Module 2

1.Mention the properties and applications of LED’s.

Properties of LEDs

1. **High Efficiency**: LEDs convert a higher percentage of electrical energy into light compared to traditional incandescent and fluorescent lights, making them much more energy-efficient.
2. **Long Lifespan**: LEDs have a much longer operational life, typically lasting tens of thousands of hours, compared to incandescent bulbs.
3. **Low Power Consumption**: They require significantly less power to operate, contributing to lower energy bills and reduced environmental impact.
4. **Compact Size**: LEDs are small and can be used in a variety of applications where space is limited.
5. **Fast Switching**: LEDs can be turned on and off very quickly, which is useful in applications requiring rapid switching.
6. **Durability**: LEDs are solid-state devices with no moving parts, making them more resistant to shock and vibration compared to traditional bulbs.
7. **Cool Operation**: They produce very little heat, reducing the risk of burns and making them safer to use in various applications.

Applications of LEDs

1. **Lighting**:
    - **Residential and Commercial Lighting**: LED bulbs and fixtures are used for general illumination in homes, offices, and public spaces.
    - **Street and Outdoor Lighting**: LEDs are used in streetlights, parking lot lights, and outdoor signage due to their efficiency and durability.
2. **Displays and Screens**:
    - **Televisions and Monitors**: LED technology is used in the backlighting of LCD screens and in the creation of direct-view LED displays.
    - **Digital Billboards and Advertising**: Bright, high-contrast LED displays are used for advertising in public spaces.
3. **Indicators and Signals**:
    - **Traffic Signals**: LEDs are used in traffic lights and pedestrian signals for their visibility and reliability.
    - **Vehicle Indicators**: Used in automotive lighting for indicators, brake lights, and headlights.
4. **Consumer Electronics**:
    - **Mobile Devices**: LEDs are used in displays, flashlights, and indicator lights on phones and tablets.
    - **Remote Controls**: Infrared LEDs are used in remote control devices.
5. **Medical Applications**:
    - **Medical Devices**: Used in various diagnostic and therapeutic equipment.
    - **Surgical Lighting**: LEDs provide bright, cool light in operating rooms.
6. **Industrial Applications**:

- **Machine Vision Systems**: Used in cameras and sensors for industrial automation and quality control.
- **Safety and Emergency Lighting**: LEDs provide reliable illumination in safety and emergency lighting systems.

7. **Specialty Applications**:
   - **Grow Lights**: LEDs are used in horticulture to provide the specific light spectrum needed for plant growth.
   - **Architectural Lighting**: Used to highlight features of buildings and landscapes.
   - **Aquarium Lighting**: Provide the right spectrum of light for aquatic environments.

2. Define QLED's. Mention the properties and applications of QLED's.

Quantum Light emitting diodes (QLED's).

These are the type of light emitting diode, that uses Quantum dots to emit light.

They produce high quality image with excellent color accuracy and brightness.

Properties of QLED's

- High color accuracy.
- High Brightness.
- Produce more color accurately.
- Low Power Consumption.
- Long life Span and High efficiency.
- More flexibility.

Applications of QLED's

- Used in TV Screens, Digital Cameras, Mobile Phones, etc.,
- Used in Personal gaming Equipment's.

- Used to filter light from LED's.
- Used in Digital Signal Displays.
- Used in electronic Displays in Car and other Vehicle's.

3. Define OLED's. Mention the properties and applications of OLED's.

Organic Light Emitting Diodes (OLED's)

These are the type of display technology, that uses thin organic layers to emit light, when a current is applied.

In which organic materials are used.

Properties of OLED's:

- Thin and Flexible.

- High Contrast ratio.
- Produce more accurate color.
- Very thin and Light Weight.
- Low Power Consumption.
- Fast response time.
- Very high efficiency.
- Self-emissive.
- Long life span.

Applications of OLED's

- Used in Consumer Electronics like TV, Computer Monitor, Mobile Phones, etc.,
- Used in Automotive Industry.
  Ex:- Dashboard Displays, Lighting Systems, Electronic Displays in car, etc.,
- Used in Wearable devices like Smart Watches, Fitness Trackers, etc.,
- Used in Medical instruments like Surgical lights, Diagnostic Equipment's, etc.,

4. What are Liquid Crystals? Explain classification of Liquid Crystals with example.

Liquid Crystals:-

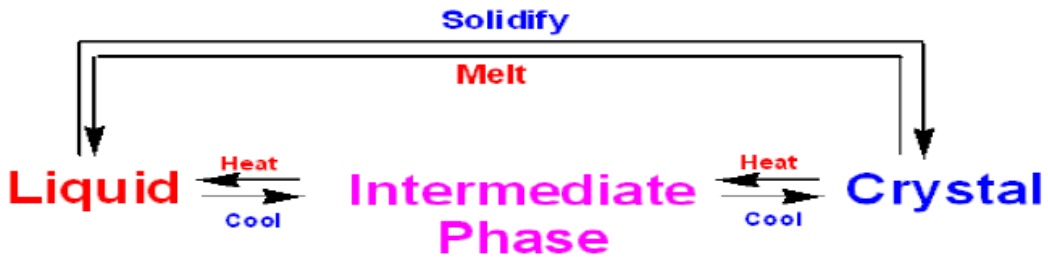
A liquid Crystals is a Phase between Solid and Liquid States.

Ex: - Cholerteryl Benzoate (145.5° to 178.5°C)

P – Azoxyphenetole (137° to 167°C)

P – Azoxyanisole (116° to 135°C)

Anisaldazine (165° to 185°C)



Classification of Liquid Crystals

1. **Thermotropic Liquid Crystals**
2. **Lyotropic Liquid Crystals**

1. Thermotropic Liquid Crystals:-

These are the class of compounds that exhibit liquid crystalline behavior on variation of temperature.

Ex: - Cholerteryl Benzoate (145.5° to 178.5°C)

P – Azoxyphenetole (137° to 167°C)

P – Azoxyanisole (116° to 135°C),

Anisaldazine (165° to 185°C)

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(a). Nematic LC's.

(b). Chiral Nematic LC's.

(c). Smectic LC's.

(d). Discotic LC's.

(a). Nematic LC's:-

These LC's are formed by compounds that are optically inactive.

Ex: P – Azoxyanisole (118° – 135°C)

(b). Chiral Nematic LC's:-

These LC's are formed from optically active compounds having Chiral centers.

Ex: - Cholesteryl Benzoate, Cholesteryl Myristate, Cholesteryl Formate, etc.,

(c). Smectic LC's:-

These are LC's that exhibit a layered structure in their mesophase.

Ex: - (4-(trans-4-n-hexylcyclohexyl).

(d). Discotic LC's:-

These are the LC's shown by molecules which have disc like structure.

Ex: - Benzene hexan-alkonotes, etc.,

2. Lyotropic Liquid Crystals:-

These are the liquid crystals obtained, when an appropriate concentration of a material is dissolved in some solvents.

Ex: - Soap Mixture, Phospholipids, etc.

5.Explain the classification of Electronic memory devices with example.

Classification of electronic memory devices:-

1. Transistor Type Electronic Memory.
2. Capacitor Type Electronic Memory.
3. Resistor Type Electronic Memory.
4. Charge Transfer Effects Electronic Memory.

1. Transistor Type Electronic Memory:

These type of devices contains a five electronic circuit, including a complementary metal oxide semiconductor, transistor and capacitor. In this electronic circuit "0" and "1" corresponds to the discharged and charged states of the capacitors.

Ex: DRAM (Dynamic Random Access Memory),
SRAM (Static Random Access Memory)

Some key materials used in these devices are Silicon, Metal oxides like Silicon Dioxide, Hafnium Oxide, Polysilicon, Metals like Al, CU, etc.,

2. Capacitor Type Electronic Memory:

A capacitor type consists of two metal plates which are capable of storing an electric charge. It is used to store data. It is like a battery that holds data based on energy.

If the capacitor is charged, it holds the binary numeral "1" and hold "0" when the cell is discharged.

Ex: - Dynamic Random Access Memory

Organic and Polymeric ferroelectric materials are used in these type of memory devices.

3. Resistor Type Electronic Memory:

This type of memory device uses switchable resistive materials to store data. Initially, the device is under high resistance state or OFF and logical value 0 state. When resistance changed or under external applied field changes to low resistance sate or ON logical value "1".

Ex: Resistive Random Access Memory (RRAM)

Some key materials used are Metal oxides like TiO2, HfO2, Metals like Pt, Ag, Dielectrics like SiO_2, etc.,

4. Charge Transfer Effects Electronic Memory:

This type of electronic device is based on the charge transfer effects of a charge transfer complex.

A charge transfer complex consists of two parts, one electron donor and other an electron acceptor. It is called as a donor-acceptor complex.

The conductivity of CT complex is dependent on the ionic binding between the D-A components.

Ex: Ferroelectric Random Access Memory (FeRAM)

What are Nanomaterials? Mention the properties of Silicon Nanocrystal suitable for optoelectric devices.

Nanomaterials and Organic materials for Optoelectronic devices:

Nanomaterials:-

Any materials in which at least one dimension is less than 100nm is called nanomaterials.

Ex:- Silicon Nanocrystals

Properties of Silicon nanocrystals:

- Silicon Nanocrystal has wider band gap energy due to quantum confinement.
- Si NCs shows higher light emission property (Photoluminescence).
- Si NCs exhibit quantum yield of more than 60%.
- Si-NCs exhibit tunable electronic structure.
- Larger surface area-volume ration.

Organic materials for Optoelectronic devices [Light absorbing materials – Polythiophenes] (P3HT):-

Polythiophenes are an important class of conjugated polymers, environmentally and thermally stable material.

Chemical structure of P3HT [Poly(3-hexylthiophene)] is a polymer with chemical formula $(C_{10}H_{14}S)_n$.

It is a polythiophene with a short alkyl group on each repeat unit.

Explain the properties of light absorbing materials Polythiophenes suitable for optoelectric devices.

Properties of Polythiophene:

- P3HT is a semiconducting polymer with high stability and exhibits conductivity due to holes therefore considered as p-type semiconductor.
- Poly-3-hexylthiophene (P3HT) have great capability as light-absorbing materials in organic electronic devices.
- P3HT has a crystalline structure and good charge-transport properties required for Optoelectronics.
- P3HT has a direct-allowed optical transition with a fundamental energy gap of 2.14eV.
- Fundamental band gap of P3HT is 490nm visible region, corresponding to $\pi \rightarrow \pi^*$ transition, giving electron-hole pair.
- P3HT indicate that an increase in the conductivity is associated with an increase in the degree of Crystallinity.