

Characteristics of Polymeric Materials & its Industrial Significance



Physics

KEYWORDS : Polymeric Material, Design, development, Characterization

Dr. Mahendra Kumar

Assistant Professor, Deptt. of Physics, University of Lucknow.

ABSTRACT

This Paper deals the study of Polymeric Materials emphasize on material design, development in various other significant materials with superconductor or semiconductor properties computer assistance, eco-friendly materials, and materials that are based on the shape of new molecules.

Introduction

Polymeric materials support prosperous lifestyles, and our research focuses on these materials from various angles [1]. Research particularly emphasizes general material design. This includes the development of lightweight, strong fiber materials, heat-tolerant plastics, liquid crystals, organic EL and other optical materials, organic materials with high-function membranes, organic ultrathin films, solar cells, fuel cells and other organic materials concerned with energy conversion.

The simplest definition of a polymeric materials is a useful chemical made of many repeating units. A polymer can be a three dimensional network or two-dimensional network or a one-dimensional network [2]. Each repeating unit is the “-mer” or basic unit with “poly-mer” meaning many repeating units. Repeating units are often made of carbon and hydrogen and sometimes oxygen, nitrogen, sulfur, chlorine, fluorine, phosphorous, and silicon. To make the chain, many links or “-mers” are chemically hooked or polymerized together. Polymers occur in nature and can be made to serve specific needs. Manufactured polymers can be three-dimensional networks that do not melt once formed [3]. Such networks are called THERMOSET polymers. Epoxy resins used in two-part adhesives are thermoset plastics. Manufactured polymers can also be one-dimensional chains that can be melted. These chains are THERMOPLASTIC polymers and are also called LINEAR polymers. Plastic bottles, films, cups, and fibers are thermoplastic plastics.

Polymers abound in nature. The ultimate natural polymers are the deoxyribonucleic acid (DNA) and ribonucleic acid (RNA) that define life. Spider silk, hair, and horn are protein polymers [4]. Starch can be a polymer as is cellulose in wood. Rubber tree latex and cellulose have been used as raw material to make manufactured polymeric rubber and plastics. The first synthetic manufactured plastic was Bakelite, created in 1909 for telephone casing and electrical components. The first manufactured polymeric fiber was Rayon, from cellulose, in 1910. Nylon was invented in 1935 while pursuing a synthetic spider silk.

Characteristics of Polymeric Materials

The majority of manufactured **Polymeric Materials** are thermoplastic, meaning that once the polymer is formed it can be heated and reformed over and over again. This property allows for easy processing and facilitates recycling. The other group, the thermosets, cannot be remelted [5]. Once these polymers are formed, reheating will cause the material to ultimately degrade, but not melt.

Every polymer has very distinct characteristics, but most polymers have the following general attributes.

1. Behaviour with chemicals.

when the chemical comes in contact with skin or eyes or is ingested will emphasize the need for chemical resistance in the plastic packaging. While solvents easily dissolve some plastics, other plastics provide safe, non-breakable packages for aggressive solvents.

2. Dual property of Polymers : thermal and electrical insulators.

All the appliances, cords, electrical outlets and wiring that are made or covered with polymeric materials. Thermal resistance is evident in the kitchen with pot and pan handles made of polymers, the coffee pot handles, the foam core of refrigerators and freezers, insulated cups, coolers, and microwave cookware. The thermal underwear that many skiers wear is made of polypropylene and the fiber fill in winter jackets is acrylic and polyester.

3. Degrees of strength.

From toys to the frame structure of space stations, or from delicate nylon fiber in pantyhose to Kevlar, which is used in bullet-proof vests. Some polymers float in water while others sink. But, compared to the density of stone, concrete, steel, copper, or aluminum, all plastics are lightweight materials.

Manufacturing of Polymers

Extrusion produces thin fibers or heavy pipes or films or food bottles. Injection molding can produce very intricate parts or large car body panels. Plastics can be molded into drums or be mixed with solvents to become adhesives or paints. Elastomers and some plastics stretch and are very flexible. Some plastics are stretched in processing to hold their shape, such as soft drink bottles. Other polymers can be foamed like polystyrene (Styrofoam™), polyurethane and polyethylene.

Characteristics and colors. Polymers have many inherent properties that can be further enhanced by a wide range of additives to broaden their uses and applications. Polymers can be made to mimic cotton, silk, and wool fibers; porcelain and marble; and aluminum and zinc. Polymers can also make possible products that do not readily come from the natural world, such as clear sheets and flexible films.

Composition of Polymers Many polymers are made of repeat units derived from natural gas or coal or crude oil. But building block repeat units can sometimes be made from renewable materials such as polylactic acid from corn or cellulose from cotton linters. Some plastics have always been made from renewable materials such as cellulose acetate used for screwdriver handles and gift ribbon. When the building blocks can be made more economically from renewable materials than from fossil fuels, either old plastics find new raw materials or new plastics are introduced.

Usefulness in various Materials

Polymers can be made into clear, waterproof films. PVC is used to make medical tubing and blood bags that extend the shelf life of blood and blood products. PVC safely delivers flammable oxygen in non-burning flexible tubing. And anti-thrombogenic material, such as heparin, can be incorporated into flexible PVC catheters for open heart surgery, dialysis, and blood collection. Many medical devices rely on polymers to permit effective functioning.

Industrial Significance

Plastics and rubbers are widely used in industrial applications. This can be as piping systems for chemicals, transport hoses, conveyor belts, tanks, membranes and a large number of other products. For all these products it goes that they need to be suitable for their application and that you have to be sure that you can rely on the well functioning. For instance glass reinforced pipes should not break due to high bending loads. Also leakages of seals can easily lead to high costing damage. For other parts it goes that after building they might not be able to be reached or replaced and therefore failure should be avoided completely.

In the commercial production of plastics, elastomers, man-made fibres, adhesives, and surface coatings, a tremendous variety of polymers are used. There are many ways to classify these compounds. In plastic (thermoplastic and thermosetting resins), polymers are divided between those that are soluble in selective solvents and can be reversibly softened by heat (thermoplastics) and those that form three-dimensional networks which are not soluble and cannot be softened by heat without decomposition (thermosets). In the article man-made fibre, fibres are classified as either made from modified natural polymers or made from entirely synthetic polymers.

Polymers for Sensors

A new generation of sensors is likely to appear in the near future based on thin film coatings deposited on integrated circuit chips, optical fibres or in the form of self supporting films. One of the most important polymers is polyvinylidene fluoride (PVDF). It is a piezoelectric polymer which when stressed or strained will produce a voltage or current. Many polymer materials are piezoelectric as a result of the dipolar nature of their molecules. They have the advantage over ceramics in that they can be fabricated in large areas and are hence more versatile. PVDF sensors have been under development for several years for acoustic transducers, hydrophone projectors and receivers, ultrasonic devices and piezoelectric voltage generators. It has also been proposed that PVDF may replace traditional carbon microphones and is used to construct high fidelity headphones and telephones. PVDF lends itself to the fabrication of large area conformed hydrophones, towed arrays and sonobuoy systems. Cost reduction as well as weight reduction and performance enhancement are expected from this new technology. Another area

where polymers are likely to make an impact is in the area of gas detectors. Several sensing mechanisms have been studied, mostly using thin polymer coatings that absorb, selectively transmit or chemically react with the agent to be detected. The change in capacitance, weight or other property of the layer is detected by an electrical device coupled to the sensor. Polyimide humidity sensors detect the capacitance variation of a thin polyimide layer when its content of absorbed water is varied ~2. Dew point sensors detect the formation of water drops at the polyimide/air interface when the chip temperature reaches the dew point. Several methods exist for the detection of gas or vapour being absorbed. A very sensitive technique is to use surface acoustic wave (SAW) oscillators. If a polymer layer is deposited on the wave path, a shift in its weight will produce a comparable shift in frequency. Polymers also play an important role in chemical field-effect transistor (CHEMFET) devices. These consist of Si metal oxide semi-conductor field effect MOSFET transistors in which exposure of the device gate to gases or vapours produce a variation in the output drain signal. The main problem is to gain selectivity for the species to be detected. The use of ion sensitive and selectively permeable polymer membranes ensures that only specific molecules or ions will reach the MOS device.

Other Uses of Polymers

Optical fibres are currently making an impact in the communications area and are constructed of glass with graded refractive index. The outer surface must be smooth and must not be damaged when the cables are laid. Most optical fibres are protected by being coated with a layer of protective polymer. Operation of optical communications often requires that the materials should be able to respond in a non linear fashion. Materials are currently being developed capable of operation as frequency doublers and active switches. Liquid crystals and liquid crystal polymers are being used as switchable and semi-permanent data storages. Polymers are also widely used in magnetic recording media and optical storage elements.

Conclusion

The list of areas into which polymers and organic molecules are being introduced is wide and illustrates the fact that the role of these materials is becoming active rather than the traditional passive role of organic materials.

REFERENCE

1. Kulcke, A., Gurschler, C., Spock, G., Leitner, R. and Kraft, M. (2003) On-Line Classification of Synthetic Polymers Using Near Infrared Spectral Imaging. *Journal of Near Infrared Spectroscopy*, 11, 71-81.
2. Lloyd, G.R., Brereton R.G., Faria, R. and Duncan, J.C. (2007) Learning Vector Quantization for Multiclass Classification: Application to Characterization of Plastics. *Journal of Chemical Information and Modeling*, 47, 1553-1563.
3. Crompton, T.R. (1993) *Practical Polymer Analysis*. Plenum Press, New York.
4. William D. Callister, Jr, *Materials Science and Engineering – An introduction*, sixth edition, John Wiley & Sons, Inc. 2004.
5. V. R. Gowariker, N. V. Viswanathan, and Jayadev Sreedhar, *Polymer Science*, New Age International (P) Limited publishers, Bangalore, 2001.