An Appraisal scheduled Polymer - Physics

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Abstract - In the present paper a theoretical approach has been made to discuss the classification of polymer, properties of polymer, methods of film formation, thickness measurement, charging methods and various applications of polymer.

Index Terms - Polymer, electret, plastics, fibers.

INTRODUCTION

Polymers and polymeric materials are having been playing a very important role in making new devices and thus pave the way for substituting the old outdated materials. This has resulted in the birth of new disciplines like molecular electronics, conducting polymers (including synthetic metals), organic semiconductors and plastic electronics. Polymers are gaining attention of scientific and technological community because of their wide range of applications in industrial, pharmaceutical, medical fields etc [1].

Polymers had appeared in their many natural forms like wood, cotton, cellulose, starch, etc. which man began to use. Most of the synthetic polymers are of a relatively recent origin. Infact, they appeared just later than the radio and airplane did. Polymers are giant complex molecules and are quite different from low molecular weight compounds like common salt.

A polymer is made up of many small molecules which have combined to form a single long or large molecule. The individual small molecules from which polymer are formed are known as monomer molecules and are linked to form a big polymer molecule the process being known as 'polymerization' [2]. If we look for desirable properties like – resistance to chemicals, amenability for quick and mass production and for fabrication into complex shapes in a wide variety of colors-some polymers will almost always meet our requirement. Polymers can be converted into strong solid articles, flexible rubber-like masses, soft and resilient foams, smooth and fine fibers, clean and clear glass-like sheets, swollen, jelly-like food materials and so on.

They can be used to bond objects, seal joints, fill cavities, beat loads- infact anything from clothing to powering a space vehicle to even replacing human organs [3]. In 1962 microphones with thin flexible polymer electret were introduced [4]. The optical absorption spectra of many polymers have been reported earlier but it was only in the last decade that attention has been paid to the evaluation of optical constants (refractive indices, absorption coefficients etc.) of pure and doped polymers [5-8].

CLASSIFICATION OF POLYMERS

Polymers can be classified in many different ways. All the conversion processes occurring in our body are due to the presence of enzymes. those of enzymes or proteins.

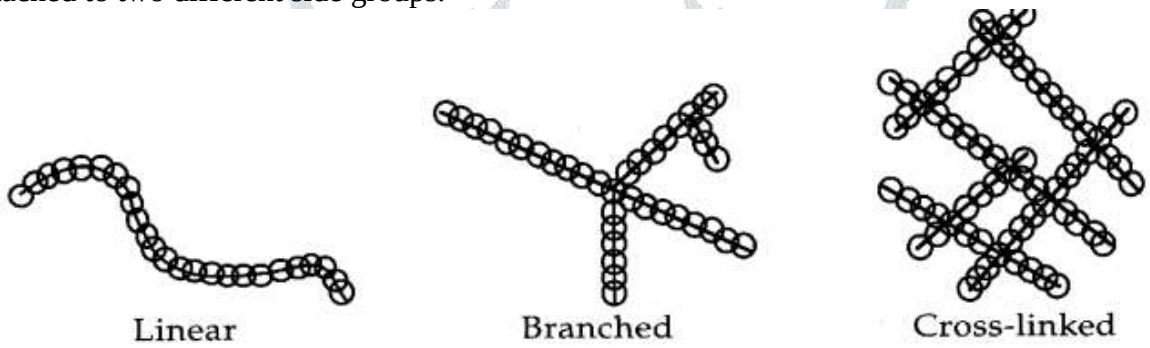
Based on the way in which the polymer chains are bounded together in the solid, polymers may be classified as thermoplastics and thermosetting. When they are heated, their plasticity increases and plastic flow occurs. The material softens and ultimately melts. The melting point of thermoplastics is of the order of few hundred oC. The main advantage of thermoplastics is that they can re-melt and re-mold, that is, they can be recycled as shown in figure. Examples of thermoplastics are polyethylene, polypropylene, polyvinylchloride, nylon etc.

Thermosetting polymers are the one in which the single unit joins in more than one direction with several branches. The side chains form a three dimensional network of primary covalent bonds. When thermosets are heated, further polymerization reaction occurs and on cooling to room temperature become hard and brittle.

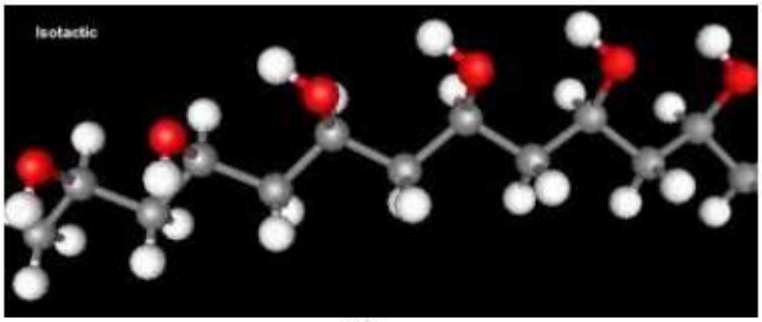
On heating after hardening, they do not soften like thermoplastics; they decompose due to reaction with atmospheric oxygen as shown in figure. Examples of thermosets are vulcanized rubbers, epoxies and phenolic and polyester resins.

Thermoplastic Polymer

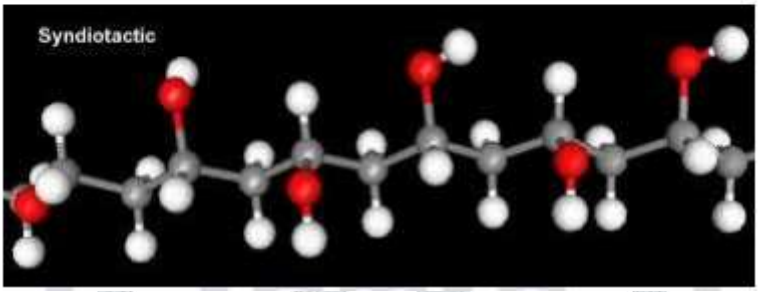
In linear polymers the 'mer' units are joined together in single chains as shown in figure. Chains are bonded to each other by weak van der waal forces. For example polyethylene, polyvinylchloride, nylon, etc. In branched polymers, the chain contains sidebranches as shown in figure. The packing in these polymers is very small and so they have low density. In cross linked polymers as shown in figure adjacent linear chains are joined to one another at various positions by covalent bonds. This kind of cross linking is achieved during synthesis of the polymer or by chemical reactions at elevated temperature with additive atoms/molecules [10-14]. The variation in polymer structure is observed when the backbone of polymer molecule contains a carbon atom attached to two different side groups.



The variation in polymer structure is observed when the backbone of polymer molecule contains a carbon atom attached to two different side groups. Syndiotactic Polymer: Polymers in which chain is made up of units having opposite spatial configuration of each asymmetric carbon atom are known as syndiotactic polymers as shown in figure. Atactic Polymer: Polymer in which groups are arranged randomly in space over the chain are known as the Atactic polymer as shown in figure.



(a)



PROPERTIES OF POLYMER

If we look for desirable properties like – resistance to chemicals, amenability for quick and mass production and for fabrication into complex shapes in a wide variety of colors-some polymers will almost always meet our requirement [3]. In recent years, structural, optical, thermal and electrical properties of polymers have attracted much attention in view of their application in electronic and optical devices such as optical waveguides and data storage materials [17-21].

The most basic property of a polymer is identifying of its constituent monomers. Second is a set of properties known as micro structure. Chemical properties, at the nano scale describe how the chains interact through various physical forces [22]. Materials such as glass, ceramics, polymers and biocomposites are non conducting materials. They prevent flow of current through them.

As good insulators, polymers possess excellent dielectric properties. Many authors have reported theoretical and experimental work related to these properties [23-26]. Tensile strength: The tensile strength of a chemical material qualifies how much stress the material will endure before failing [27,28]. Young's Modulus of elasticity: Young's Modulus quantify of the polymer.

Boiling point: Boiling point of a polymer substance is never defined due to the fact that polymers will decompose before reaching theoretical boiling temperatures [29-32]. Chemical cross-linking: Cross linking consists of the formation of chemical bonds between chains. Among other applications, this process is used to strengthen rubbers in a process known as vulcanization, which is based on cross linking by sulphur.

Electrical properties of Polymer: Material such as glass ceramics polymers and paper are on non conducting materials. They prevent flow of current through them. Therefore they can be used for insulative purpose. When the main function of non-conductive material is to provide electrical insulation, it is called insulator. When non-conducting materials are placed in an electric field, they modify the.

FILM FORMATION METHODS

Over the past few years deposition of this film have been received in numerous next as per as physical and chemical techniques are concerned [35]. Thin films are thin material layers ranging from fractions of a nanometer to several micrometers in thickness and its formation starts with nucleation followed by coalescence and subsequent thickness growth, with nucleation followed by deposition parameters in all the physical vapor deposition techniques. Methods of film preparation are useful. Films prepared by different techniques acquire different properties.

Therefore method of film formation is an important factor and these are (a) Thermal Evaporation: Thin films are produced from polymers by thermal evaporation of bulk material. Here the material to be deposited is hearted to a high temperature at a very low pressure and in extremely clean conditions where it vaporizes. The vapor is then allowed to condense on a substrate, together with gaseous fraction and solid residue. Evaporated polymer films are contaminated due to the vigorous boiling action of the molten polymer, and due to the rapid evolution of breakdown products.

However, uncontaminated films can be obtained by choosing a low evaporation temperature and thus a slow rate of deposition and by specially designed thermal evaporation methods, combination of internal baffles and flash evaporation and laser evaporation [36]. The advantage of this method is that the deposition rate remains constant. sputtering are based on the effect that the free electrons ejected from the evaporate can be accelerated in an electric field to cause further bombardment of the surface of the target and a self sustaining reaction. Some other systems are based on increasing the electron path lengths so that the self sustained system can work at relatively low pressures. (c) Glow discharge: The film formed in a glow discharge is pin holes free and possess a numbers of unique and desirable properties.

The thin film a glow discharge method or a glow discharge is initiated between the electrodes, in the indirect method; the substrate is placed in the formed. (d) Gaseous discharge: Thin films of polymers can be obtained when a gas discharge is maintained in the vapors of monomer. The discharge is a cold one and no hot cathode emission is necessary. The problems associated with high gas pressures and substrate heating has been minimized by utilizing a longitudinal magnetic field to compress to glow discharge in a tube and r. f. electrode less excitation. (e) Hot pressing:

The first method of film fabrication was hot pressing. In this method the polymer powder is placed in between two ferrotype photographic plates and hot pressed at a temperature 10-150C above the crystalline melting point under pressure. The film is then removed from the press and immediately quenched in ice-water in order to obtain necessary thickness [37, 38]. (f) Film from polymer solution: The flawless method for preparing thin films from polymer solution. (a) Isothermal immersion technique:

Solution of suitable concentration is kept at a desirable temperature for a given period of time yield the required film thickness. Polymer solution of non concentration is spread over an optically plane glass plate of non surface area which is made to float in mercury pool. Solvent is allowed to evaporate at a suitable constant temperature and the resulting film detached from the substrate using a blade. Lack of proper instrumentation and precautions may result into the films containing air bubbles and non-uniform thickness. The thickness of film depends upon concentration of the solution.

FILM THICKNESS MEASUREMENT METHODS

Measurement of thickness of sample with sufficient accuracy is essential so that desired conclusion could be drawn about the electrical properties of polymer samples. These thickness measurement methods may be divided as mechanical method.

A. Mechanical method: Mechanical techniques are given below. (a) Stylus method: In this method a fine stylus is moved over a stepped surface formed by the edge of the film and the substrate. This stylus undergoes transverse vibrations at the step which is recorded and amplified after being fed into an electronic circuit [39, 40]. Since the mass is defined as the density multiplied by the volume and the area and mass of the film can be measured precisely using physical balance and venire calipers. The thickness, t, of the film can be computed using the following formula

$$t = M/d. A$$

CHARGING METHODS OF SAMPLE

"photoelectric method". An electrical field is applied on a polymeric dielectric at a high temperature and thereafter it is cooled down while the field is still applied. This method of polarizing a dielectric, is preparing the thermoelectric known as 'Thermal method'.

If the range of the electrons is greater than the polymer sample thickness, charging occurs mainly due to the secondary emission of back scattering is known as 'Electron beam method'.

When inorganic photoconductors are irradiated with ultraviolet or visible light under an applied field, a permanent polarization is achieved due to the generation of charge carriers in the sample. These carriers are than displaced by the applied field eventually trapped at the dielectric electrode interface or in the volume resulting in a two separate charge clouds of opposite sign or a single charge cloud is known as 'Photoelectric method' [4].

APPLICATIONS OF POLYMERS

Polymers have obviously not been discovered overnight. They came out of long and persevering studies by a host of motivated scientists whose work has enriched human life. Today, the overall insight into polymer science and technology is so deep that material scientist can create an almost limitless range of new materials. A bulletproof material like polycarbonate which combines the transparency of glass and the strength of steel is one such example. Polymers have also found valuable applications in bioengineering:

for understanding of membranes, neutral signals, biological memory in regeneration, electrical mediation in tissue growth and other phenomena. It is expected that they may find many other revolutionary applications in the field of medical science and space technology, etc. [49]. In the initial days many scientists and engineers thought that the polymers are electrical insulators and their applications are limited by this property. The discovery (or synthesis) of polyacetylene in 1977 changed this concept and this discovery gave a new class of materials which is known as semi conducting or conducting polymers [50]. Many polymers have their conductivity increased by several orders of magnitude by doping process and converted into electronic polymers and have become of very great scientific and technological importance [51].

Medicine: Many biomaterials, especially heart valve replacement and blood vessels are made of polymers like Dacron, Teflon and polyurethane. Consumer Science: Plastic containers of all shape and sizes are light weight and economically less expensive than the more traditional containers. Clothing, floor covering, garbage disposal bags and packaging are other polymer. Industry: Automobile parts, windshields for fighter planes, pipes, tanks, packing materials, insulation, wood substitutes, adhesives matrix for composites and elastomers are all polymer applications used in industrial market. Sports: Playground equipment, various balls, golf clubs. Swimming pools and protective helmets are often produced from polymers [14, 15].

Other forms of this material include high and ultra-high molecular weight polyethylene HMW and UHMW, as they are known.

In 1885, artificial silk was patented and the modern fiber industry was launched. The combination of strength, weight, and durability has made these materials very important in modern industry.
Nylon has special properties which distinguishes it from other materials. One such property is the elasticity.

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