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Conducting Polymers

Polymers, long chain monomers that have been continually attached till they create chains. A few common polymers that we use every day are polyethylene (also known as polythene), made from ethylene (ethene), PVC, made from vinyl chloride. Though these are polymers, they are not conducting polymers. A few examples of conducting polymers are polyacetylene, polyaniline and polypyrrole. The main component these compounds have being alternating pi-bonds, which enables the compounds to conjugate and have a flow of electrons in one direction. The mechanism for this being that any pi-bonds can break into a positive and negative charge, the negative charge can flow through the double bonds, the component of electricity. The above type of conduction is a working of how intrinsically conducting polymers work.

The next type of conducting polymers is doped conducting polymers, these conducting polymers are doped with various trivalent or pentavalent, creating an excess of holes and electrons respectively. This helps an intrinsic conductor conduct electricity better. Intrinsically conducting polymers can be easily doped by reducing or oxidising the backbone of the structure as it possesses low ionisation potential but a high electron affinity. p type doping can be done by treating the intrinsic conducting polymer with a Lewis acid, oxidising, and creating positive charge on the backbone of the polymer. Adding a Lewis base does the opposite, reducing and creating negative charges on the backbone structure, creating an n type conductor.

The last type of conducting polymers is extrinsically conducting polymers, these conducting polymers can only conduct due to the presence of external agents being added to the structure of the polymer backbone. The two types of creating these types of polymers is by 1) adding metallic traces to the polymer, where it acts as a binder and 2) by blending a conducting polymer with another polymer for better physical strength. All the above types of conducting polymers are utilised for commercial and testing purposes, preferably as a fibre.

Conductive polymers show a lot of properties excluding electricity conduction alone. They show varying magnetic, optical, wettability and microwave absorbing properties. With these in mind, various applications can be filled with the use of conducting polymers. Conductive polymers are very effective replacements for current metal usage because of its flexibility and low cost while still conducting electricity. They can be used to make a variety of transistors and diodes. These polymers can also constitute to making nanotubules and devices, which can be used to make bigger appliances.

Conducting polymers could make effective sensors as they can be differently doped to make them more specific to a certain type of need. They can be made into chemical sensors, optical sensors, and biosensors by doping them in specific ways. Chemical sensors are a main part of safety and quality checking in the food and health industry. Certain doped polyaniline nanofibers show better sensitivity for NH_3 . This is an example of conducting polymers being used to detect certain chemicals in the air.

With the fossil fuel era slowly coming to an end, a new form of energy and storage to keep it. Conductive polymers have a high capacitance, making them ideal for storing large amounts of energy. Because of this property, conductive polymers may make excellent super capacitors. As their

lifetime may not be too impressive, they can be made into nanocomposites to increase it. Since conducting polymers have a property of being sensitive to light, they make good solar cells when doped with certain metal oxides. Conductive polymers are also a good choice for lithium-ion battery's electrodes because of high capacitance and good cyclic performance.

The last major application is in the biomedical industry. Tissue engineering is a field that benefits from conducting polymers. These compounds can be made into conductive nanofibers with high area. Conducting polymers are also flexible; movement is an essential part of a tissue. A few compound nanofibers, like biocellulose nanofibers reinforced with polyurethane, are already in use to replace scaffolds in bone tissue. Conductive polymers have also been used in neural interfaces for the same reasons. Another use for these polymers is to create artificial muscles, actuators.

With upcoming discoveries about nanofibers and conductive polymers, various uses are coming forth. Some potential applications are in the making of "plastic digital non-volatile memory devices", they can also be used as a better corrosion protector for mild steel, for its low cost and conductivity.

Sources:

Tapan K. Das & Smita Prusty (2012): Review on Conducting Polymers and Their Applications, PolymerPlastics Technology and Engineering, 51:14, 1487-1500