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APPLICATIONS OF CONDUCTING POLYMERS : A REVIEW

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Abstract: There are two principle gatherings of applications for these polymers. The primary gathering uses their conductivity as its fundamental property. The second gathering uses their electro activity. The broadened p systems of conjugated polymer are profoundly helpless to compound or electrochemical oxidation or reduction. These change the electrical and optical properties of the polymer, and by controlling this oxidation and reduction, it is conceivable to correctly control these properties. Since these reactions are frequently reversible, it is conceivable to methodicallly control the electrical and optical properties with a lot of accuracy. It is even conceivable to change from a conducting state to an insulating state.

Table 1.1: Group of applications of conducting polymers

Group – I	Group – II
Electromagnetic shielding	Electrical displays
Electrostatic materials	Chemical and biochemical sensors
Conducting adhesives	Molecular electronics
Printed circuit boards	Rechargeable batteries
Artificial nerves	Drug release system
Antistatic clothing	Optical computers
Piezoceramics	Smart structure
Thermal sensors	Ion exchange membranes
Aircraft structures	Electromechanical actuators

Group 1 - Conductivity:

a) Antistatic covering

By covering an insulator with a thin layer of conducting polymer it is conceivable to keep the development of friction based electricity. Such a discharge can be hazardous in a domain with combustible gases and fluids and furthermore in the explosives industry. In the PC industry the sudden discharge of electricity produced via friction can harm microcircuits.

a) Conductive adhesives

By placing monomer between two conducting surfaces and allowing it to polymerize, it is possible to stick them together. This is a conductive adhesive and is used to stick conducting objects together and allow an electric current to pass through them.

b) Electromagnetic shielding

Many electrical devices, particularly computers, generate electromagnetic radiation, often radio and microwave frequencies. This can cause malfunctions in nearby electrical devices. The plastic casing used in many of these devices is transparent to such radiation. By coating the inside of the plastic casing with a conductive surface this radiation can be absorbed.

c) Printed circuit boards

Many electrical appliances use printed circuit boards. These are copper coated epoxy-resins. The copper is selectively etched to produce conducting lines used to connect various devices. These devices are placed in holes cut into the resin. In order to get a good connection, the holes need to be lined with a conductor. Copper has been used, but the coating method, electroless copper plating, has several problems. It is an expensive multistage process, the copper plating is not very selective and the adhesion is generally poor. This process is being replaced by the polymerization of a conducting plastic. If the board is etched with potassium permanganate solution a thin layer of manganese dioxide is produced only on the surface of the resin. This will then initiate polymerization of a suitable monomer to produce a layer of conducting polymer. This is much cheaper, easy and quick to do, is very selective and has good adhesion.

d) Artificial nerves

Due to the biocompatibility of some conducting polymers they may be used to transport small electrical signals through the body, i.e. act as artificial nerves.

e) Aircraft structures

Weight is at a premium for aircraft and spacecraft. A drop in magnitude of weight could give better performance to the internal combustion engine[5]. Modern planes are often made with light weight composites. This makes them vulnerable to damage from lightning bolts. By coating aircraft with a conducting polymer the electricity can be directed away from the vulnerable internals of the aircraft.

Group 2: Electro activity:

a) **Molecular electronics**

Molecular electronics are electronic structures assembled atom by atom. One proposal for this method involves conducting polymers. An example is a modified polyacetylene with an electron accepting group at one end and a withdrawing group at the other. A short section of the chain is saturated in order to decouple the functional groups. This section is known as a 'spacer' or a 'modulable barrier'. This can be used to create a logic device. There are two inputs, one light pulse which excites one end and another which excites the modulable barrier. There is one output, a light pulse to see if the other end has become excited. To use this there must be a great deal of redundancy to compensate for switching 'errors'.

b) Electrical displays

Depending on the conducting polymer chosen, the doped and undoped states can be either colourless or intensely coloured. However, the colour of the doped state is greatly redshifted from that of the undoped state. The colour of this state can be altered by using dopant ions that absorb in visible light. Unlike liquid crystal displays, the image formed by redox of a conducting polymer can have a high stability even in the absence of an applied field.

c) Rechargeable batteries

The polymer battery, for example, a polypyrrole-lithium cell operates by the oxidation and reduction of the polymer spine. During charging the polymer oxidizes anions in the electrolyte which enter the permeable polymer to adjust the charge made. At the same time, lithium particles in electrolyte are electrodeposited at the lithium surface. During releasing electrons are expelled from the lithium, making lithium particles

reemerge the electrolyte and to go through the heap and into the oxidized polymer. The positive destinations on the polymer are decreased, discharging the charge-adjusting anions back to the electrolyte. This procedure can be rehashed about as regularly as a commonplace secondary battery cell.

d) Electromechanical actuators

Electromechanical actuators depend on the capacity of numerous conducting polymers to experience changes in measurement during doping and dedoping. This can be as extensive as 10%. Because of this property, conducting polymers can be utilized to straightforwardly change over electrical vitality into mechanical vitality. The strategy for doping and dedoping is fundamentally the same as that utilized as a part of rechargeable batteries talked about above. What is required are the anodic strip and the cathodic strip changing size at various rates during charging and releasing. The applications of this incorporate small scale tweezers, miniaturized scale valves, smaller scale positioners for tiny optical elements, and actuators for micromechanical arranging, (for example, the arranging of natural cells).

e) 'Smart' structures

A standout amongst the most advanced applications for conducting polymers are 'brilliant' structures. These are things which adjust themselves to improve themselves. Applications of savvy structures incorporate active suspension systems on autos, trucks and prepare; movement control in burrows and on streets and scaffolds; harm appraisal on vessels; programmed damping of structures and programmable floors for automated

Conducting polymers have imperative applications in molecular hardware, electrical showcases, electromagnetic protecting, printed circuit sheets, rechargeable batteries, strong electrolytes and optical PCs. Other potential utilizations of these conducting polymers are in synthetic, biochemical and thermal sensors, artificial nerves, tranquilize discharge frameworks, antistatic garments, particle trade layers, erosion assurance, electromechanical actuators and "brilliant" structures.

Enthusiasm for conducting polymers has its inception in the conceivable business uses of these materials. The business applications depend on the guarantee of a novel combination of light weight, processibility and electrical conductivity. A portion of the conducting polymers can change their optical properties on utilizations of current or voltage and subsequently may discover valuable applications as warmth shutter and light emitting diode (LED).

However, issue blocking these awesome applications is the poor processibility in these polymers. Change of the processibility will empower researchers and technologists to investigate this to make another looking universe of conducting polymers. Much research is required before a considerable lot of the above application will turn into a reality. The strength and processability both should be generously enhanced on the off chance that they are to be utilized as a part of the commercial center. The cost of such polymers should likewise be generously brought down. Notwithstanding, one must think about that, albeit customary polymers were incorporated and examined in labs around the globe, they didn't end up across the board until long stretches of innovative work had been finished. Polymeric conduits with low thickness, great electrical conductivity combined with minimal effort represent a genuine test to the built up inorganic semiconductor innovation.

A portion of the critical uses of conducting polymers are talked about underneath.

Conducting Polymers in Sensors

The concoction properties of conducting polymers make them exceptionally helpful for use in sensors. This uses the capacity of such materials to change their electrical properties amid response with different redox specialists (dopants) or by means of their unsteadiness to dampness and warmth. A case of this is the improvement of gas sensors. It has been demonstrated that Polypyrrole carries on as a semi 'p' type material.

Its resistance increments within the sight of a diminishing gas, for example, smelling salts and abatements within the sight of an oxidizing gas, for example, nitrogen dioxide. The gases cause an adjustment in the close surface charge bearer (here electron openings) thickness by responding with surface adsorbed oxygen particles. Another sort of sensor created is a "biosensor". This uses the capacity of tri-iodide to oxidize polyacetylene as a way to gauge glucose concentration. Glucose is oxidized with oxygen with the assistance of glucose oxidase. This produces hydrogen peroxide, which oxidizes iodide particles to tri-iodide particles. Subsequently, conductivity is relative to the peroxide concentration, which is corresponding to the glucose concentration.

This utilizes the ability of conducting materials to change their electrical properties during reaction with various redox agents (dopants). It has been shown that polypyrrole behaves as a quasi 'p' type material. Its resistance increases in the presence of a reducing gas such as ammonia, and decreases in the presence of an oxidizing gas such as nitrogen dioxide. Hence it can be used in a gas sensor. Conducting polymers also find application in biosensor, p^H sensor, chemical sensor, strain sensor, thermal sensor etc.

Conducting Polymers in Electrochromic Devices

Conjugated polymers that can be more than once determined from protecting to conductive state electrochemically with high complexity in shading are promising materials for electrochromic device innovation. Conjugated polymers have an electronic band structure. The vitality hole between valence band and the conduction band determines the characteristic optical properties of the polymers. The shading changes evoked by doping are because of the alteration of the polymer band electronic structure. The electrochromic materials have been utilized in expansive territory show boards. In engineering, electrochromic devices are utilized to control the sun vitality crossing a window. In car industry raise see mirrors are a decent application for electrochromic framework.

Conductive Polymers in Aircraft Industry

Present day planes are regularly made with lightweight composites. This makes them helpless against harm from lightning jolts. Covering aircraft with a conducting polymer can coordinate the power coordinated far from the defenseless internals of the aircraft.

Polypyrrole has been endorsed for use in the U.S. Naval force's A-12 stealth assault bearer aircraft for use in edge card segments that disseminate approaching radar vitality by conducting electric charge over a slope of expanding resistance that the plastic material produces.

Conducting Polymers as Catalyst

Conducting polymers are relied upon to act as redox catalyst as they show redox property. A few reports have been found in writing on adjustment of conducting polymers and their utilization as catalyst for little natural atoms. Conducting polymers in their different oxidation states interconvert each other, which grants to build redox cycle for synergist responses.

Conducting Polymers inside the Human Body

Because of the biocompatibility of some conducting polymers, they might be utilized to transport little electric flags through the body, i.e., go about as "artificial nerves". Maybe, adjustments to the mind may in the long run be considered. The utilization of polymers with electro dynamic response has prompted their utilization to imitate natural muscles with high sturdiness, huge activation strain, and innate vibration damping. This closeness picked up them the name "Artificial Muscles" and offers the capability of growing naturally propelled robots.

Conducting Polymers as Antistatic Fabrics

Another promising item fusing conducting polymers is Contexò which is a fiber. The fiber is covered with a conductive polymer material called Polypyrrole and can be woven to make an Antistatic texture. Antistatic fabrics are likewise being investigated for conceivable application in clean room applications.

Conductive Polymers for Medical Applications

Appropriate for an assortment of utilizations, conductive thermoplastic mixes can fulfill the medicinal industry's requirement for scaled down, high-quality parts. Most can withstand best in class sterilization methods, including autoclave and numerous are guaranteed for virtue and pre-tried to limit ionic tainting. Restorative applications utilizing conductive thermoplastics include:

- Bodies for asthma inhalers. Since the correct measurement of asthma pharmaceuticals is basic to help, any static „capture" of the fine particulate medications can influence recuperation from a fit.
- Airway or breathing tubes and structures. A stream of gases makes turboelectric charge or rot. A development of such charges could cause a blast in high-oxygen airs.
- Antistatic surfaces, holders, bundling to take out residue fascination in pharmaceutical assembling.
- ESD housings to give Faraday confine detachment to electronic segments in screens and symptomatic gear.
- ECG electrodes made from exceedingly conductive materials. These are X-beam straightforward and can lessen costs contrasted and metal parts.
- High thermal exchange and microwave engrossing materials utilized as a part of warming liquids.

Modern Applications of Conducting Polymers

A standout amongst the most advanced applications for conducting polymers is 'shrewd' structure. These are things, which modify themselves to improve them. A case is a golf club, which adjust continuously to people's inclination to cut or undercut their shots. A more feasible application is vibration control. Savvy skis have as of late been produced which don't vibrate amid skiing. This is accomplished by utilizing the power of the vibration. Different utilizations of keen structures incorporate dynamic suspension frameworks on autos, trucks and scaffolds; harm evaluation on pontoons; programmed damping of structures and programmable floors for robotics.

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