Internal Assessment Test 3 – April 2023

Sub:	Applied Chemistry					Sub Code:	BCHES102	Branch:	CSE & CSE(DS)
Date:	01-04-2023	Duration:	90 min's	Max Marks:	50	Sem / Sec:	I / I,J, K & L		OBE

Question no. 1 is COMPULSORY and answer any THREE FULL Questions from the rest.

			MARKS	CO	RBT
1	(a)	What are Memory Devices? Explain any two electronic memory devices with examples.	[7]	CO1	L2
	(b)	What are photoactive and electroactive materials and explain their working principle in display system.	[7]	CO1	L3
2	(a)	Explain the types of organic memory devices by taking p-type semiconductor materials.	[6]	CO1	L3
	(b)	Define liquid crystals? Describe the classification of liquid crystals with suitable examples.	[6]	CO1	L2
3	(a)	What are nanomaterials? Explain any four properties of Polythiophenes (P3HT) suitable for optoelectronic devices.	[6]	CO1	L2
	(b)	What are OLED's. Discuss their properties along with applications.	[6]	CO1	L2

4	(a)	Explain the types of organic memory devices by taking n-type semiconductor materials.	[6]	CO1	L3
	(b)	Describe the properties and explain the applications of Liquid crystals in LCD's with the help of diagram.	[6]	CO1	L3
5	(a)	What are light emitting electrochemical cell and discuss their properties and applications.	[6]	CO1	L2
	(b)	What are QLED's. Explain the properties and applications of QLED.	[6]	CO1	L2

(Chief Course Instructor)

1(a) What are Memory Devices? Explain any two electronic memory devices with examples.

Memory devices are electronic components that can store and retrieve digital data. These devices are used to hold data and programs that a computer needs to access quickly, such as the operating system, applications, and user files.

Classification of electronic memory devices

According to the device structure, electronic memory devices can be divided into three primary categories such as:

- **Transistor type electronic memory devices**
- **Capacitor type electronic memory devices**
- **Resistor type electronic memory devices**
- **Charge transfer type electronic memory devices**

A. Transistor-type electronic memory devices

Transistor-based electronic memory devices are a type of memory device that uses transistors as the building blocks for data storage due to their speed, reliability, and low power consumption. The basic principle of transistor-type electronic memory is that it stores data as charges on the gates of transistors, which act as switches. When the transistor gate is charged, it represents a binary "1", and when it is discharged, it represents a binary "0". The data can be read from the transistor by measuring the voltage level on the gate.

Examples:

1. Dynamic Random Access Memory (DRAM) is a type of volatile memory that uses a capacitor and a transistor to store a single bit of data.

2. Static Random Access Memory (SRAM) is a type of volatile memory that uses transistors to store data in a flip-flop circuit.

B. Capacitor type electronic memory devices

Capacitor type electronic memory refers to a type of non-volatile memory that uses capacitors to store digital data. The basic principle of capacitor type electronic memory is that it stores data as electrical charge on a capacitor. The charge can be stored in the capacitor for an extended period, making it a non-volatile memory. When the data needs to be read, the charge on the capacitor is measured and translated into a digital value.

Examples:

1. DRAM (Dynamic Random Access Memory): It is commonly used in computer memory and is volatile, which means that the data is lost when power is turned off.

2. NAND Flash Memory is a type of non-volatile memory that is commonly used in storage devices like USB drives, memory cards, and solid-state drives (SSDs).

1(b) What are photoactive and electroactive materials and explain their working principle in display system.

Photoactive materials

Photoactive materials are those materials that can absorb light energy and undergo a photochemical reaction. They can convert light energy into chemical or electrical energy.

The ***principles*** that govern photoactive materials are based on the absorption of light by the material and the subsequent generation of excited states.

1. Absorption: Photoactive materials must be able to absorb light energy in order to generate excited states. The absorption spectrum of a material determines which wavelengths of light it can absorb and how efficiently it can do so.

2. Excited states: When a photoactive material absorbs light, it undergoes a photochemical reaction that generates excited states. These excited states are unstable and can decay back to the ground state by emitting light.

3. Energy transfer: Excited states can transfer energy to other molecules, either within the same material or to a different material. This energy transfer can lead to the generation of electrical or chemical energy.

Photoactive materials are used in photovoltaic cells which convert sunlight into electrical energy, and photocatalysts, which use light energy to catalyze chemical reactions. Photoactive materials have significant applications in display systems.

Electroactive materials

Electroactive materials are those materials that can conduct electricity and exhibit changes in their electrical properties in response to an external electric field.

Examples of electroactive materials include ***conductive polymers***, which have electrical conductivity similar to metals.

The principles that govern electroactive materials are based on the ***interaction between the material and the electrical field***.

1. Conductivity: Electroactive materials must be able to conduct electrical current in order to respond to an external electrical stimulus. This can be achieved through the presence of mobile charge carriers, such as electrons or ions.

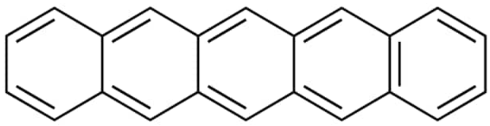
2. Response time: Electroactive materials must be able to respond quickly to changes in the electrical field. The response time of the material is determined by the mobility of the charge carriers and the speed at which they can move through the material.

3. Electrical properties: The electrical properties of the material, such as its resistivity, permittivity, and capacitance, determine how it will respond to an external electrical stimulus.

2(a) Explain the types of organic memory devices by taking p-type semiconductor materials.

Organic memory devices use p-type and n-type semiconductor materials to create a heterojunction that can be used to store data.

P-type semiconductors materials that have an excess of positively charged ***hole***s (deficiency of electrons in their valence band), which can conduct electricity. Example of p-type organic semiconductor materials used in organic memory devices is ***pentacene***.



- Pentacene has a high "hole" mobility, which makes pentacene a suitable material for use in memory devices.
- Pentacene is used in organic memory devices like ***organic flash memory*** *and* ***organic resistive random access memory (RRAM)*** due to its excellent performance, with fast switching speeds, low power consumption and good stability.

2(b) Define liquid crystals? Describe the classification of liquid crystals with suitable examples.

Liquid crystals are a unique state of matter between solid (crystalline) and liquid (isotropic) phases.

<u>Classification</u>

Liquid crystals can be classified as:

- **Thermotropic liquid crystals**
- **Lyotropic liquid crystals**

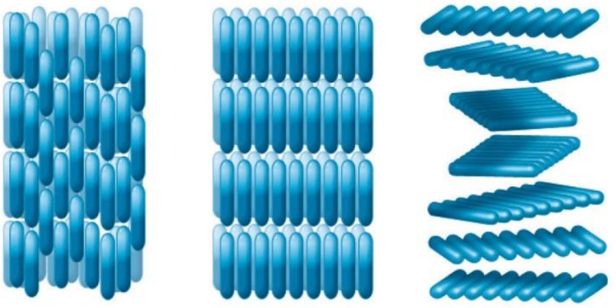
A. Thermotropic liquid crystals

- ❖ When long-chain organic solids are heated, they undergo sharp phase transitions at particular temperatures yielding liquid crystals.
- ❖ The phase transition involving these intermediate phases is mostly naturally affected by the changing temperature and hence, they are ***thermotropic liquid crystals***.

Thermotropic liquid crystals have been classified into the following types:

1) **Nematic liquid crystals**

2) **Smectic liquid crystals**
3) **Cholesteric liquid crystals**



(1) Nematic (or thread-like liquid crystals)

- The molecules move either sideways or up and down. Each molecule can also twist or rotate around its axis giving rise to a twisted nematic.
- Since the molecules are oriented in one direction, they exhibit anisotropy.
- In this case, the molecules are readily aligned in the same direction in the presence of ***electric and magnetic fields***.
- The alignment of molecules is ***temperature sensitive*** – as the temperature is increased, the degree of orientation of the nematic crystals decreases and they change into isotropic liquids.

Examples: p-azoxyphenetole, anisaldazine.

(2) Smectic (or soap-like liquid crystals)

- The molecules in smectic crystals are oriented parallel to each other as in the nematic phase but in layers.
- These layers can pass each other because the force between the layers is weak.
- They are denoted by alphabet letters A, B, C, etc. Some common types of smectic liquid crystals are given below.

(a) Smectic A In smectic A, the molecules are aligned perpendicular to the layer planes.

(b) Smectic C The arrangement of molecules is similar to smectic A except that the molecules are slightly tilted.

- They have high viscosity and are not suitable for devices.

(3) Cholesteric liquid crystals

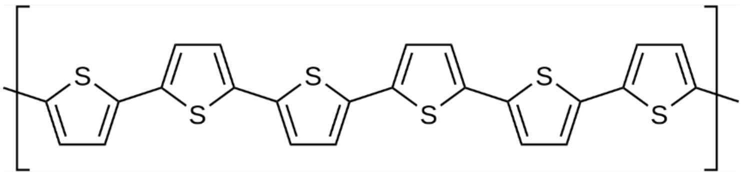
- This type of mesophase is formed by derivatives of cholesterol such as cholesteryl esters.
- Like the nematic phase, the molecules in this type of crystal are also parallel to each other but arranged in layers.

- The molecules in successive layers are slightly twisted or rotated with respect to the layers above and below to form a continuous helical or spiral pattern.
- ***Cholesteryl benzoate***, the first known liquid crystal, is of cholesteric type. Its transition temperature is 146 °C and its melting point is 178.5 °C.

3(a) What are nanomaterials? Explain any four properties of Polythiophenes (P3HT) suitable for optoelectronic devices.

Nanomaterials are materials that have at least one dimension measuring less than 100 nanometers (nm), which is typically on the order of a few hundred atoms or molecules.

Polythiophenes are organic materials (***conjugated polymers***) that have been extensively studied as light-absorbing materials in optoelectronic devices, particularly in organic photovoltaic (OPV) devices.



Properties for which they are used in optoelectronic devices:

1. They have ***high extinction coefficients***, meaning they absorb a large amount of light per unit thickness.
2. They can be easily processed into ***thin films*** using solution-based methods.
3. They have ***good stability***.
4. They can be tuned to have a ***range of optical and electronic properties***, allowing for the optimization of device performance.

3(b) What are OLED's. Discuss their properties along with applications.

Organic light-emitting diodes (OLEDs) are a type of display technology that uses thin organic films to emit light in response to an electric current.

<u>Properties</u>

Some of the key properties of Organic Light Emitting Diodes (OLEDs) include:

- **Thinness and flexibility**: OLEDs are very thin and flexible, which makes them suitable for use in curved or flexible displays.
- **High contrast**: OLEDs have a high contrast ratio, which means that they can produce deep blacks and bright whites, resulting in images with vivid and rich colors.
- **Fast response time**: OLEDs have a fast response time, which means that they can switch on and off quickly, resulting in smooth and seamless motion in video content.
- **Wide viewing angle**: OLEDs have a wide viewing angle, which means that the image quality is maintained even when viewed from different angles.

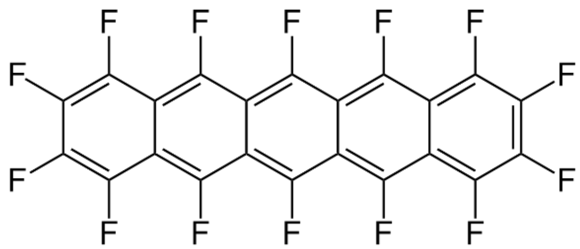
Applications

- **Televisions and displays**: OLED displays are used in televisions, monitors, smartphones, and other electronic devices.
- **Lighting**: OLEDs can also be used as a source of lighting in various applications, including automotive lighting, street lighting, and architectural lighting.
- **Wearable devices**: The thin and flexible nature of OLEDs makes them suitable for use in wearable devices, such as smartwatches and fitness trackers.
- **Automotive**: OLEDs can be used in automotive applications, such as dashboard displays, interior lighting, and taillights.

4(a) Explain the types of organic memory devices by taking n-type semiconductor materials.

An **n-type semiconductor** organic material is a type of organic material that has an excess of electrons in its conduction band. This material is used in the construction of organic electronic devices such as ***organic field-effect transistors*** (OFETs).

Perfluoropentacene is an n-type semiconductor organic material that is used in organic memory devices. It is a fluorinated derivative of pentacene.



Perfluoropentacene has a high electron mobility and low ionization potential, which makes it a promising candidate for use in organic memory devices.

4(b) Describe the properties and explain the applications of Liquid crystals in LCD's with the help of diagram.

Properties of Liquid Crystals

1. Anisotropy: Liquid crystals are anisotropic, meaning that they exhibit different properties in different directions. This is due to the alignment of the molecules within the liquid crystal.

2. Birefringence: Liquid crystals are birefringent, meaning that they can split light into two polarized components, each of which is transmitted at a different velocity.

3. Optical activity: Some liquid crystals are optically active, meaning that they rotate the polarization of light that passes through them.

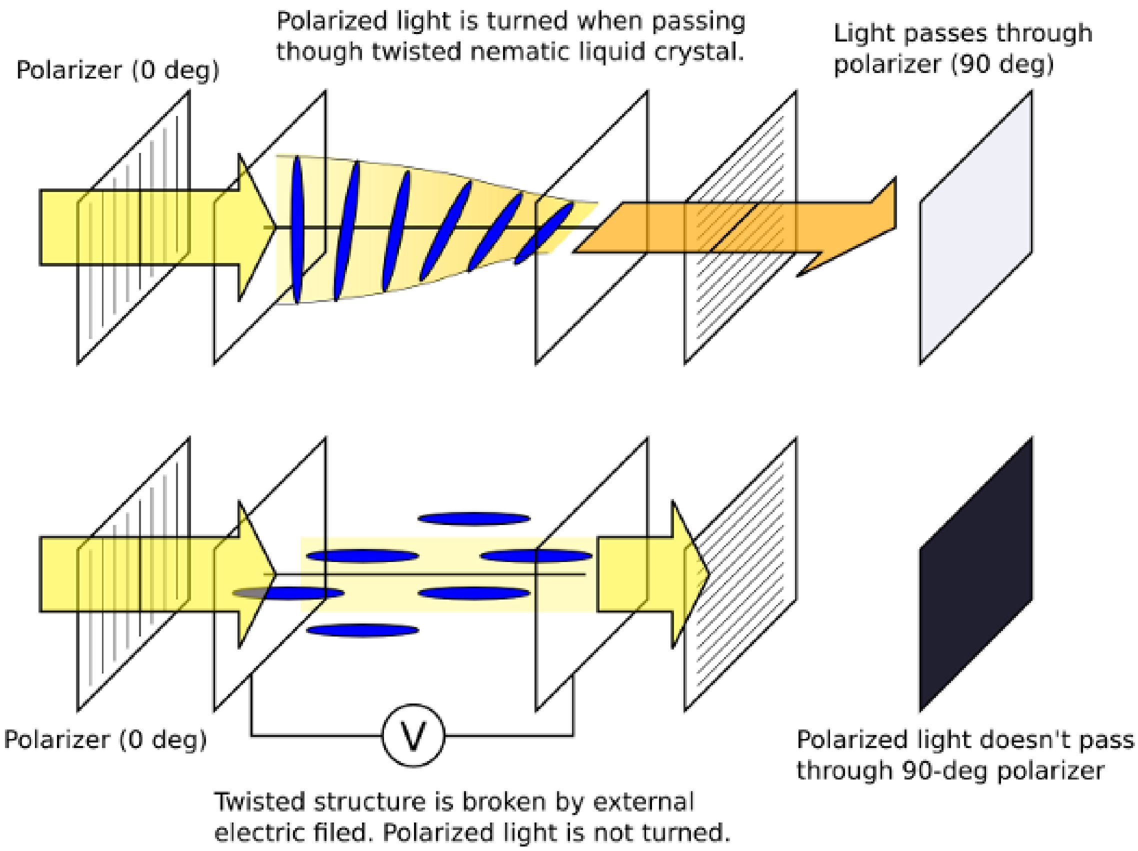
4. Viscosity: Liquid crystals have a relatively high viscosity compared to conventional liquids, which allows them to maintain their orientation even in the absence of an external force.

<u>Application of liquid crystals: LCDs</u>

Liquid crystal displays (LCDs) are widely used in electronic devices such as televisions, computer monitors, and mobile phones.

Working principle:

- In an LCD, a thin layer of liquid crystals is sandwiched between two transparent electrodes, and the electrodes are connected to a power source.
- When an electric field is applied, the liquid crystal molecules align themselves along the direction of the electric field, changing the orientation of their polarization, and this in turn modifies the optical properties of the liquid crystal.
- A backlight behind the LCD panel shines light through it.
- The liquid crystal layer selectively blocks or transmits the light, depending on the orientation of the liquid crystal molecules.
- The result is that different areas of the LCD can appear either light or dark, creating images and text.



5(a) What are light emitting electrochemical cell and discuss their properties and applications.

A light-emitting electrochemical cell (LEC) is a type of device that generates light using electrochemical processes.

Properties

- **Low-cost fabrication**: LECs can be fabricated using simple and low-cost methods, such as spin-coating, inkjet printing, or screen printing, which can lead to significant cost savings compared to other light-emitting devices.
- **High efficiency**: LECs can exhibit high internal quantum efficiency. This high efficiency can lead to brighter and more energy-efficient light sources.
- **Flexibility**: LECs can be fabricated on flexible substrates, allowing for the development of flexible and conformal light sources that can be integrated into a wide range of applications.
- **Large-area coverage**: LECs can be fabricated over large areas, making them suitable for the development of large-scale lighting and display applications.

Applications

- **Lighting**: LECs can be used to produce bright and energy-efficient lighting sources, with the potential to replace traditional incandescent or fluorescent bulbs.
- **Displays**: LECs can be used to create flexible and lightweight displays, including large-area displays for signage and advertising, as well as small-scale displays for wearable electronics and mobile devices.
- **Sensors**: LECs can be used as sensors for detecting gases, biological molecules, and other analytes.
- **Photovoltaics**: LECs can be used to produce electricity from sunlight, by combining a light-absorbing layer with a light-emitting layer.

5(b) What are QLED's. Explain the properties and applications of QLED.

Quantum light emitting diodes (QLEDs) are a relatively new type of light-emitting diode (LED) that use quantum dots as the emitting layer.

Properties of QLED

- **Accurate and vibrant colors**: QLEDs are capable of producing highly accurate and vibrant colors due to their use of quantum dots, which emit light of a specific color when they are excited by a light source or an electrical current.
- **Energy-efficient**: QLEDs are more energy-efficient than traditional LCD displays because they do not require as much backlighting.

- **High contrast**: QLED displays have high contrast ratios, which means that the difference between the darkest and brightest areas of the display is greater, resulting in more detailed and lifelike images.
- **Long lifespan**: QLEDs have a longer lifespan than traditional LCD displays because they do not suffer from the same issues of backlight burnout or color fading over time.

Applications of QLED

- **Televisions and displays**: QLED displays are commonly used in televisions, monitors, smartphones, and other electronic devices.
- **Lighting**: QLEDs can also be used as a source of lighting in various applications, including automotive lighting, street lighting, and architectural lighting.
- **Medical imaging**: QLEDs can be used in medical imaging applications, such as in MRI machines, to produce high-resolution and accurate images.
- **Virtual and augmented reality**: QLED displays are suitable for use in virtual and augmented reality applications due to their ability to produce vibrant and accurate colors, which can enhance the immersive experience.