.

WHAT IS AN OLED?

- OLEDs are solid state devices composed of thin films of organic molecules that is 100 to 500 nanometres thick.
- They emits light with the application of electricity.
- They doesn't require any backlight. i.e., they are self emitting.
- They are made from carbon and hydrogen.

HISTORY

- The first OLED device was developed by Eastman Kodak in 1987.
- In 1996, pioneer produces the world's first commercial PMOLED.
- In 2000, many companies like Motorola, LG etc developed various displays.
- In 2001, Sony developed world's largest fullcolor OLED

HISTORY (CONTD.)

- In 2002, approximately 3.5 million passive matrix OLED sub-displays were sold, and over 10 million were sold in 2003.
- In 2010 and 2011, many companies announced AMOLED displays.
- Many developments had take place in the year 2012.

FEATURES

- Flexibility.
- Emissive Technology.
- Light weight and thin.
- Low power consumption.
- High contrast, brighter and perfect display from all angles.

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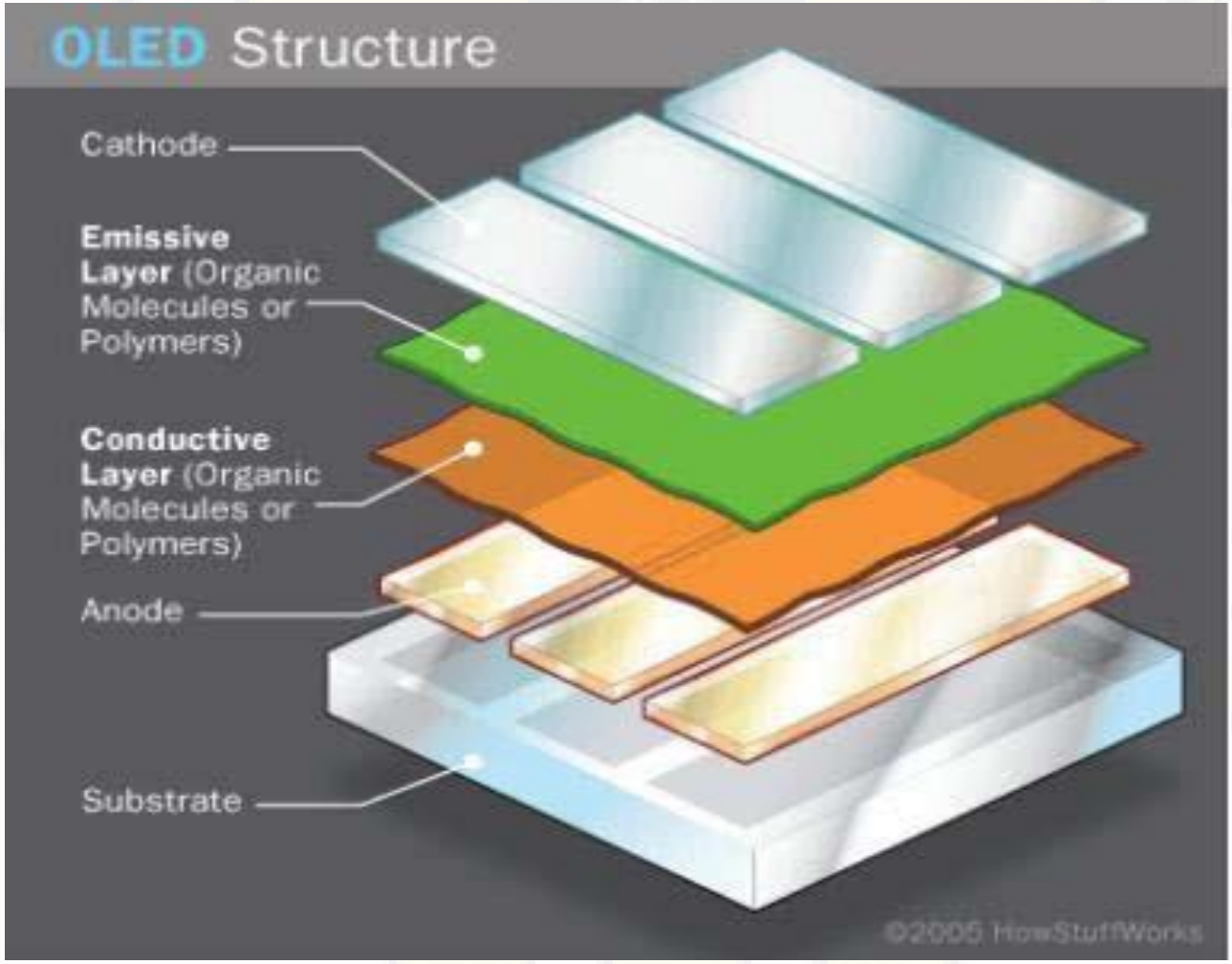
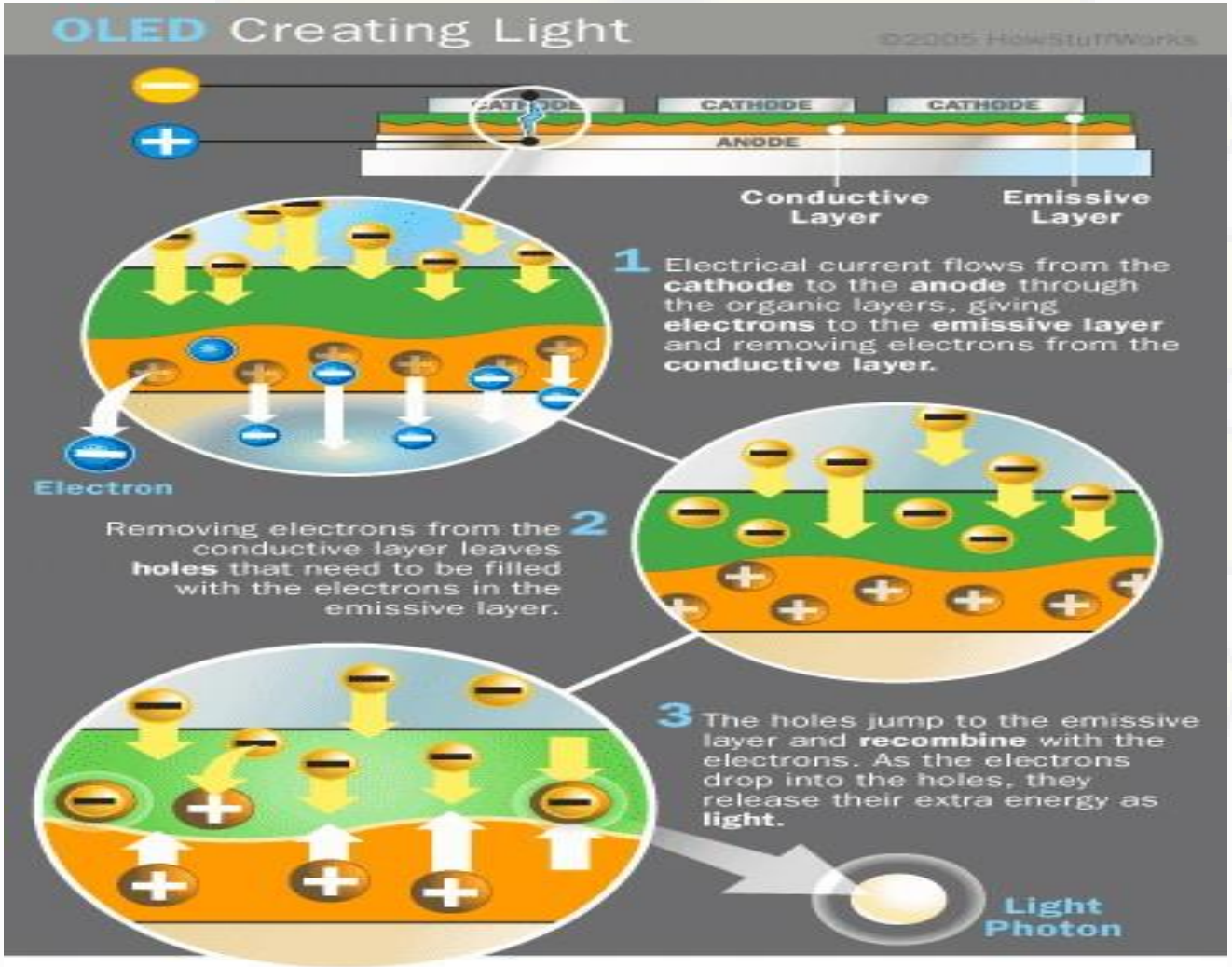
STRUCTURE OF OLED(FIGURE)



How OLED Works



WORKING PRINCIPLE

- A voltage is applied across the anode and cathode.
- Current flows from cathode to anode through the organic layers.
- Electrons flow to emissive layer from the cathode.
- Electrons are removed from conductive layer leaving holes.
- Holes jump into emissive layer .
- Electron and hole combine and light emitted.

NUFACTURING OF OLED

- Vacuum deposition or Vacuum Thermal evaporation (VTE)
- Organic vapor phase deposition (OVPD)
- Inkjet Printing

Types of OLEDs

- Passive-matrix OLED
- Active-matrix OLED
- Transparent OLED
- Top-emitting OLED
- Foldable OLED
- White OLED

1. Passive-Matrix OLED (PMOLED)

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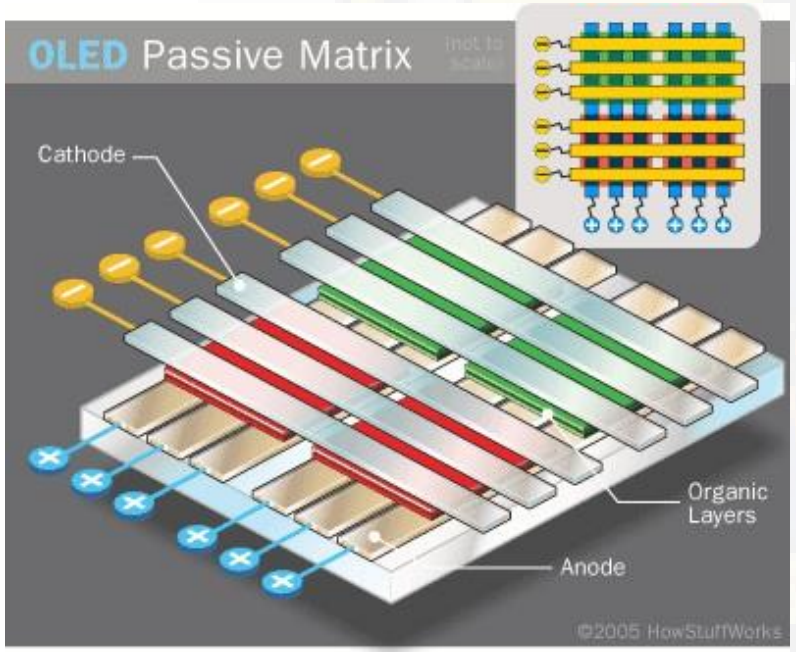

- Perpendicular cathode/anode strip orientation
- Light emitted at intersection (pixels)
- External circuitry
  - Turns on/off pixels
- Large power consumption
  - Used on 1-3 inch screens
  - Alphanumeric displays

2. Active-Matrix OLED (AMOLED)

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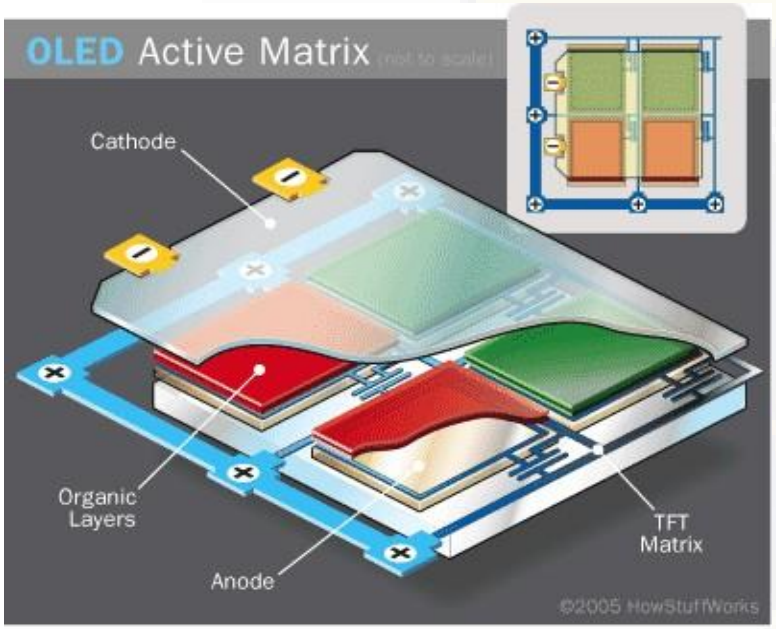

- Full layers of cathode, anode, organic molecules
- Thin Film Transistor matrix (TFT) on top of anode
  - Internal circuitry to determine which pixels to turn on/off
- Less power consumed then PMOLED
  - Used for larger displays

3. Transparent OLED(TOLED)

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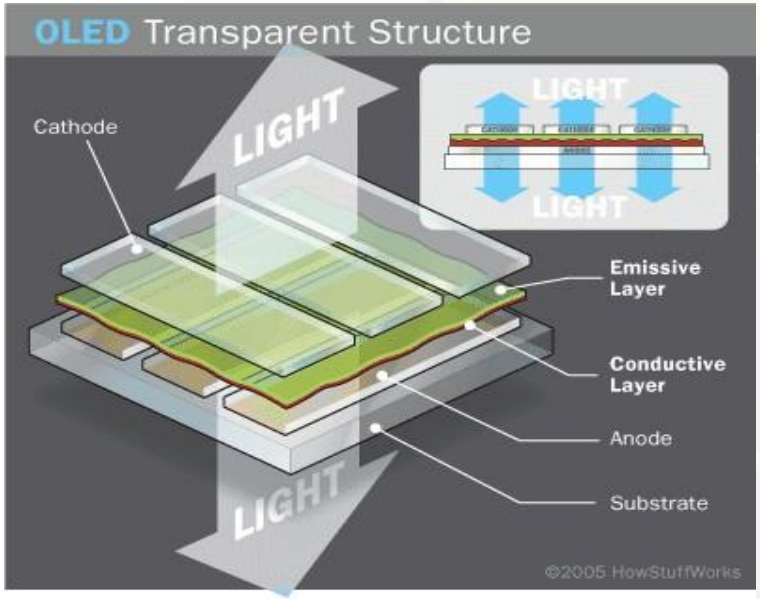

- Transparent substrate, cathode and anode
- Bi-direction light emission
- Passive or Active Matrix OLED
- Useful for heads-up display
  - Transparent projector screen
  - Glasses

4. Top-emitting OLED(TEOLED)

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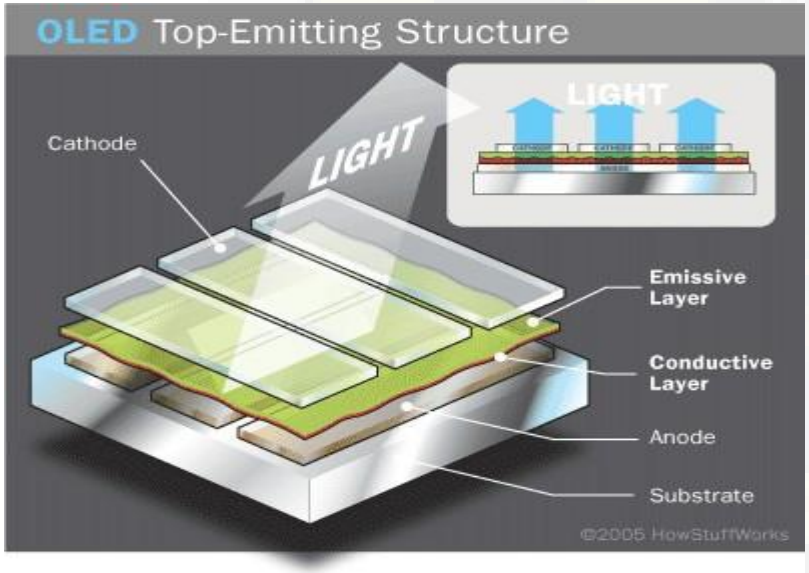
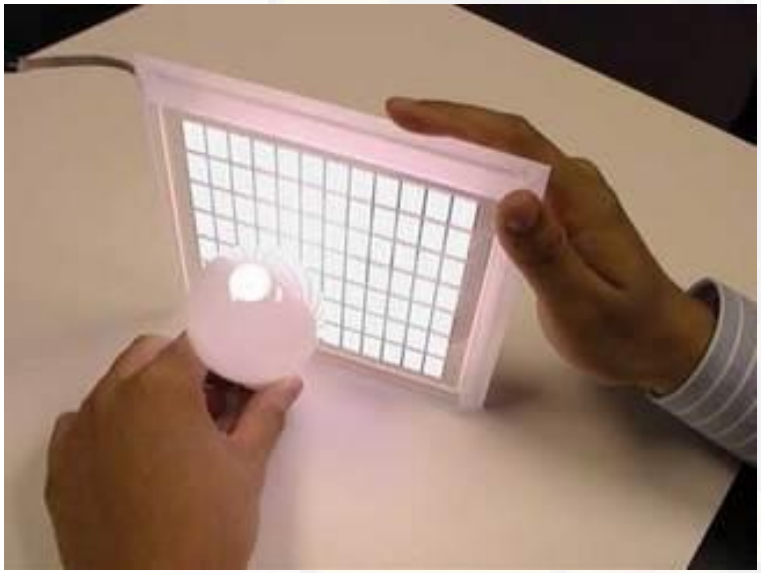


- Non-transparent or reflective substrate
- Transparent Cathode
- Used with Active Matrix Device
- Smart card displays

5. Foldable OLED

- Flexible metallic foil or plastic substrate
- Lightweight and durable
- Reduce display breaking
- Clothing OLED

6. White OLED



- Emits bright white light
- Replace fluorescent lights
- Reduce energy cost for lighting
- True Color Qualities

vantages of OLED

1. Very thin panel of approximately 1mm
2. Low power consumption
3. High brightness
4. High contrast ratio of 10,000 : 1
5. Wide viewing angle of 170°
6. Foldable display panel

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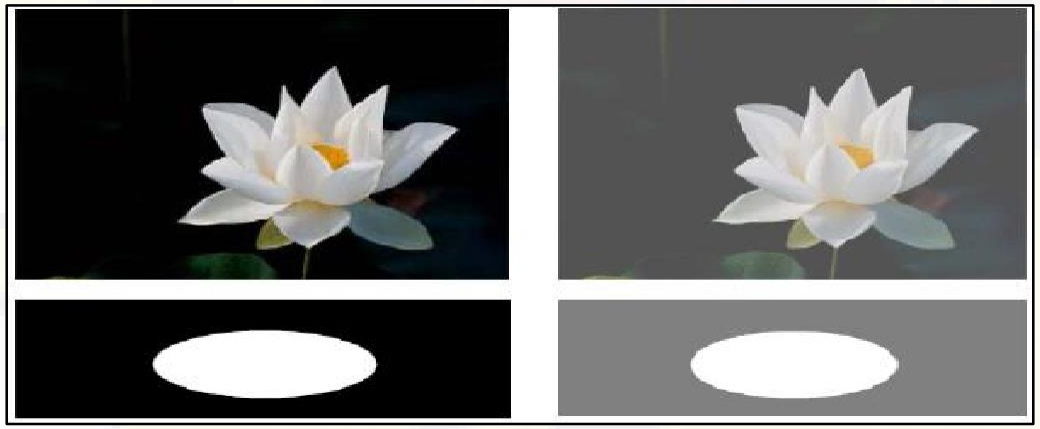
Advantages of OLED display over TFT-LCD display

1. Contrast Ratio

- Higher contrast ratio than TFT-LCD display
- Better impression for higher brightness



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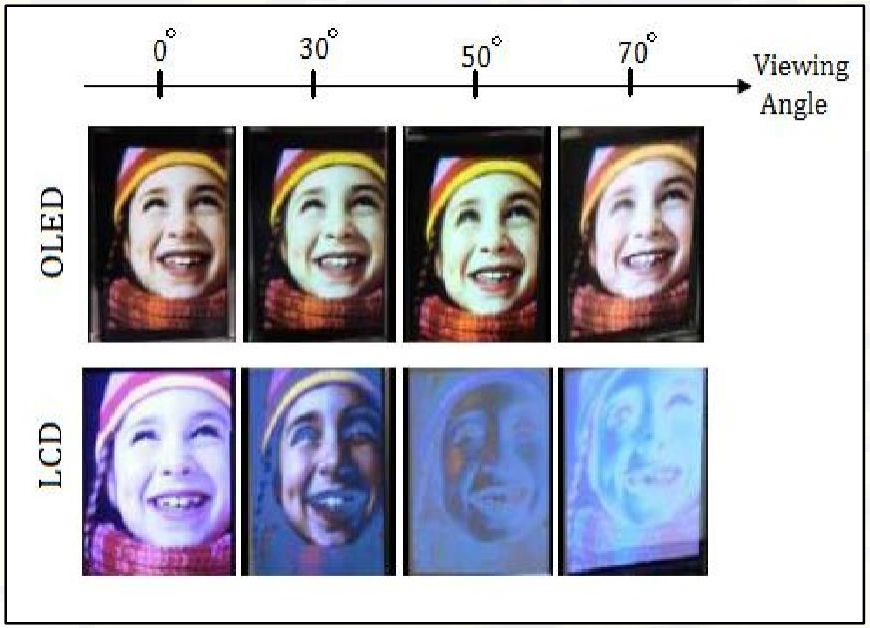
2.Viewing Angle

- Higher viewing angle up to 170° for constant contrast ratio



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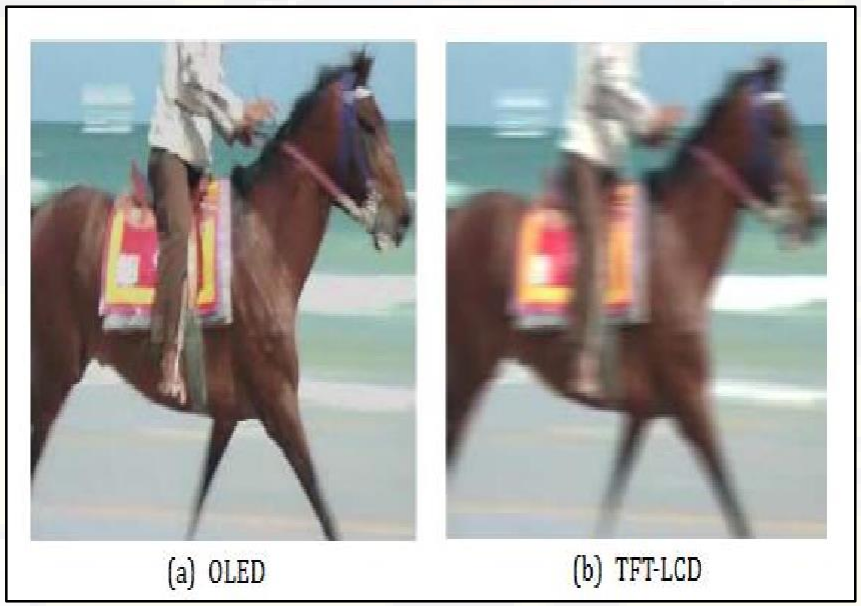
3. Response Time

- Fast time response in order of <50 us
- Comparison by graphical point of view



(a) OLED (b) TFT-LCD

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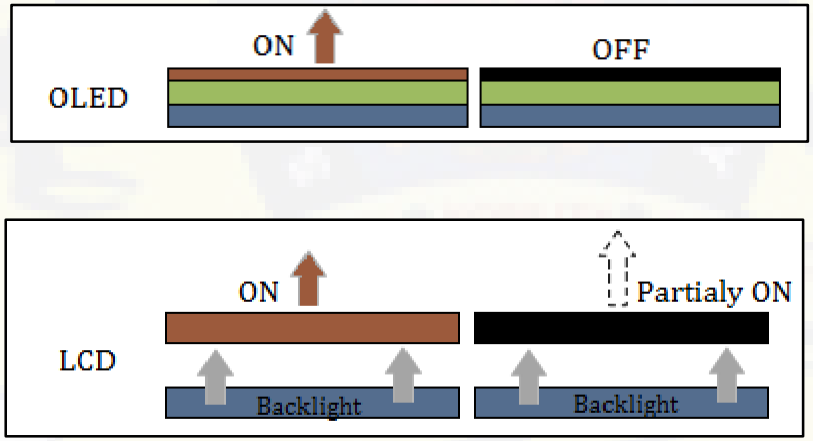
4. Backlight Function

- No backlight required in OLED display
- During black background OLED is turned OFF
- In LCD backlight is still required



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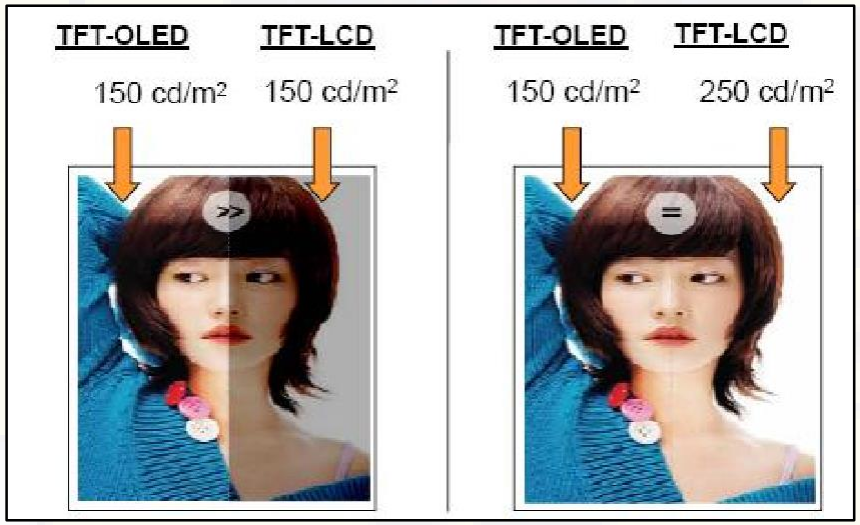
5. Power Efficiency

- OLED display is more power efficient than TFT-LCD display
- For the same power OLED display is more brighter



OLED Disadvantages

- Lifetime
  - White, Red, Green → 46,000-230,000 hours
    - About 5-25 years
  - Blue → 14,000 hours
    - About 1.6 years
- Expensive
- Susceptible to water
- Overcome multi-billion dollar LCD market

APPLICATIONS

Major applications of OLED technology are

- OLED TV.
- Mobile phones with OLED screens.
- Smart watch with OLED screens.

OLED TV


Samsung
OLED TV


4K ULTRA HD OLED TV
ULTRA HD CURVED OLED TV


4K curved OLED

MOBILE PHONES WITH OLED SCREEN

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ART WATCH WITH OLED DISPLAY

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CONCLUSION

- Limited use caused by degradation of materials.
- OLED will replace current LED and LCD technologies
- Expensive
- Flexibility and thinness will enable many applications