CBCS SCHEME

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BCHES102/202

First/Second Semester B.E./B.Tech. Degree Examination, June/July 2024
Applied Chemistry for CSE Stream

Time: 3 hrs. Max. Marks: 100

Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.
2. VTU Formula Hand Book is permitted.
3. M : Marks , L: Bloom's level , C: Course outcomes.

		Module – 1	M	L	C
Q.1	a.	What are electrochemical sensors? Explain the principle and working of electrochemical sensor.	07	L1	CO1
	b.	Explain the principle, working and any two applications of optical sensor.	06	L1	CO1
	c.	What is Quantum Dot sensitized solar cell? Explain the construction and working of Quantum Dot sensitized solar cell.	07	L1	CO1
		OR			
Q.2	a.	Explain the detection of bio-molecule ascorbic acid using disposable sensor and also write the electro oxidation reaction.	07	L1	CO1
	b.	Explain the working principle of electrochemical gas sensors for the detection of SO_x and NO_x .	06	L1	CO1
	c.	Explain the construction and working of Li-ion battery. Mention any two applications.	07	L1	CO1
		Module – 2			
Q.3	a.	What are memory devices? Explain the classification of electronic memory devices.	07	L2	CO2
	b.	Define optoelectronic device. Explain the working principle of optoelectronic device.	06	L2	CO2
	c.	What are liquid crystals? Explain the classification of liquid crystals.	07	L2	CO2
		OR			
Q.4	a.	Explain the types of organic memory devices by talking p-type and n-type semiconducting materials.	07	L2	CO2
	b.	Explain any three properties and applications of polythiophene (P3HT) suitable for optoelectronic devices.	06	L2	CO2
	c.	What is QLED? Mention any three properties and applications of QLED.	07	L2	CO2
		Module – 3			
Q.5	a.	Define metallic corrosion. Explain electrochemical theory of corrosion.	07	L3	CO3
	b.	A thick steel sheet of area 400 $inch^2$ is exposed to moist air. After 2 years of period, it was found to experience a weight lost of 375g due to corrosion if the density of steel is 7.9 g/cm^3, calculate CPR in mpy and mmpy.	06	L1	CO3
	c.	What are reference electrodes? Explain the construction, working and applications of calomel electrode.	07	L1	CO3
		OR			
Q.6	a.	What is galvanization? Explain galvanization of Iron. Mention its applications.	07	L1	CO3
	b.	What are concentration cells? Calculate the cell potential of the following cell at 298 K. $Ag \mid AgNO_3(0.005M) \parallel AgNO_3\ (0.5M) \mid Ag$	06	L1	CO3
	c.	Explain the principle and instruction of conductometry taking estimation of weak acid using a strong base as an example.	07	L2	CO3

		Module – 4			
Q.7	a.	In a sample of a polymer 20% molecules have molecular mass 15,000g/mol, 35% molecules have molecular mass 20000g/mol. Calculate the number average and weight average molecular mass of the polymer.	07	L3	CO4
	b.	Explain the preparation of Kevlar. Mention any four applications.	06	L2	CO4
	c.	Explain the generation of hydrogen by Alkaline water electrolysis with a neat labelled diagram.	07	L2	CO4
		OR			
Q.8	a.	What are conducting polymers? Explain the conduction mechanism in polyacetylene through oxidative doping technique. Mention any two applications.	07	L3	CO4
	b.	What are PV cells? Explain the construction and working of photovoltaic cell.	06	L2	CO4
	c.	Explain the generation of hydrogen by proton exchange membrane electrolysis.	07	L2	CO4
		Module – 5			
Q.9	a.	Define E-waste. Explain the sources and composition of E-waste.	07	L2	CO5
	b.	Explain the ill effects of materials used in manufacturing electrical and electronic products.	06	L2	CO5
	c.	Explain pyrometallurgical process of extraction of E-waste.	07	L2	CO5
		OR			
Q.10	a.	Explain the extraction of gold from E-waste.	07	L2	CO5
	b.	Explain direct recycling of E-waste.	06	L2	CO5
	c.	Write a brief note on role of stakeholders for example, producers consumers, recyclers and statutory bodies in management of E-waste.	07	L2	CO5

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First/Second Semester BE/B.Tech Degree Examination - June/July - 2024

2024

Applied Chemistry for CSE Stream

Q1 a What are electrochemical Sensors and Explain the principle and working of electrochemical Sensor. (07 Marks)

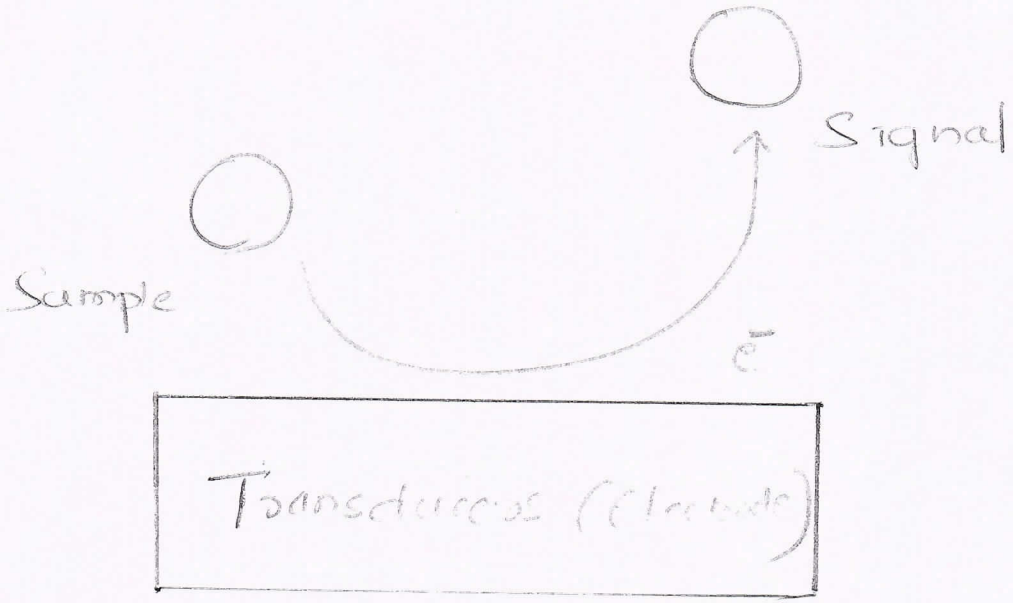
Ans:- Electrochemical Sensors are class of Sensors in which the electrode is transducer element, these devices are now found in wide range of commercial applications.

Working principle

→ Electrochemical Sensors are powerful analytical tool due to their Superior Sensitivity and Selectively quick response Period. Simplicity in operation and miniaturization

The fundamental Concepts in the detection of analytes by electrochemical sensors involves the measurement of electric Current generated by chemical reactions in the electrochemical System.

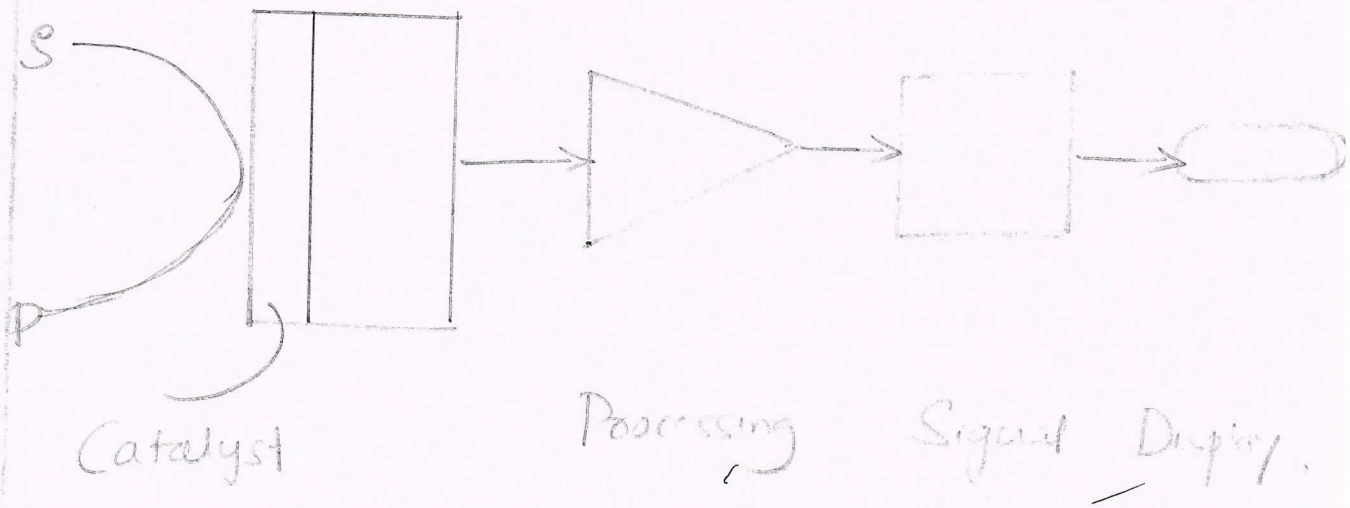
Working



Electrochemical Sensors working Mechanism involves the interaction of the target analyte material with the electrode surface and bringing the desired change as a consequence. to a ~~redo~~ redox reaction which generates an electrical signal that can be transformed to explore the nature of

the analyte species.

Nano material electrode surface can be remarkably transformed by the process of functionalization which can be executed by the attachment of biomolecules such as aptamers, peptides, and antigen/antibody that functions as the specific chemical recognisation element.



b) Explain the Poincipple, working and any two applications of optical sensor (6 Marks)

Ans:- Poincipple
Optical sensors use visible or ultraviolet light to interrogate sensors for analysis.

Optical sensors can be represented in general terms as a wavelength selectable light source the sensor material itself interacting with analytes and a light detector.

Optical sensors have two basic Methods to obtain sensor data from target Molecules that are level based and label free Methods.

Working

Detector Monitors Varies by technique Eg: refractive Index, Scattering, diffraction absorbance, reflectance, photo luminescence chemiluminescence etc) can cover different regions of the electro magnetic Spectrum and can allow measurement of multiple properties.

The focus of the articles however is an optical sensor arrays that use absorbance

reflectance or fluorescence arrays detectors (ie digital cameras and scanners

Applications :

Applications of these optical sensors ranges from computers to motion detectors. For optical sensors to work effectively. they must be the correct type for the application so that they maintain their sensitivity to the property they measure.

optical sensors are integral parts of many common devices. Including computers copy machines (Xerox) and light fixtures that turn on automatically in the dark.

Some of the common applications include alarm systems, Synchros for photographic flashes and systems that can detect the presence of objects.

Colourimetry

Quantitative Measurement of absorbance or reflectance spectra) is of course

one of the oldest of analytical technique and colorimetric sensors stretch back even before the beginnings of chemistry.

C) What is Quantum dot sensitized Solar cell? Explain the construction and Working of Quantum Dot sensitized Solar cell (07 Marks)

Ans:- Quantum dots are considered to be artificial atoms.

Quantum dots (QD's) are semiconductor particles a few nanometers in size. having optical and electronic properties that differ from those of larger particles.

Construction

Photo Anode - It is conducting glass over which semiconductor is coated (TiO_2) outer layer of photoanode is coated with quantum dots (QD's).

Electrolyte - Photo anode is contact with redox electrolyte. It is a hole conductor. Polysulfide is used as conductor.

Cathode Electrode It is used to regenerate electrolyte and complete the circuit.

Working

1. Q.D's are exposed to Sunlight.
2. Q.D s absorb solar energy, electrons move from ~~The surface~~ valance band to conduction band. these electrons are transferred to semiconductor, leaving behind holes on the surface of QD's.
3. Electrolyte take up the holes from the surface of QD's and get reduced.

$$S^{2-} + 2h^+ \longrightarrow S.$$

$$S + S^{2-}_{x-1} \longrightarrow S^{2-}_{x} \quad (x = 2 \text{ to } 5)$$

4) Electrons flows from anode to cathode through external circuit.

5) At cathode electrolyte is regenerated taking up electrons from cathode.

$$S_x^{2-} \longrightarrow S + S_{x-1}^{2-}$$

$$S + 2e^- \longrightarrow S^{2-}.$$

Q2a Explain the detection of biomolecule ascorbic acid using disposable sensor and also write the electrooxidation reaction (6 Marks)

Detection of Ascorbic Acid.

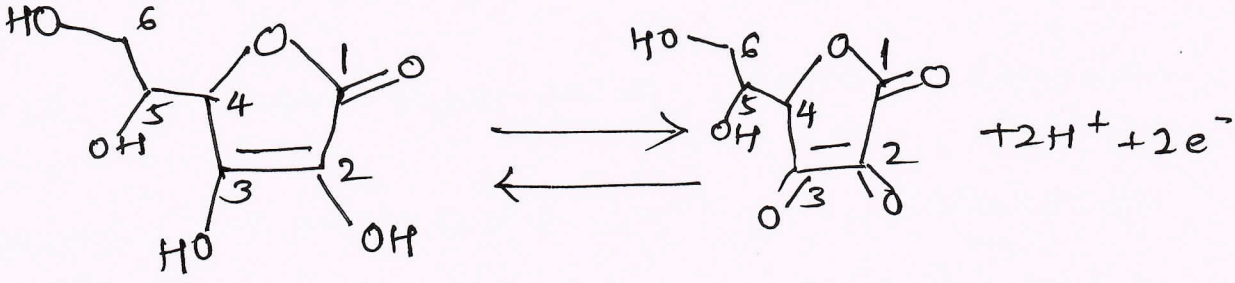
Ascorbic Acid is a chemical name of Vitamin-C it is water soluble. In the disposable strip the sensing electrode counter and reference electrode are printed using screen printing technology

Working

Active Material is coated on sensing electrode and working electrode have been coated with

a conductive ink of C (MWCNT) and modified with gold nanoparticles. With Reference electrode is Ag | AgCl.

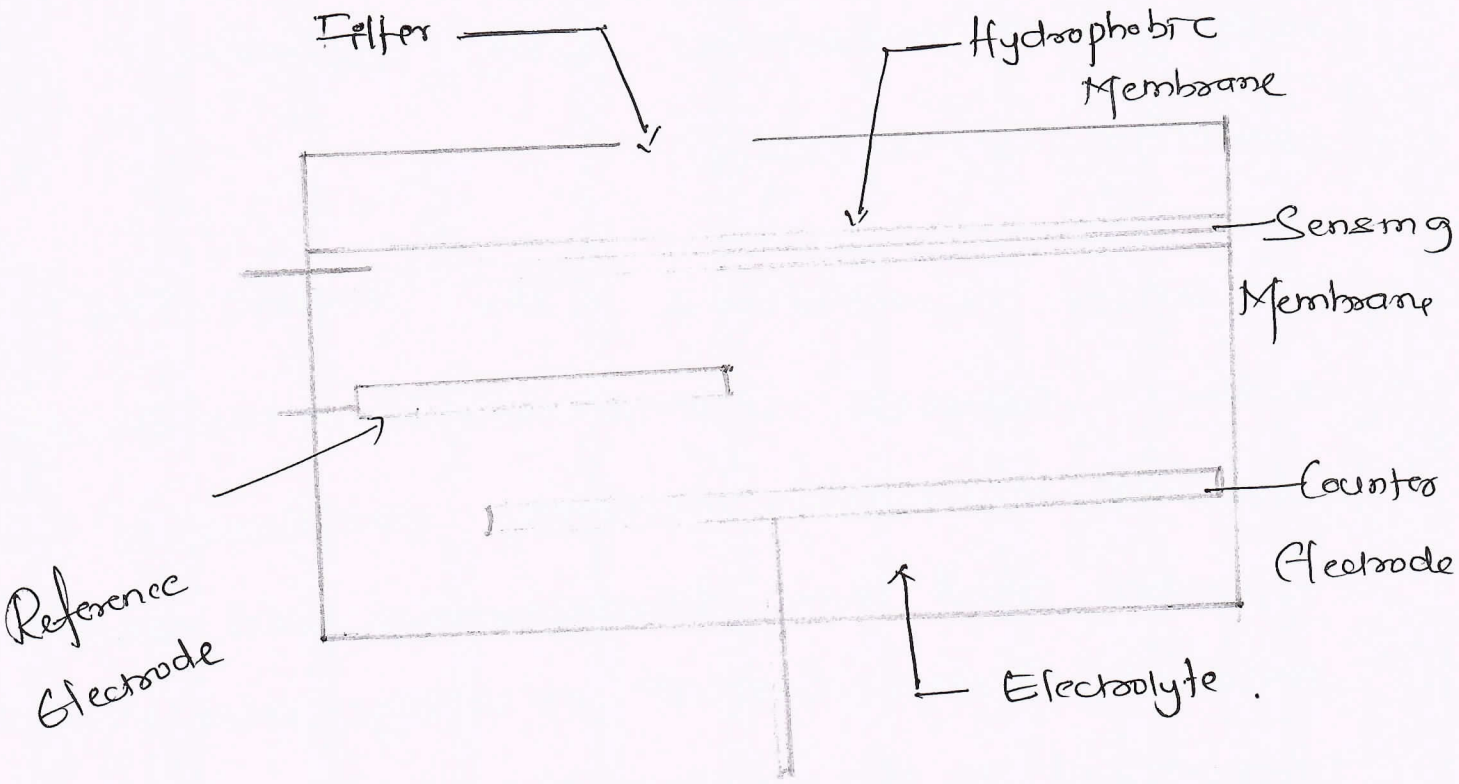
The sensor is immersed in the analyte. The analyte diffuses and adsorbed on the sensing electrode. The sensing electrode oxidizes ascorbic acid into dehydroascorbic acid and produces electric current or voltage and it is proportional to the concentration of the ascorbic acid.



Ascorbic Acid Dehydroascorbic acid

6) Explain the Working principle of electrochemical gas sensors for the detection of SO_x and NO_x (6 Marks)

Ans: Electrochemical gas sensors for SO_x and NO_x



Filters ; used to prevent unwanted contaminants mainly particulate matter.

Membrane: A gas permeable membrane is used to regulate the gas flow into the sensors It allows only analyte gas to pass and prevent the leakage of the electrolyte.

Electrodes : two or three electrodes are used on the requirement. Working or sensing counter and reference electrode.

Electrolyte: Electrolyte should be ionic conductor

and chemically stable. Main role is it transport charge within the sensor. Contact all electrode effectively and solubalise the reactant and product for efficient transpost.

Sensors of NO_x

The sensors contains two or three electrodes.

Sensing electrode : Au/ Nafion

Electrolyte : 0.5 M H_2SO_4

Working

→ The diffusion of gas analyte through filter membrane and then finally through electrolyte on to the surface of sensing electrode.

→ Adsorption of analyte gas molecules on the surface of sensing electrode

→ oxidation of analyte on the surface of sensing electrode liberating electrons

→ Desorption of product from the electrode surface

→ Diffusion of the product away from the

reaction zones to bulk of electrolyte.

$$SO_2 + 2H_2O \longrightarrow SO_4^{2-} + 4H^+ + 2e^-$$

Sensors for NO_2

The sensors contain two or three electrodes

Sensing electrode : Au, Pt/ Nafion

Electrolyte : 1M H_2SO_4.

Working

→ The diffusion of gas analyte through filter membrane and than finally through electrolyte on the surface of sensing electrode.

→ Adsorption of analyte gas molecules on the surface of sensing electrode.

→ Oxidation of analyte on the surface of sensing electrode, deberating electrodes.

→ Desorption of product from the electrode surface

→ Diffusion of the products away from the reaction zone to bulk of electrolyte.

$$NO_2 + 2H^+ + 2e^- \longrightarrow NO + 2H_2O.$$

Q2c Explain the construction and working of Li-ion Battery. Mention any two applications. (07 Marks)

Ans:-

Lithium-Ion Battery

construction Diagram

→ Lithium ion has four layer structure

→ A positive electrode made with lithium cobalt oxide has a current collector made of thin lithium foil - Cathode.

→ A nagative electrode made with specialty carbon has a current collector of thin copper foil - Anode.

→ A seperator is a fine porous polymer film

→ A electrolyte made with lithium salt in an organic solvent

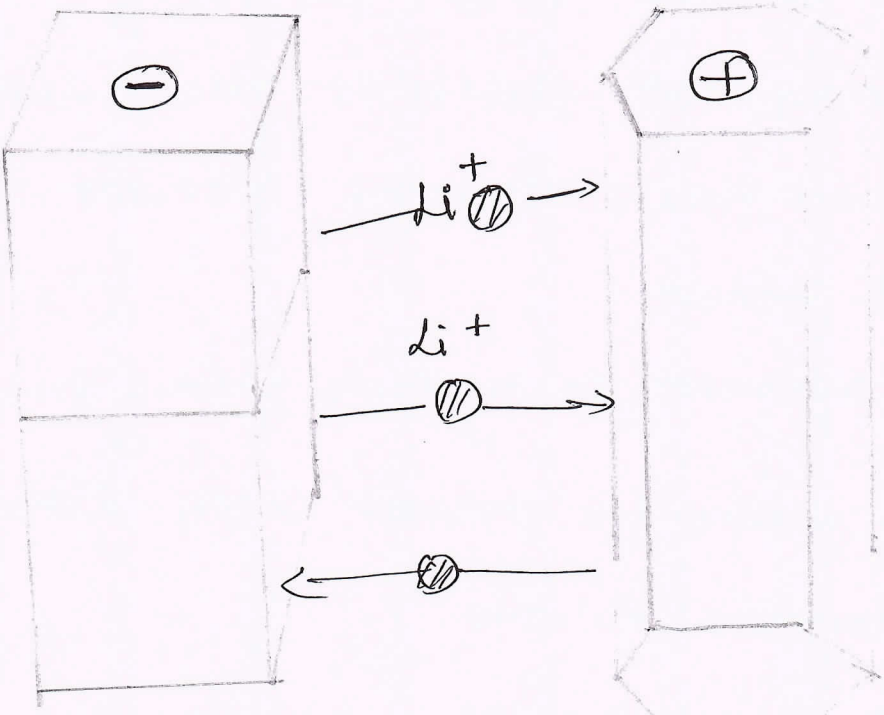
→ The electrolytes are selected in such a way that there should be an effective transport of Li ion to the cathode during discharg

(7)

Working

The principle behind the working is that during charge, lithium ion in the cathode (lithium cobalt oxide) moves from layer to layer in crystallized carbon anode. Charge balancing in cathode is ensured by oxidation of Co(+3) to Co(+4). Electrons released by such oxidation are transferred to anode through external circuit.

During Discharge lithium ions from anode moves to the cathode and Co(+4) is reduced to Co(+3).



Before charging: C_6 $LiCoO_2$

C_6Li_x $Li^+_{1-x}Co^{+3}_{1-x}Co^{4+}_xO_2$.

Charging Reaction

$$LiCoO_2 \rightleftharpoons Li^{+}_{(1-x)}Co^{+3}_{(1-x)}Co^{+4}_{x}O_2 + xLi^{+} + xe^{-}$$

$$C_6 + xLi^{+} + xe^{-} \rightleftharpoons C_6Li^{0}_{x}$$

Applications

- Used in Calculators, Cameras, Camcoders Laptop and Computers

Q3a What are Memory device? Explain the classification of electronic memory devices. (07 marks)

Ans:-

A memory device is a piece of hardware used to store data. Most electronic devices such as computers, mobile phones, tablets etc All have a storage device that stores data and programms.

(1) Transistor Type Electronic Memory devices.

Transistors made from silicon a semiconductor It is converted to p-type and n-type Semiconductn.

by doping toivalent and pentavalent impurities. transistors are made using p-type and n-type semiconductor. A transistor is a miniature electronic component that can work either as an amplifier or a switch. A computer memory chip consists of billions of transistors.

Capacitor type Electronic Memory device.

A capacitor consists of two metal plates which are capable of storing of 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.

Resistor type Electronic Memory device.

Memory devices containing switchable resistive materials are classified as resistor type memory. resistive random access memory (RRAM). Resistor type electronic memory usually has a simple structure.

having a metal – insulator metal structure general referred to as MIM structure.

Charge transfer Effects type Electronic Memory device

A charge transfer (CT) complex is defined as an electron donor acceptor (D-A) complex characterized by an electronic transition to an excited state in which a partial transfer of charge occurs from the donor moiety to the acceptor moiety. The conductivity of a CT complex is dependent on the ionic binding between the D-A components.

b) Define optoelectronic device. Explain the working principle of optoelectronic device. (06 Marks)

Ans:- Absorption and emission of light radiation in the wavelength region from ultraviolet to near infrared.

Photogeneration of charge carriers (photons of light creates electron-hole pair in the semiconductor)

Oorganic materials for optoelectronic devices (Light absorbing materials — Polythiophenes. (P3HT)

Polythiophenes are an important class of conjugated polymers. environmentally and thermal stable material. Chemical structure of P3HT Poly (3-hexylthiophene) is a polymer with chemical formula $(C_{10}H_{14}S)_n$ It is a Polythiophenes with short alkyl group. on each repeat unit.

Highly ordered (P3HT) are composed of closely packed P-P stacked (p-p distance of 0.33 nm). fully extended chains which are oriented peopendicular to the ~~substance~~ substrat.

~~Diagram~~

The organic compounds with conjugation and π- electron are capable of exbiting the optoelectronic properties. Organic material broadly classified as three catagories.

1. Small Molecules
2. Oligomers with well-defined structure
3. Polymers.

Properties of nanomaterials are different from bulk materials

1. Quantum Confinement effect.
2. Increased Surface area to volume ratio.

b) What are liquid crystals? Explain the classification of liquid crystals. (07 Marks)

Ans: A distinct state of a matter in which degree of molecular ordering is intermediate between the ordered crystalline state and completely disordered liquid state.

Classificaton

Thermotropic liquid crystals (TLC)

The compounds which exhibit liquid crystal behaviour with variation of temperature are called thermotropic liquid crystals.

Ex: 1) Cholesteryl Benzoate (145.5°C & 178.5°C)

2) P Azoxy Anisole (118°C & 135°C)

Leotropic liquid crystals.

Some of the compounds transformed into liquid crystal.

Phase when mixed with another substance or solvent by the variation of concentration of the compound are called lyotropic liquid crystal.

(1) Soap water mixture

(2) Phospholipid water mixture.

Types of Thermotropic liquid crystals

1) Nematic Liquid Crystals (NLC)

2) Chiral liquid crystals or Cholesteric liquid ~~for~~ crystals

3) Smectic liquid crystals (SLC)

4) Columnar Liquid Crystals or Discotic Liquid Crystals (DLC).

Q4a Explain the types of organic memory devices by talking p-type and n-type semiconducting materials. (10 marks).

Ans:- Organic memory device stores data based on the different electrical conductivity state (on and OFF) in response to an applied electric field.

The P-type organic Semiconductor Material "Pentacene"

An organic Molecule with π- conjugated system and possesses holes as major charge carrier is called p-type Semiconductor.

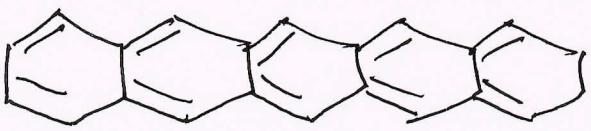
Ex: Pentacene

These molecules show bistable states when external field is applied ie ON and OFF state.

It is linearly fused aromatic compound with five benzene rings

It can be obtained in crystal and thin film form.

It shows good hole mobility hence it behaves as a p-type Semiconductor.

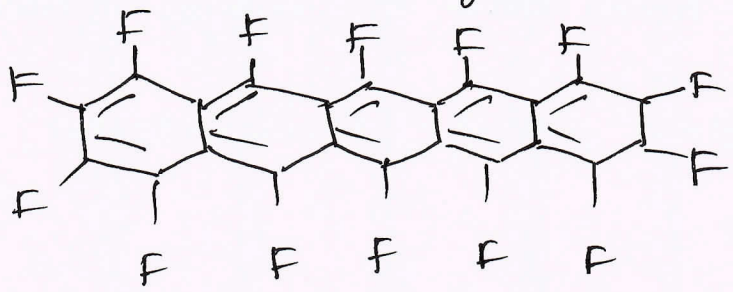


Pentacene

When n-type organic semiconducting material Perfluoropentacene.

When all the hydrogen atom of pentacene is replaced by Flourine atom. It Formed

Perfluoropentacene. Basically Flourine is electron withdrawing nature. Hence it converts this Molecule into n-type semiconductor.



Sh Explain any three properties and applications of polythiophene (P3HT) suitable for optoelectronic device. (6 Marks)

Properties

(1) P3HT is a semiconducting polymer with high stability and exhibits conductivity due to holes therefore considered as p-type semiconductor.

(2) Poly-3-hexylthiophene (P3HT) has great capability as light absorbing materials in organic electronic devices.

(3) P3HT has a crystalline structure and good charge transport properties required for optoelectronics.

4) P3HT has a direct allowed optical transition with a fundamental energy gap of 2.14eV.

5) Fundamental band gap of P3HT is 490 nm visible region corrosponding to $\pi-\pi^*$ transition giving electron hole pair.

Applications

1. P3HT-ITO forms a p-n junction permits the charge carriers to move in opposite direction and hence used in Photo voltaic device.
2. It can be used as a positive electrode in lithium battrey
3. Used in the Construction of organic Solar cells
4. Manufacture of smart Windows.

4c What is QLED? Mention any three properties and applications of QLED. (07 Marks)

Ans: QLED is an electroluminescent device that use quantum dots (QD's) as a source of light emission

Properties

1. Accurate and Vibrant Colours :- QLED are capable of producing highly accurate and vibrant colours due to their use of quantum dots. which emit light of a specific colour when they are excited by a light source or an electric current.

2. Energy efficient - QLED's are more energy efficient than traditional LCD displays because they do not require as much back lighting

3. High contrast - QLED displays have high contrast ratio's which means that the difference between the darkest and brightest areas of the display is greater resulting in more detailed and life like images.

Applications

1. Flat panel TV screen
2. Digital Cameras
3. Mobile phones.

Q5a) Define Metallic corrosion Explain Electrochemical theory of corrosion (07 marks)

Ans:- Corrosion is defined as the destruction and consequent loss of metals through chemical or electrochemical attach by the environment.

Electrochemical theory of corrosion

Electrochemical theory is called as wet corrosion since aquous medium or moist air is required for corrosion to take place.

For example:- When iron undergoes corrosion

$$Fe \longrightarrow Fe^{2+} + 2e^-$$

Anodic reaction is a simple oxidation reaction in which the metal atom are converted into their ions liberating electrons.

At Anodic Reaction Anodic region

$$M \longrightarrow M^{n+} + ne^-$$

A> In neutral or alkaline and in the absence of oxygen hydroxide ions are formed with simultaneous liberation of hydrogen

$$2H_2O + 2e^- \longrightarrow 2OH^- + H_2$$

B> Absorption of oxygen takes place in the presence of oxygen

In Acidic medium and in the presence of oxygen

$$4H^+ + O_2 + 4e^- \longrightarrow 2H_2O$$

In neutral or alkaline medium and in the presence of oxygen, hydroxide ions are formed by the following reaction

$$2H_2O + O_2 + 4e^- \longrightarrow 4OH^-$$

Corrosion of iron produces Fe^{2+} ions and OH^- ions at anode and cathode sites respectively. Those ions diffuse more rapidly than OH^- ions their combination

occurs more commonly near cathodic region to produce insoluble $Fe(OH)_2$. In an oxidizing Environment it is oxidized to ferric oxide and the yellow rust is hydrated ferric oxide.

$$2Fe^{2+} + 4OH^- \longrightarrow 2Fe(OH)_2$$

$$4Fe(OH)_2 + O_2 + 2H_2O \longrightarrow 2[Fe_2O_3 \cdot 3H_2O]$$

Rust.

Q5

b A thick steel sheet of area 400 inch2 is exposed to moist air After 2 years of period, it was found to experience a weight lost of 375 g due to corrosion If the density of steel is 7.9 g/cm3. Calculate CPR in mpy and mmpy.

Ans:-

$A = 400\ inch^2$ $\quad K = 534$

$W = 375\ g = 375 \times 10^3\ mg$ $\quad A = 400\ inch^2$

$\delta = 7.9\ g/cm^3$. $\quad T = 2 \times 24$

=

$$CPR = \frac{KW}{SAt}$$

$$= \frac{534 \times 375 \times 10^3}{7.9 \times 400 \times 2 \times 365 \times 24}$$

$$= \frac{200250000}{55363200}$$

$$= 3.61 \text{ mm/yr.}$$

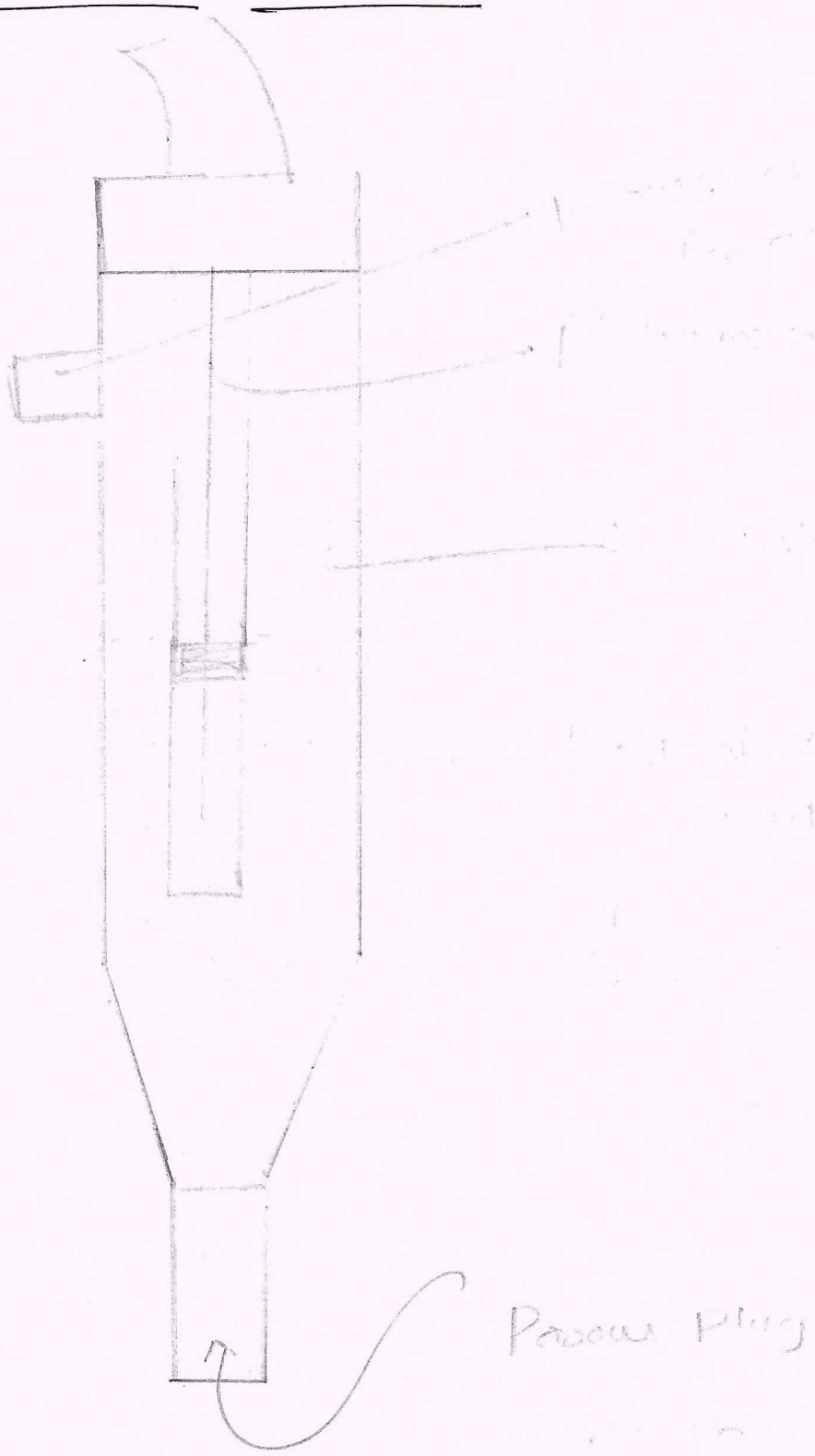
$$= 3.65 \times 24 \times \frac{1}{365}$$

$$= 0.24 \text{ mm/yy.}$$

Q5 What are reference electrode? Explain the Construction, working and application of calomel electrode (07 marks)

Ans:- An electrode of known potential relative to which the electrode potential of test electrode can be determined is reference electrode

Calomel Electrode



Construction :

The electrode consist of two concentric glass tube.

The inner tube contains a paste of mercurous chloride in Mercury

The outer tube contains a solution of KCl

A little of mercury along with platinum wire in the inner tube helps the external contacting of electrode.

A small hole at the bottom of inner tube establishes contact with KCl in the outer tube.

Working

Depending on the potential of electrode with which the calomel electrode is connected, calomel electrode acts as cathode or anode.

Reactions when the electrodes acts as Cathode in forward reaction or anode (in the backward direction)

Cathodic Reduction

$$\frac{1}{2}Hg_2Cl_2 + e^- \longrightarrow Hg + Cl^-$$

Anodic Oxidation

Electrode potential equation

$$E = E^\circ - 2.303\frac{RT}{F}\log[Cl^-]$$

Electrode is reversible to chloride ions

Potential changes with the changing concentration of chloride

Applications

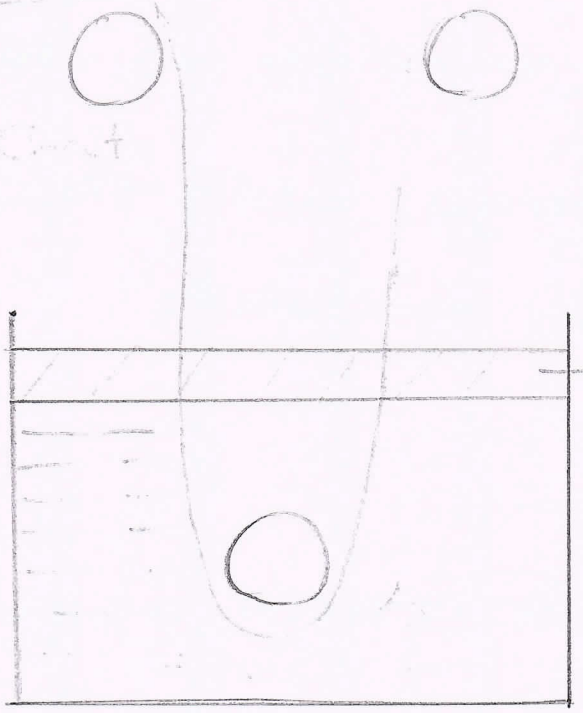
The electrode is used as reference electrode in potential determinations.

6a What is galvanization? Explain galvanization of Iron. Mention it's applications (07 Marks)

Ans:-

Galvanization refer to hot dipping Method. of Coating of Zinc over Iron (Acidic Metal Coating) and Control the Corrosion. of Iron.

This Method is employed for continuous metal sheet, wires and pipes etc.



Object metal Surface needs preparation oil, grease, wax etc are removed by organic solvents. Then it is treated with hot dil H_2SO_4 (Acid Pickling) For removing the scales. washed with water and Air dried.

clean and dry metal sheets are then immersed into a bath containing molten Zinc (mp - 419°C) maintained at 430-450°C. An ~~Am~~ ammonium chloride flux is used to avoid the oxidation of molten Zinc. Excessive Zn from the sheets drawn is removed and uniformity achieved by passing it between two regulated hot rollers. Zinc coated sheets are annealed to have from bonding between the metals with better surface characteristics. And what comes out is galvanized steel.

Applications :- Roofing sheet, fanang wires, pipes etc.

8b What are concentration cell? Calculate the cell potential of the following cell at 298 K.

Ag | $AgNO_3$ (0.005 M) || $AgNO_3$ (0.5M) | Ag

(6 Marks)

Ans :-

Concentration Cell - A cell constructed by the combination of two electrodes made of the same chemical substances but with changing concentration of the electrolyte or electrode. is concentration cell.

cell representation

$Ag \mid AgNO_3 (0.005M) \parallel AgNO_3 (0.5M) \mid Ag$

$C_1 = 0.005 M, \quad C_2 = 0.5 M \quad T = 298 K.$

$n = 1$

$$E_{cell} = 2.303 \frac{RT}{nF} \log \frac{C_2}{C_1}$$

$$= 2.303 \times \frac{8.314 \times 298}{1 \times 96500} \log \frac{0.5}{0.005}$$

$$= 0.0591 \times \log 100$$

$$= 0.0591 \times 2$$

$$= 0.1182 V$$

Q6 C Explain the principle and Instrumentation of Conductometry taking estimation of weak acid using as a strong base as an example (07 Marks)

Ans:-

Principle: Electrolyte solution conducts current by the migration of ions under the influence of an electric field.

$$E = IR.$$

I - Current R - Resistance.

Instrumentation

It consists of a platinum electrode each of unit area of cross section placed unit distance apart.

The electrodes are ~~placed~~ dipped in the electrolyte solution taken in a beaker It is connected to a Conducting measuring device.

The titrant is added from a burette and solution is stirred.

The conductance is measured after the addition of the titrant at intervals of 0.5mL.

Mixture of ~~Strong~~ Weak Acid and Strong Base.

HCl

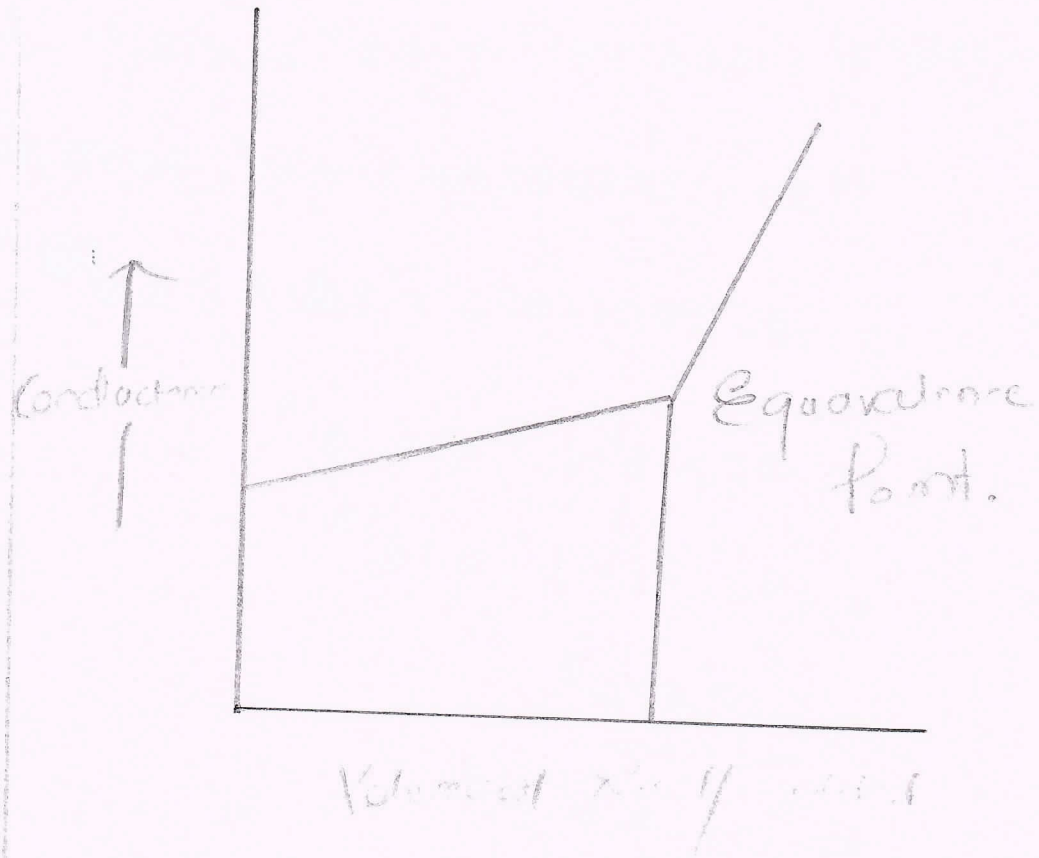
Consider the titration of acetic acid with a strong base (NaOH)

CH_3COOH V/s NaOH.

$CH_3COOH + NaOH \longrightarrow CH_3COONa + H_2O$.

Consider the titration of acetic acid with a strong base NaOH. The conductance of weak acid solution increases until the acid completely neutralized.

A plot of Conductance against the volume of NaOH is shown in the figure. The plot of intersection of the two lines is the neutralization point.



5 7a In a Sample of a polymer 20% molecules have molecular mass 15000 g/mol, 35% Molecules have molecular mass 20,000 g/mol Calculate number average and Weight average molecular mass of the polymer. (7 Marks).

Ans:

$N_1 = 20\%$ $M_1 = 15000\ g/mol$

$N_2 = 35\%$ $M_2 = 20,000\ g/mol$.

$\Sigma n_i = 20 + 35 = 55$

$\Sigma n_i M_i = 20(15000) + 35(20,000)$

$= 1000000$

$$\sum N_i M_i^2 = 20(50000)^2 + 35(20,000)^2$$

$$= 20(225\,000\,000) + 35(400\,000\,000)$$

$$= 45\,000\,000\,000 + 1.4 \times 10^{10}$$

$$= 45 \times 10^8 + 1.4 \times 10^{10}$$

$$= (45 + 1.4) \times 10^{18}$$

$$= \underline{46.4 \times 10^{18}}.$$

Number Average Molecular Weight

$$\overline{M_n} = \frac{\sum N_i M_i}{\sum n_i} = \frac{1000\,000}{55}$$

$$= \underline{18181.81}$$

Weight Average Molecular Weight

$$\overline{M_w} = \frac{\sum N_i M_i^2}{\sum N_i M_i}$$

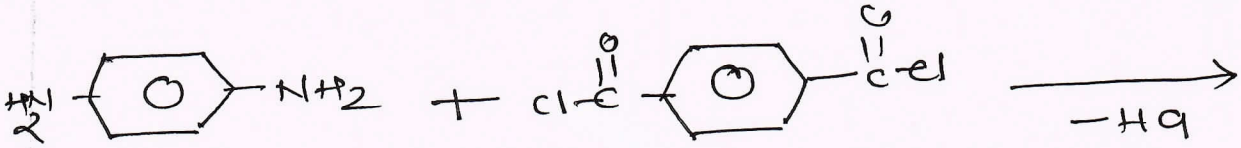
$$= \frac{46.4 \times 10^{18}}{1000000}$$

$$= \underline{464 \times 10^{13}}.$$

8b Explain the Preparation of Kevlar. Mention any four applications (06M)

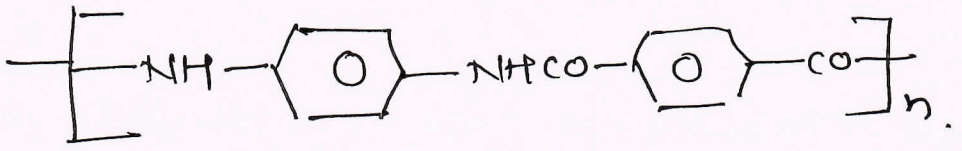
Ans:

Condensation polymerization of 1,4 phenylene diamine (para - phenylene diamine) and terephthaloyl chloride gives Kevlar Hydrochloric acid is the byproduct of polymerization.



para- phenylene diamine

Terephthaloyl Chloride



Kevlar (polyaramid)

Applications

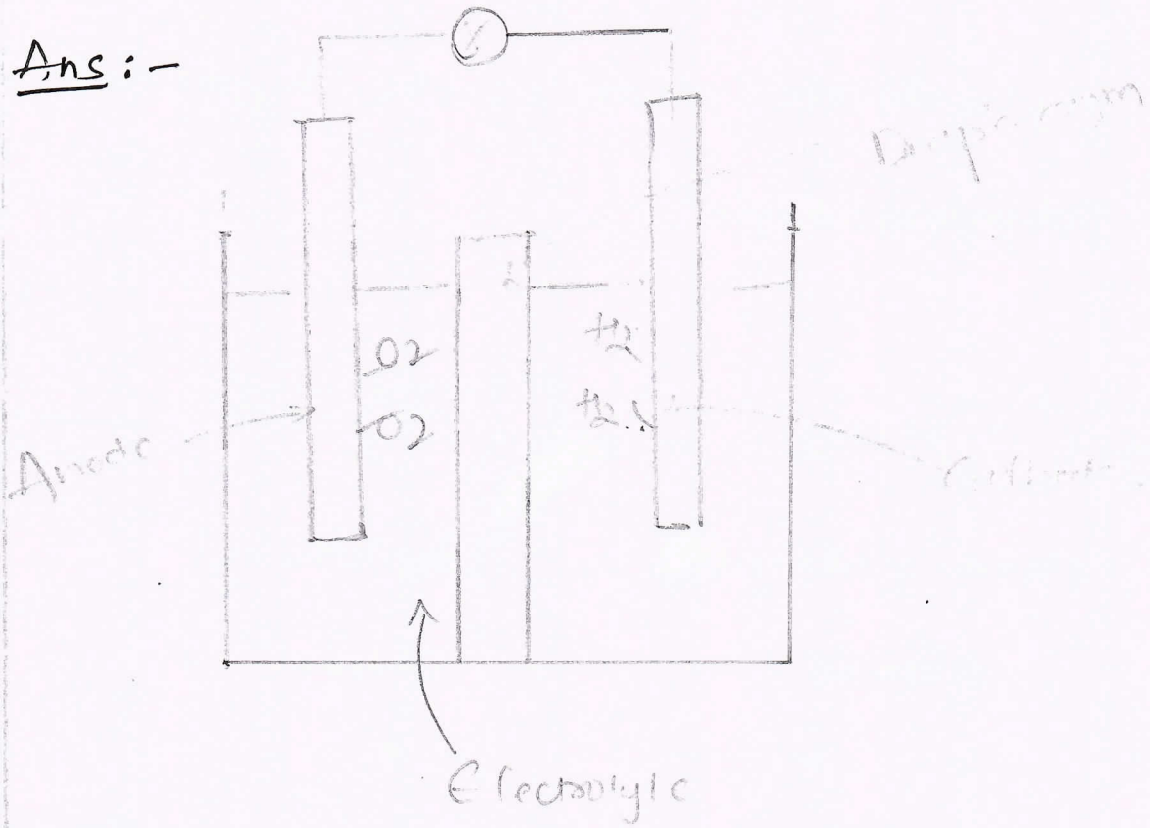
1. Light weight boat hulls
2. Helmets.

3) It is used to manufacture of gloves sleeves, jackets

4) Used in table tennis plies.

Q.7 c Explain the generation of hydrogen by Alkaline water electrolysis with a neat labelled diagram. (07 Marks)

Ans :-



→ It consists of two electrodes ie anode and cathode

→ Both electrodes are made up of Ni based metal, because it is more stable during the oxygen evolution.

→ These electrodes are immersed in KOH solution (25-35 %).

→ Both electrodes are seperated by porous diaphragm prevent gases crossover and allows only hydroxide ions.

→ Cell Voltage 1.3 – 2 V.

→ When electricity passed at anode hydroxide ions lose electrons and forms water molecules.

Anode $2\bar{O}H \longrightarrow \frac{1}{2}O_2 + H_2O + 2e^-$

→ At cathode

[redacted] water molecule accept electrons and liberate hydrogen gas. and forms hydroxide ions.

→ These hydroxide ions move from cathode to anode through diaphragm and process continuous.

Cathode

$$H_2O + 2e^- \longrightarrow H_2 + 2\bar{O}H$$

Total reaction $2H_2O \longrightarrow O_2 + 2H_2$.

S8q What are conducting polymers? Explain the Conduction Mechanism in polyacetylene through oxidative doping technique. Mention any two applications (07 Marks).

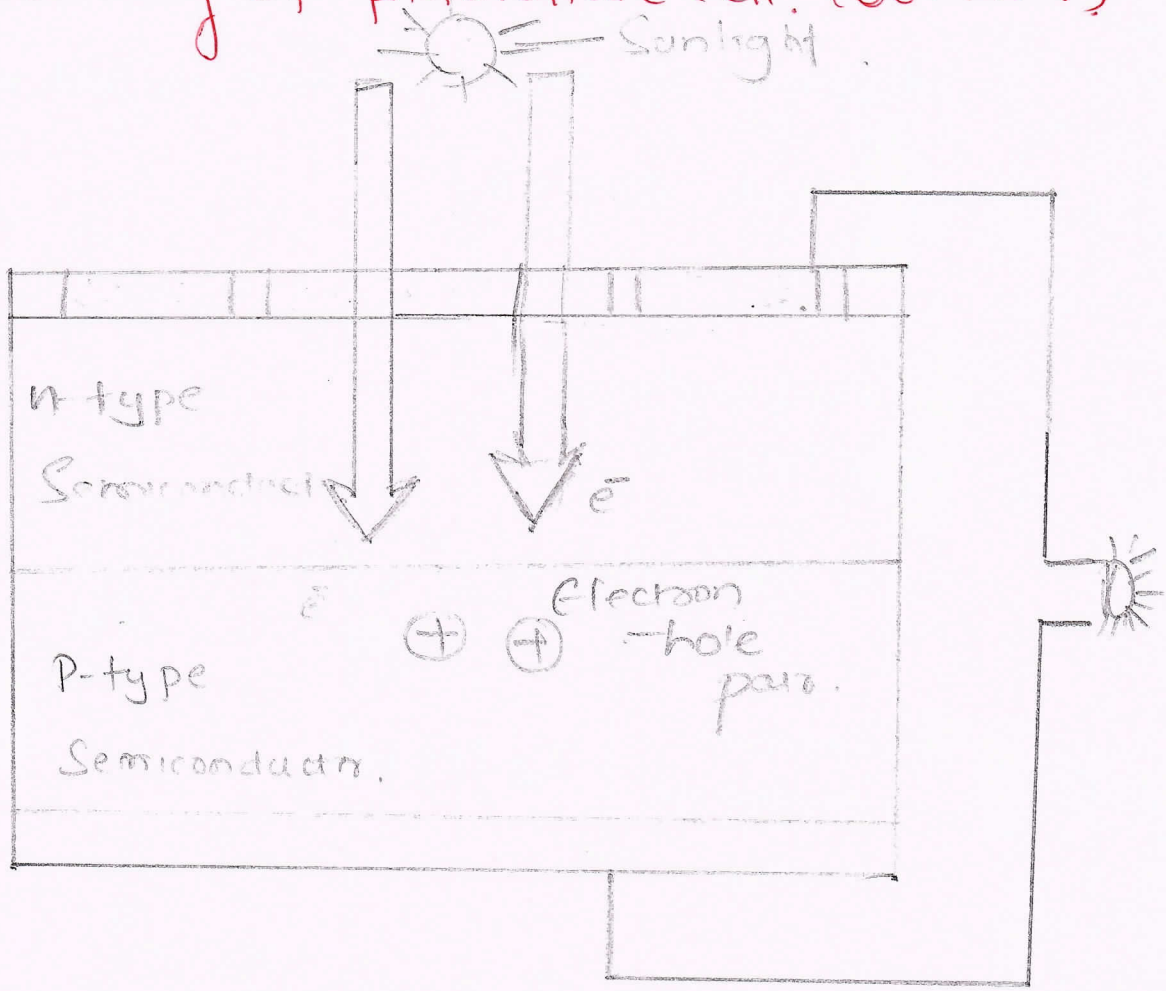
Conducting polymers

Linear, organic polymers with conjugate Single and double bonds with suitable doping by oxidation or reduction or proton etc with delocalised π-electron system exhibiting conductivity equavalents of metals are refered to as conducting polymers.

Oxidative doping

In the frost step oxidative doping by I_2 in CCl_4 removes an electron from the conjugated chain forming radical cation or polaron. Further oxidation gives bipolaron (biradical dication). Radicals converge and lead to formation of soliton.

b) What are PV cells? Explain the Construction and working of photovoltaic cell. (06 Marks)



1. Photovoltaic cell is made of a semiconductor diode (p-n -junction)

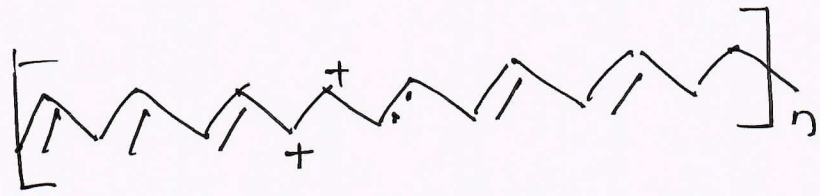
2. The diode has two electrical contacts A grid metal contact (to faculitate light to pass through the PV cell). is used on top side and a layer metal contact on the bottom side. Layer metal used is generally Silver.

Delocalization of the positive charge imparts conductivity to the polymer. Thus, the oxidative doping of the polymer is referred to as p-type doping.

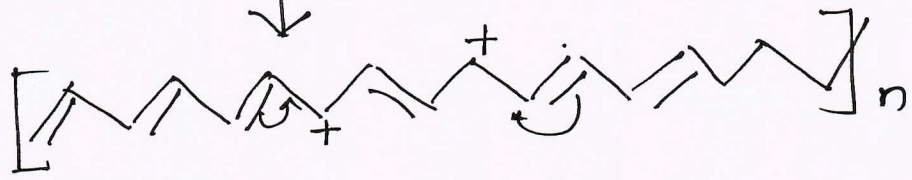
Polyacetyline

Treatment with Iodine in CCl4

I_2 / CCl_4



I_2 / CCl_4



Bipolaron

Soliton.

3. Metal grid permits the light to fall on the diode between the grid lines.

4. An antireflective coat (Si_3N_4) — Silicon Nitride or TiO_2 — titanium dioxide or energy conversion

Working

1. When electromagnetic radiation (sunlight) having energy sufficient to overcome the barrier potential falls normal to the surface of the p-n-junction, electron hole pairs are formed.

2. The electrons move towards the n-region as it is positively charged.) and holes move towards p-region (as it is negatively charged).

3. When an appliance or battery is connected between the two contacts, circuit is completed and electrons are driven into the external circuit enabling the functioning of the appliance or charging of the battery. Charged battery is used for applications such as lighting, telecommunication

4 Depending on the energy requirement PV cell connected series and parallel.

PV cell :- Photovoltaic cells or Solar cells are devices that convert solar energy into electrical energy from Semiconductors.

Q8 c Explain the generation of hydrogen by proton exchange membrane electrolysis (CO4 Marks)

Ans:- Generation of hydrogen by electrolysis of water.

It is the process of splitting of water into oxygen and hydrogen gas by electrolysis.

→ It consists of two electrodes anode and Cathode

→ Both are seperated by Membranes

→ When electricity is passed oxidation takes place at anode it gives H^+ ions and electron

and liberates oxygen gas.

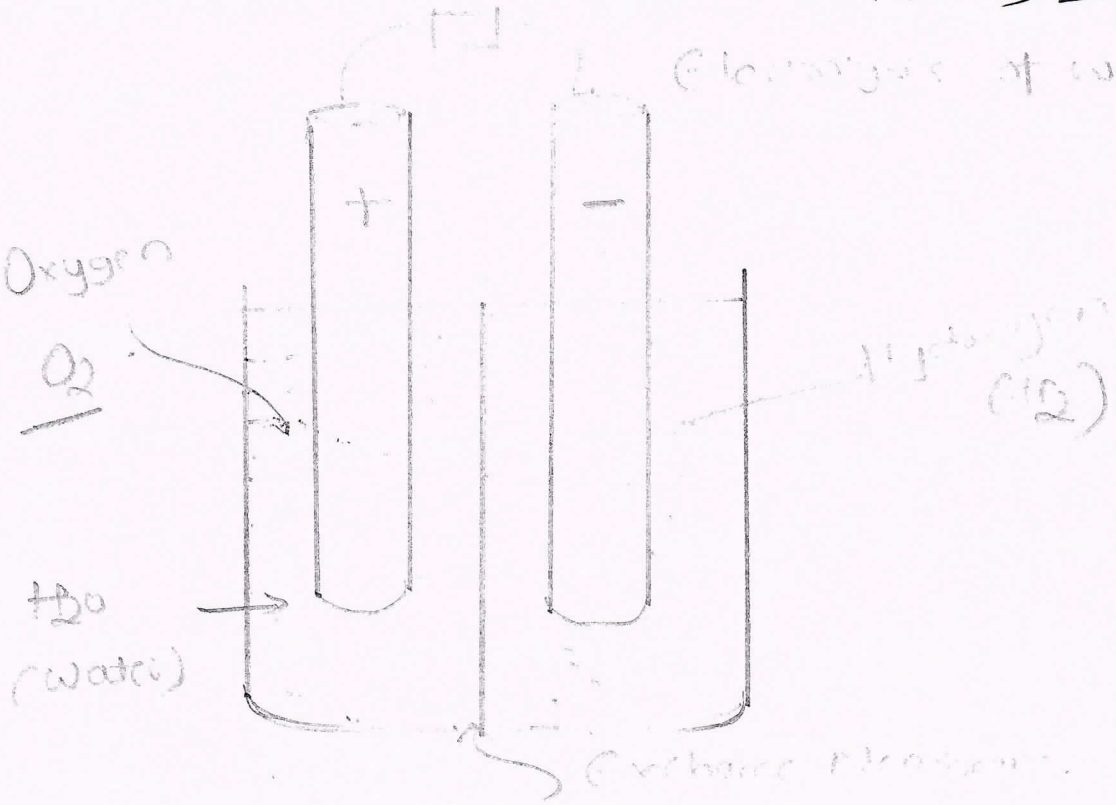
At Anode

$$2H_2O(l) \longrightarrow O_2(g) + 4H^+(aq) + 4e^-$$

→ The H^+ ions move into cathodic compartment through membranes and electrons move from anode to cathode through external circuit.

→ At cathode the H^+ ions accepts electrons and forms H_2 gas. This liberated hydrogen gas is used as a fuel.

→ at Cathode $4H^+ + 4e^- \rightarrow 2H_2(g)$.



Q9a

Define E-waste. Explain the Sources and Composition of E-waste (7 Marks)

Ans:- This is redundant Solid waste generated by electronic equipment or components which work with electric current or electromagnetic fields.

Sources of E-waste

(1) Domestic regions, discarded computer component (monitors, printers, CPU's, keyboards, mouse, scanners laptops etc. lampclocks, electronic toys. calculators, cell phones, refrigerators. Microware ovens toasters kitchen hoods.

(2) Research / testing laboratory testing / analytical instruments, microscopes, computer components pointers, Scanners

(3) Institution organisations office etc where older versions of computers.

Composition of E-Waste

1. E-waste contains about 65% of iron Steel, and other metallic materials including costly metals like platinum, Gold, Silver and toxic metals like lead, Mercury, cadmium, chromium

2. E-waste contains about 21% of polymeric, non-biodegradable materials including PVC's, Polychlorinated biphenyls boominated flame retardant plastics.

3. It contains about 11.8% of CRT and LCD screens and other materials like glass wood, plywood and ceramics

4. Most of these products ended up in landfills, rubbish dumps and recycling centers creating several complications for ewaste management officials,

Sq 1b Explain the ill effects of materials used in manufacturing electrical and electronic products. (06 Marks)

Ans:- Major Problem with the e-waste is passing off toxic metals and organic compounds present in e-waste into ecosystem that is air, water and soil and ultimately to living beings.

Most of these heavy metals are carcinogenic particulate matter released from open burning can adsorb metal particles and enter into human body.

People living nearby to e-waste collection dumping and incineration sites are direct victims for the toxic contaminants. There are higher number of incidences with skin damages headache, vertigo, chronic gastritis, gastric ulcers

a) Smelting

Copper Smelting is commonly used for recovery of non-ferrous metal fractions from e-waste. The processed Scrap after preliminary stage contains mainly iron aluminium, copper, lead, tin, antimony, zinc and precious metals as metallic constituents.

b) Combustion of E-Waste

Combustion is a low technology, low cost, straight forward operation focusing only on the recovery of valuable metals. Here, e-waste is subjected to open burning in uncontrolled manner which release all sorts of pollutants into atmosphere.

c) Incineration of electronic waste

Incineration is a controlled combustion of the waste with suitable emission units. The incinerator has two connected furnaces.

contaminants such as heavy metals, dioxins, furans, PAH's, PCB's and polybrominated biphenyls can create gastrointestinal irritation and laxative effects, abnormal Sperm quality Chromosome aberration, DNA Damage reduced fertility and adverse birth effects.

7c Explain pyrometallurgical process of Extraction of E-waste. (07 Marks)

Ans:- ~~Pyrometallurgical~~ Pyrometallurgy technology is used to extract pure non-ferrous and precious metals from e-waste. The Methods require elevated temperatures to reduce / Extract the metals and therefore require high amount of energy input. Smelting, Combustion, pyrolysis and molten salt processes are the main pyrometallurgical methods employed for recovery of metals from e-waste.

In the first furnace electronic waste is burnt at temperature above 800°C.

d) Pyrolysis of electronic waste.

Pyrolysis is a thermal decomposition of electronic waste at higher temperatures in a oxygen free environment. During pyrolysis irreversible thermal decomposition reactions take place leading to the formation of low molecular products.

12a Explain the extraction of gold from E-Waste. (07 Marks).

Ans: Gold metal has good electrical conductivity and chemical stability and hence it is used for making integrated circuits of electronic devices. coating of contacts and connectors. Electronic industry uses over 300 tons of gold each year.

Electronic waste contains 10 times more excessive concentration of gold compared to -

gold ores. It approximately contains 10 to 10,000 g of gold/ton.

Hydrometallurgical Method.

There are three stages in metal recovery by hydrothermal Method.

(1) Pretreatment Stage

(2) Chemical treatment Stage

(3) Metal recovery Stage.

a) Poetreatment stage

Poetreatment stage involves physical seperation of metal components from electronic waste as discussed above followed by smelting of the mixture. In some cases, in hydrometallurgical process, main steps are chemical treatment and metal recovery steps.

In the pretreatment step. electronic waste is manually dismantled to separate various fractions like metals, ceramics, plastics, wood and paper

are used to recover metals from leached solutions. Selective recovery is possible for most processes.

Gold can also be extracted from leaching solution by electrodeposition of gold from dicyanoaurate gold complex. Pure gold metal taken as cathode and inert anode are dipped in leach solution. When current is applied gold is electrodeposited on cathode.

Qb Explain direct recycling of E-waste (06 Marks).

In the previous sections various methods available for scientific processing of electronic waste to recover useful chemical components from it were discussed. The techniques are used to prevent disposal of electronic waste by means of dumping or

Techniques such as gravity Seperation, electrostatic Separation, magnetic seperation and eddy current Seperation are used to Seperate metals from other fractions.

Chemical treatment Stage

In the chemical treatment stage, targeted metals are leached into Solution by treating with appropriate chemical reagents. Several leaching agents such as thiosulphate alkali cyanide, and many acids such as hydrochloric acid, Sulfuric acid and nitric acid can be used to leach gold into Solutions.

$$4Au + 8CN^- + O_2 + 2H_2O \longrightarrow 4Au(CN)_2^- + 4OH^-$$

Metal recovery Stage

In the last step metal is recovered from leach Solutions. Varieties of methods like electrodeposition, solvent extraction, ion exchange adsorption precipitation and cementation

landfilling because this results in waste of valuable materials and can also cause environmental problems due to contamination of heavy metals. But all these processes require a lot of energy and money. Another cost-effective method for recycling of electron waste is by direct recycling.

Direct recycling means harvesting electronic components directly from electronic waste without breaking them further into small components. Harvesting materials are further processed with the healing methods to regenerate recycled materials. the regenerated Materials have performance equavalent to originally manufactured materials. Thus in this Method, all the complicated chemical and matallurgical steps involved in conversion of electronic waste components into original

chemicals are avoided. Recycling loop is shortened, hence it requires less amounts of energy and reagents. And hence it is the most environmentally friendly method. However, there are few problems associated with direct recycling method. Direct regeneration of components depends on state of health of used electronic materials. Defects and impurities accumulated during usage could affect the quality of the refurbished active material and direct recycling may not restore the initial properties of pristine active materials.

Q10c Write a brief note on role of stakeholders for example producers, consumers, recyclers and statutory bodies in management of E-waste (07 marks).

Ans: Four stakeholders in environmental management of the electronic waste they are

during sale of electronic products and returning it with interest at the time of exchange of electronic product.

c) Forming the group of manufacturers who monitor and encourage the recycling of electronic ewaste.

d) Bearing the transportation cost and collection fees to ease the collection process.

3) Recyclers (recycling units and collection units).

The main role of recyclers in management electronic waste are.

a) The accountability of recycling unit is dismantling, recycling, processing of electronic ewaste materials, management of scrap materials (like incineration) and reselling of recycled materials).

1> Statutory goverment regulatory bodies.

These statutory bodies play a pivotal role in management of electronic waste Main role of statutory Bodes are

(1) To collect the green tax from consumer through producer

(2) Apply some extra charges on the producers (manufacturing units) in the form of penalty when no proper recycling of electronic waste is assured from manufacturing units.

(3) Provide the incentives in the form of subsidy to recycles and collectors when recycling of electronic waste is monitored properly.

2) Producers

(1) The accountability to collect green tax

(2) Charging an additional amount on consumer

b) establish the collection units and the group of people who can ensure return back of electronic products by consumer in exchange offer or directly approach consumer for door-to-door collection.

c) Collect the electronic waste from the collection units dealer or retailer.

4) Consumer

The main role consumer in management of electron waste are.

(1) The accountability to pay green taxes

(2) Develop self awareness on electronic waste management and involves in awareness programs.

(3) returning of electronic waste to collection units.

Prepared by

Dr V H Naik

(Dr. S.M. Galagali)

2 lacks ✓

2.50 lacks ✓

3. lacks ✓ 3 lacks