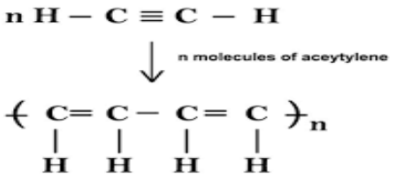
Explain the synthesis of Polyacetylene and mention its applications.

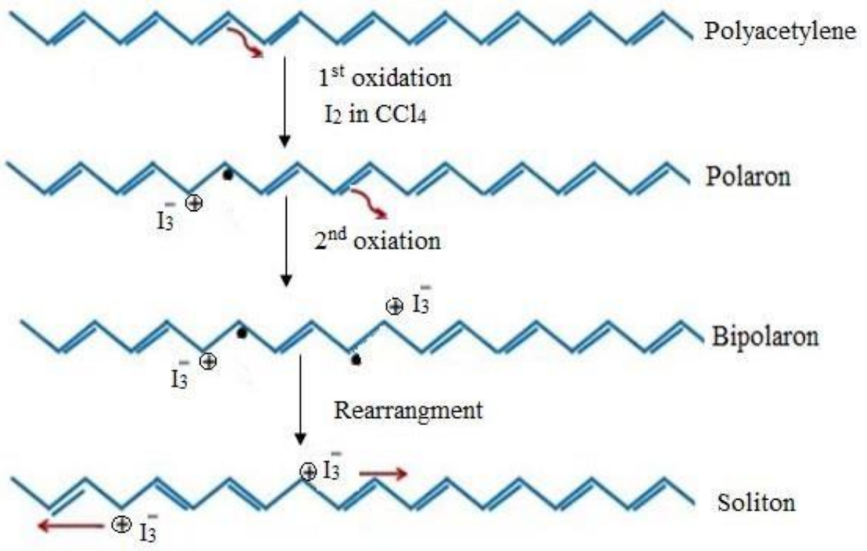
It forms by the oxidative polymerization of acetylene monomer to form a continuous linear chain of olefin groups.



Application

- Fabrication of organic thin transistors.
- Non-volatile memory devices based on organic transistors.
- Fabrication of organic photovoltaic cells.
- Fabrication of organic light-emitting devices (OLED).
- Conducting polymer actuators and Micropumps.
- Focus upon polymer membranes that incorporate electronically conducting polymers and piezoelectric polymers.

Discuss the conduction mechanism in Polyacetylene through oxidative and reductive doping technique.



- Conjugation in the Π bond system of conducting polymers facilitates the flow of electricity.
- I_2 oxidative dopants remove an electron from the Π backbone, creating a polaron, which is a positive charge on a carbon atom that can conduct electricity.
- Further oxidation leads to the formation of a bipolaron, and heavily oxidized chains create solitons.
- Solitons are "kinks" in the chain that enable conduction by decreasing the barrier for interconversion.

Explain the preparation, properties, and commercial applications of graphene oxide.

Hummers method:

- Mix Hummer's reagents with NaNO3 and gradually add pure graphite powder into the hot concentration of H2SO4 solution that is cooled in an ice bath.
- Slowly add KMnO4 to the mixture to keep the reaction temperature below 20°C to prevent overheating and explosions.
- Treat the suspension with an H2O2 solution to complete the reaction with KMnO4, and then wash it with HCl and H2O.
- Filter the suspension and dry it to obtain GO sheets. This modified method is a reliable and common way to produce high yields of GO.

Staudenmaier method:

- Create a slurry of graphite in fuming HNO_3 and add $KClO_3$ as an oxidizing agent.
- Introduce an additional concentrated H_2SO_4 and HNO_3 as oxidizing agents to the mixture.
- Add an additional $KClO_3$ slowly over the course of one week to the mixture.
- The improvised version of the chemical synthesis of GO produces highly oxidized GO using a simple procedure.

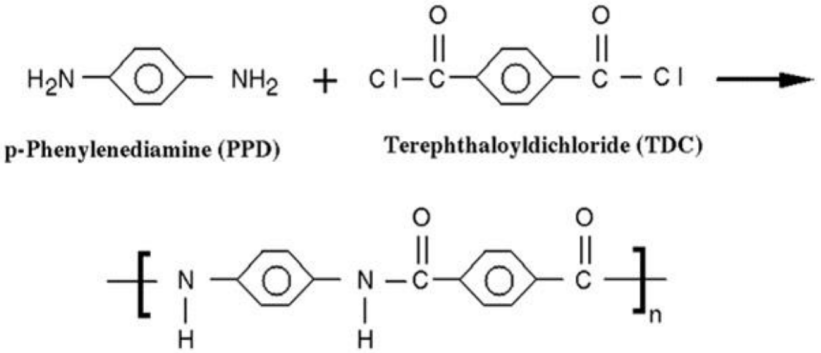
Properties

- Biocompatibility: GO particles are not harmful to living organisms, useful in biomedical applications.
- Chemical stability: GO particles are chemically stable, allowing them to be used in harsh chemical environments.
- Good electrical conductivity: GO particles have high electrical conductivity, useful in electronic devices such as sensors and actuators.
- Highly hydrophilic: GO particles attract water molecules and can disperse easily in water.
- High surface area: GO particles have a large surface area, useful in various applications such as in catalysis and energy storage.
- Stable dispersions: GO particles can form stable dispersions in various organic solvents due to hydrogen bonding with solvent molecules.
- Transparent material: GO particles are transparent, useful in transparent films and coatings.

Application

- Graphene synthesis: Graphite oxide can be used as a precursor to make graphene.
- Transparent conductive films (TCFs): It can be used to fabricate TCFs.
- Cellular imaging: Functionalized graphene oxide can be used for fluorescence and photoluminescent imaging in cells.
- Biomedical field: GO has potential applications in bio-sensing, detection, drug-carrier materials, and antibacterial materials, based on its fluorescence properties.
- Battery and touch screens: GO is being studied as a possible replacement for tin-oxide (ITO) in batteries and touch screens.

Explain the preparation, properties, and commercial applications of Kevlar.



- Kevlar belongs to a family of aramids
- It is an aromatic polyamide with the name poly [para-phenylene terephthalamide]: This means that the chemical structure of Kevlar contains alternating benzene rings and amide groups, giving it its unique properties.

- The linkage through para positions of the phenyl rings gives Kevlar a strong ability to stretch and hence its extra strength: The para-aramid structure of Kevlar results in strong covalent bonds that resist breaking, and the ability of the fibers to stretch helps absorb energy and prevent them from breaking.

Properties

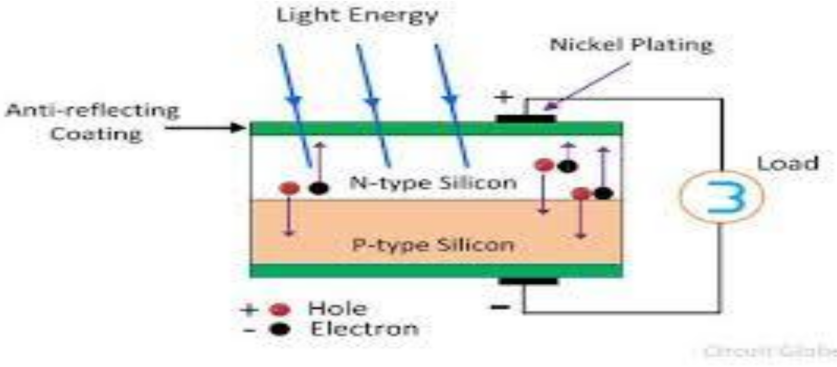
- It has higher tensile strength and modulus than fiberglass:
- Kevlar is stronger and stiffer than fiberglass, making it an attractive choice for high-performance applications.
- Kevlar fibers are used for structures requiring good stiffness, high abrasion resistance and lightweight
- Kevlar's high strength and stiffness, combined with its resistance to abrasion, make it useful in a variety of applications, such as body armor, sports equipment, and aerospace components.

Applications:

- Used in lightweight boat hulls.
- Aircraft fuselage panels and pressure vessels
- high performance race cars
- bulletproof vests and puncture resistant bicycle tyres.

Explain the construction and working of photovoltaic cells. Mention the advantages and disadvantages.

Principle: The principle involved is the ejection of electrons from a metal surface by striking with photons of solar radiation.



Construction & Working :

The device consists of a p-n junction diode coated with an anti-reflective layer (TiO2). Two electrical contacts are provided, one in the form of a metallic grid at the top of the junction and the other is a layer of silver on the bottom of the cell. The antireflective layer coated in between the metallic grids allows light to fall on the semiconductor. The photons of solar radiation entering n-type semiconductor breaks barrier potential and moves to p-type semiconductor where photons knock the electrons in p type to form electron hole pair. The free electrons so formed will travel through the circuit from n-type and recombine with holes again in p-region. The movement of electrons from n type to p type generates electric current. The electrical energy produced from the solar cell is used for various applications.

Advantages:

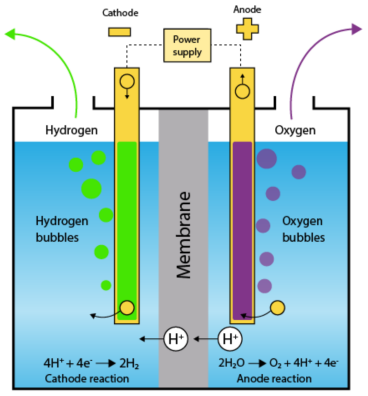
1. Eco friendly
2. No moving parts in the PV cell, hence no wear and tear. 3. Energy conversion devices.
4. Do not undergo corrode
5. Low operating cost (no fuel)
6. No recharging

What is Green Fuel (Hydrogen fuel)? Mention the advantages of green fuel.

Green fuel is also known as biofuel, a type of fuel distilled from plants and animals materials, more environmentally friendly than widely used fossil fuels that power most of the world. Green hydrogen is a clean energy source that only emits water vapor and leaves no residue in the air, unlike coal and oil. One of the many advantages of green hydrogen is that hydrogen is one of the most abundant elements found on Earth, although it is hard to find in its free state. As a result, it needs to be extracted from other sources such as water, coal, biomass, or natural gas using several processes and resources.

- Environmentally Friendly: Green hydrogen is 100% sustainable and does not emit any polluting gasses during combustion or production. This makes it an environmentally friendly option for energy production.
- Abundant Availability: Hydrogen is the most abundant element in the universe and can be extracted from water, which makes it an unlimited resource.
- Easy Storage: Hydrogen is lightweight and easy to store, which allows it to be used at a later time or for other purposes.
- Versatility: Green hydrogen can be transformed into electricity or synthetic gas and used for commercial, industrial, or mobility purposes. Its versatility makes it a valuable energy source.
- High Energy Density: Hydrogen has a high theoretical energy density, which means it contains a lot of energy for its size and weight. This makes it an efficient fuel source.
- High Electrochemical Reactivity: Hydrogen has high electrochemical reactivity, which means it can be used in fuel cells to produce electricity.
- Harmless Combustion Product: Hydrogen combustion produces harmless water vapor, which is not harmful to the environment.
- Energy Efficiency: Hydrogen fuel cell technology produces a high-density energy source that is energy efficient. Its fuel efficiency enables a higher energy production per pound of fuel than alternative energy sources.

Describe the generation of hydrogen by water electrolysis with a neat labeled diagram.



Process:

- Water electrolysis is a process of splitting water into its constituent parts, hydrogen and oxygen, by passing an electric current through it.
- The process takes place in an electrolysis unit that contains an anode, a cathode, an electrolyte, and a power supply.
- The anode and cathode are separated by the electrolyte, which can be an aqueous solution containing ions, a proton exchange membrane (PEM), or an oxygen ion exchange ceramic membrane.
- A direct current (DC) is applied from the negative terminal of the DC source to the cathode, where the hydrogen is produced. At the anode, the electrons produced by the electrochemical reaction return to the positive terminal of the DC source.

Reactions:

- In an acid aqueous electrolyte, the processes that occur at the anode and the cathode are described by equations (1) and (2), respectively:

    - Anode: $H_2O \rightarrow 1/2\ O_2 + 2H+ + 2e-$
    - Cathode: $2H+ + 2e- \rightarrow H_2$
- The half reactions occurring on the cathode and anode, respectively, can be written as:
    - Cathode: $2H_2O + 2e- \rightarrow H_2 + 2OH-$
    - Anode: $2OH- \rightarrow 1/2\ O_2 + H_2O + 2e-$
- The global reaction for both cases is: $H_2O \rightarrow H_2 + ½\ O_2$
- The standard global reaction potential is negative, so the process is not spontaneous and requires an external intervention (power source).
- The overall reaction can be written as: H_2O + electricity $\rightarrow H_2 + ½\ O_2$