Chapter 1

Introduction

Abstract

This chapter deals with the general introduction and fundamental of polymers, polymer blends and polymer composites. Various applications of polymer blends and composites are also described. The importance of the spectroscopy in the field of polymer science is explained. A detailed literature survey and motivation for selecting this problem is also emphasized at the end of the chapter.

1.1. Introduction to Polymeric age

The earliest known work with polymers was the rubber industry in pre-Columbian Mexico. They combine latex of the rubber tree with the juice of the morning glory plant in different proportions to get rubber with different properties for different products, such as bouncing balls, sandals, and rubber bands. The first modern example of polymer science is the derivatives of the natural polymer cellulose, such as celluloid and cellulose acetate developed by Henri Braconnot, Christian Schönbein and others. But it used as plastic during First World War in 1914.

The first synthetic polymer used on a commercial scale was a phenol-formaldehyde resin known as *Bakelite*, developed in the early 1900s by chemist Leo Baekeland. Hermann Staudinger was the first to propose that polymers consisted of long chains of atoms held together by covalent bonds. The first of what may be called the modern synthetic polymers were developed during the inter-war years. The first commercial manufacture of polystyrene took place in Germany in 1930, poly(methyl methacrylate) in 1936, PVC was used as a plasticized material in 1939 and poly(ethylene terephthalate) in 1943. Polyolefins, polymers derived from olefins, were started to develop around 1950. The first linear thermoplastic polycarbonate was commercially produced in 1960. Polypropylene was manufactured in 1962.

The development and production of a new polymer is an extremely costly process, so the method of reducing these costs is important. For these reasons a great interest was developed during the 1970s and 1980s in the blending of polymers of different types to give either cheaper products or products with properties which were the combination of two or more polymers.

The development of new polymers has not come to an end but polymer chemists continue to develop both new polymers and new polymerization processes for the older polymers. This leads to the introduction of polymers for special uses. Totally novel types of polymers are also synthesized with a view to investigate whether they might have useful properties.

1.2. Introduction of Polymer

The word Polymer is derived from Greek words “poly” means many and “meres” means parts. In simple statement polymer is a long chain molecule which have large number of repeating units which is called monomers. Certain polymers are found in nature like proteins, cellulose, silk etc. while many others like nylon, polystyrene, polyethylene are chemically synthesized.

1.2.1. Classification of Polymer

Hundreds of polymers have been synthesized and many more are likely to be produced in future. But fortunately on the basis of their processing characteristic, type of polymerization, on the basis of polymer structure, chemical structures, physical properties, mechanical behavior, thermal characteristics, and stereochemistry, polymers can be classified as follows.

- **Natural and Synthetic polymer**

  Polymers isolated from natural materials are called natural polymers.

  Example: cotton, silk, wool etc.

  Polymers synthesized from low molecular weight compounds are called synthetic polymers.

  Example: Polyethylene, Polyvinyl chloride (PVC), nylon etc.

- **Based on processing characteristics**

  Polymers can also be divided into groups based on their properties. All polymers can be classified in to two major groups based on their thermal processing behavior which is very useful for thermal properties of different polymers.

- **Thermoplastics**

  They can be softened in order to process into a desired form when heated are called thermoplastics.

  It can be reused and re-fabricated by applying heat and pressure.

  Example: Polyvinyl chloride (PVC), Polystyrene (PS), Polypropylene (PP) etc.

- **Thermosets**

  Polymers whose individual chains have been chemically linked by covalent bond during their fabrication and once they formed they cannot be thermally processed to re-fabricate are called thermosets.

  They resist heat softening, creep and solvent effect. Due to these properties they are useful for composite materials, coatings and adhesive applications.

  Examples: Epoxy resins, phenol-formaldehyde resins etc.

- **Based on polymerization process**

Polymers may also be classified according to their polymerization mechanism as shown below.

- **Addition or Condensation**

  Polymer which is polymerized by a sequential addition of monomers is addition polymer.

  Example: Polystyrene (PS), Poly Ethylene (PE) etc.

  Polymer which is obtained by the random reaction of two molecules is called condensation polymer. As a molecule, a monomer, oligomer or higher molecular weight functional group take part in poly condensation reaction.

  Example: Nylon-6, 6, Polycarbonate (PC), etc.

- **Step growth or Chain growth**

  Step growth polymerization is a type of polymerization mechanism in which bi functional or multifunctional monomers react to form a first dimer, then trimer and longer oligomer or eventually long chain polymer. Most condensation polymers are step growth polymer.

  Example: Polyester, Polyamide etc.

  Chain growth polymerization is technique when unsaturated monomers or molecules add on to the active side on a growing polymer chain, one at a time [1]. And as a molecules radical, anion or cation can take part in polymerization. Most addition polymers are chain growth polymer.

  Example: Polystyrene (PS), Polyvinyl chloride (PVC), etc.

Atactic, Isotactic and Syndiotactic Polymers

On the basis of the configurations, polymers can be classified into three categories viz., atactic, isotactic (cis-arrangement) and syndiotactic (trans-arrangement).

- **Atactic polymer**

  Those polymers, in which arrangement of side groups is at random around the main chain, are termed as atactic polymers.

- **Isotactic polymer**

  Those polymers in which the arrangement of side groups are all on the same side are known as isotactic polymers.

- **Syndiotactic Polymer**

  Whereas, those polymers in which the arrangement of side groups is in alternating fashion is termed as syndiotactic polymers.

- **Based on polymer structure**

Polymer may also classify based on the chemical structure of their backbone.

- **Homo chain polymer**

  Polymers having all carbon atoms along their backbone are called homo chain polymers which are further divided as polyalkylenes, polyalkenylenes and polyalkynylenes depending upon whether there are single, double or triple bonds along their backbone.

  Example: Polystyrene (PS), Polyvinyl chloride (PVC), etc.

- **Hetero chain polymer**

  Polymers having more than one atom type in their backbone are called hetero chain polymers which are grouped by the types of atoms and chemical groups e.g. carbonyl, amide or ester, etc. located along the backbone.

  Example: Polyether, Polycarbonates etc.

Depending on its ultimate form and use, a polymer can also be classified as plastic, elastomers, fibre or liquid resins.

1.2.2. Properties

Every polymer has very distinct characteristics but most polymers have the general properties. Polymer properties are broadly divided into several classes. The most basic property of a polymer is the identity of its constituent monomers. The other one is the arrangement of these monomers within the polymer at the scale of a single chain. These basic structural properties play a major role in determining bulk physical properties of the polymer, which describes how the polymer behaves as a continuous macroscopic material. Chemical properties, at the nano-scale, describe how the chains interact through various physical forces. At the macro-scale, they describe how the bulk polymer interacts with other chemicals and solvents. Some basic properties of polymers are listed below.

- Polymers are very light in weight with great degrees of strength.
- Polymers can be processed in various ways.
- Polymers have many inherent properties that can be further enhanced.
- Polymers can be very resistant to chemicals and also to weather. They only react with particular solvent.
- Polymer can act as both thermally and electrically insulator.
- Polymers have excellent transport properties such as diffusivity.
- Mechanical properties of polymers have made polymer to great interesting materials. Polymers replace many materials with their good physical properties.

1.3. Polymer Blends

The polymer industry traces its beginning to the early modification of shellac natural rubber, gutta-percha and cellulose. In 1846, Parkes patented the first polymer blend natural rubber with gutta-percha partially co-dissolved in CS_2. Blending these two isomers resulted in partially cross linked materials whose rigidity is controlled by composition [2].

1.3.1. What is Polymer Blends?

Blending indicates "an action to combine ingredients into one mass, so that the constituent parts are indistinguishable". While in plastic processing, it means the physical act of homogenization [3]. Polymer blends are physical mixtures of two or more polymers with/without any chemical bonding between them. The objective of polymer blending is to achieving feasible products with unique properties and lower cost. Blending technology also provides attractive opportunities for reuse and recycling of polymer wastes.

When two or more polymers are mixed, the phase structure of the resulting material can be either miscible or immiscible. Due to their high molar mass, the entropy of mixing of polymers is relatively low and consequently specific interactions are needed to obtain blends, which are miscible or homogeneous on a molecular scale [4]. Polymer blends exhibit properties that are superior to any one of the component. Miscibility of the constituent polymers decides the structure of the blend which in turn, decides the properties of the blend [5-7]. If there is weak interaction between constituent polymer, miscibility of polymers is weak [8]. Blending offers a unique tool for overcoming the deficiencies of the polymer without much loss in the mechanical properties [9, 10]. Knowledge of the miscibility and phase behavior of polymer blends is essential for controlling the properties of polymer blends.

1.3.2. Different kind of Polymer Blends

There are many types of polymer blends, it include from simple binary mixtures of polymer, interpenetrating networks, compatible blends, impact modified polymers, emulsion polymers, engineering polymer blends, thermosets blends, elastomeric blends, liquid crystalline polymer blends, water soluble polymer blends, natural product polymer blends and so on. But polymer blends can be broadly divided in to three categories:

- Immiscible polymer blends

  It is also known as heterogeneous polymer blends. If the blend is made of two polymers then the blend structure is not a single phase structure and two glass transition temperatures will be observed.

- Compatible polymer blends

  These blends are also immiscible polymer blends but they exhibits macroscopically uniform physical properties, which is caused by strong interaction between the component polymers.

- Miscible polymer blends

  They are also known as homogeneous polymer blends. Polymer blends that exhibit a single phase structure. In this case only one glass transition temperature is observed.

1.3.3. Properties of Polymer Blends

Polymer blends have been designed, rather than by availability. These polymeric materials must perform under strenuous mechanical, chemical, thermal and electrical conditions imposed by the requirements of a specific application. They are also accepted to stay performed at complex atmospheric conditions. All these factors point toward the need for studies of the properties and performance of polymer blends. For assessing the performance of a polymer blend, mainly study the given properties like mechanical, chemical and solvent effects, thermal, flame retardancy, electrical and optical properties. Polymer blend have very excellent properties like better processing, blow molding, mechanical (creep, impact, stiffness, strength), heat resistance, optical and electrical properties and also have lower cost.

1.3.4. Methods for Blending

The properties of a polymer blends are dependent upon the method of preparation. There are a number of methods which have been employed to prepare polymer blends. Some important and most commonly used techniques are as follow.

- **Mechanical-melt mixing**

  This is the most important and cheap method to prepare polymer blend in industry. The simplest process for the making of polymer blends from thermoplastic is mixing the polymers in the melt condition in suitable devices like rollers, extruders; kneeling machine etc. under suitable reaction conditions, chemical reaction like chain scissions, cross linking can take place in polymer melt. Grafting reaction can also be achieved by adding suitable monomers to polymer melts in extruders [11].

- **Solution cast techniques**

  Solution cast techniques is an important technique utilized to fabricate thin layered films. The solution cast process consists of the solution of the film ingredients in a suitable common solvent which further take place to dry where the solvent is evaporated. When solvent is evaporated, the resultant film is removed from substrate. Advantages of solution casting method as compared to melt process are higher quality with uniform thickness of films, highly pure and clear films with lack of residuals and free from pinholes and it is also possible to produce pattern films.

- **Latex blending**

  Latex is a colloidal dispersion of a polymer substance in an aqueous medium. Latex blends are prepared by mixing two polymers where each polymer is present in the form of polymeric microspheres dispersed in a fluid medium [12}. Blends prepared with this method would be expected to have very high interfacial area. The early emulsion polymerization of rubbers and thermoplastic acryclates provided raw ingredients for latex blending. Latex blends were used either directly as paints, adhesive and sealants or they were pelletized or spray dried.

- **Spray or freeze drying**

  In spray drying, transformation of fluid of blend materials into a dried particulate form by spraying fluid into a hot drying medium [13]. This is an ideal process, when the end products have precise quality, residual moisture content, bulk density and particle size. On other hand, a technique in which first polymers are heated above glass transition to form good solution then allow polymer solution to freeze certainly lower temperature to achieve solid polymer from solution [14].

- **Fine powder mixing**

  In this technique, mixtures of polymer powders have been made to allow for diffusion mixing at higher temperature. Mostly temperatures apply here above glass transition temperature of constituent polymers.

- **In-situ polymerization**

  The polymerization of one polymer is conducted in the presence of other polymer. Interpenetrating Polymer Networks are prepared by polymerization of different polymer networks. Polymer electrolytes are prepared by this technique.

1.3.5. Application of Polymer Blends

Since industrialization and commercialization, polymer blends tends to direct replacement of the different materials, mostly metal. This is because they can be easily formed in complex shape, corrosion resistant as well as lighter in weight than metals. Blend families tend to be appropriate for certain types of applications which require the special attributes of the major blend component.

Polymer blends are generally used in below mentioned applications: Automotive applications, Electrical and Electronics Applications, Medical Applications, Building and Construction, Business Machines and Communications, Packaging, Power Tools, different Appliances, Furniture, Recycling materials and so on.

1.4. Polymer Composites

One of the aims of material research is to developed new materials with desirable physical properties for particular application and also to understand the mechanisms which controlling these properties. Polymer composites can be developed by mixing of two or more basic constituents which containing two or more phases. The basic difference between blends and composites is that the two main constituents in the composites remain recognizable while these may not be recognizable in blends [15].

1.4.1. What is Polymer Composites?

Any of the combinations or compositions that comprise two or more materials as separate phases, at least one of which is a polymer, By combining a polymer with another material, such as glass, carbon, or another polymer, it is often possible to obtain unique combinations or levels of properties [16]. The goal of polymer composites is to improve strength, stiffness, or toughness, or dimensional stability by embedding particles or fibers in a polymer matrix or binding phase with low cost.

1.4.2. Different kind of Polymer composites

On the basis of matrix phase, composites can be classified into metal matrix composites (MMCs), ceramic matrix composites (CMCs), and polymer matrix composites (PMCs) [17]. On the basis of the dopant, polymer composites are also further classified. Types of reinforcement are particulate composites (composed of particles), fibrous composites (composed of fibers), and laminate composites (composed of laminates). Particulate composites are also classified according to the dopant particles like organic or inorganic particle, metal or non metallic particle.

1.4.3. Properties of Polymer Composites

Properties of different polymers will determine the application to which it is appropriate. The chief advantages of polymers as matrix are low cost, easy processability, good chemical resistance, and low specific gravity. Different kind of polymers such as thermoplastic polymers, thermosetting polymers, elastomers, and their blends are used for making of polymer composites. Polymer Composites are very popular due to their low cost and simple fabrication methods. It's main advantage of properties are shown below [18]:

a) High specific strength
b) High specific stiffness
c) High fracture resistance
d) Good abrasion resistance
e) Good impact resistance
f) Good corrosion resistance
g) Good fatigue resistance
h) Low cost

The main disadvantages of Polymer Composites are:

a) Low thermal resistance and

b) High coefficient of thermal expansion.

1.4.4. Methods to make Polymer Composites

The important processing methods of polymer composites are hand lay-up, bag molding process, filament winding, pultrusion, bulk molding, sheet molding, resin transfer molding, injection molding, and so on.

1.4.5. Application of Polymer Composites

Generally plastics, fibers, rubber, adhesives, paints and coatings etc. are based on polymers. One polymer can also be used for more than one application. Polymer composite materials overcome many of the shortcomings of homogeneous materials. They are currently being used in various medical field and many additional applications have been proposed. Polymer composites have also been used as sensor materials for different types of sensing applications [19]. Composites and plastics are used in a wide variety of products from advanced spacecraft to sporting goods [20]. Metal doped polymer provides suitable properties for EMI shielding [21]. In electrical field polymer composites are used in Panels, housing fittings, switchgear, insulators, and connectors. In chemical field they are widely used in Chemical storage tanks, pressure vessels, piping, pump body, valves, etc.

1.5. Selection of Polymer blends

In this section we discuss about the selection of polymers and its blends. And literature survey regarding these polymers and its blends are also described.

1.5.1. Polyvinyl chloride (PVC) and Poly methyl methacrylate (PMMA) blend

Poly (vinyl chloride) (PVC) is one of the most important and widely used thermoplastics due to its many important properties like good processability, chemical resistance, low flammability and low cost [22]. Its principal drawback, however, is low thermal stability at processing temperatures. This deficiency is overcome by adding plasticizers or processing aids in PVC. Especially poly(methyl methacrylate) (PMMA), are used as processing aids for PVC [23]. The aim for modifying PVC by blending is to manufacture new PVC polymers that combine desired physical properties at low cost. Enhancement in ionic conductivity and mechanical strength has been reported in polymer electrolytes by modifying them in the form of blends [24].

First PVC/PMMA blends were studied by Schurer et. al. [25] PVC/ PMMA blends has been studied by different approaches by different workers, it was well described by Chao Zhoul et.al. [26] Schurer [27] reported that PVC/ PMMA are miscible only in blends having PVC contents greater than 60%. Rupa Chakrabarti et. al. studied physical and mechanical properties of PVC/PMMA blend and suggested that a substantial increase in toughness accompanied with unusual increase in modulus and ultimate tensile strength occurred after initial stages of PMMA incorporation compared to pure PVC [28]. Wlochowicz and Janicki concluded that PVC / PMMA blends at all compositions are wholly amorphous two-phase system [29]. Varada investigated the miscibility of PVC with PMMA by ultrasonic and refractive index method [30]. They pointed that PVC and PMMA are miscible in all compositions. Shen and Torkelson observed that PVC/ PMMA blends are miscible at all compositions, if they are prepared between T_g and their lower critical solution temperature [31]. This discrepancy in the miscibility may be due to the different methods used for sample preparation and polymers used are having different molecular weights. S. Ramesh et.al. studied PVC/PMMA blend based polymer electrolytes and reported about interaction of PVC/PMMA blend with lithium triflate salt, ethylene carbonate (EC), dibutyl phthalate (DBP) plasticizers and also with silica [32]. The PVC/PMMA blend is a well-known system in which hydrogen bonds involving the α hydrogen and the carbonyl group of PMMA are expected. It has been reported' that this type of interaction is competing along with dipole dipole interactions between the H - C - Cl and C = 0 groups to ensure miscibility [33]. The present study involves the blending of PVC with amorphous and a rigid polymer, poly (methyl methacrylate) (PMMA) having a very high glass transition temperature (T_g). PMMA might be expected to counter balance the fall in mechanical properties of PVC is attributed to the disruption in molecular packing of stiff and rigid chains of PVC [34].

1.5.2. Poly acrylamide (PAM) and Poly vinyl alcohol (PVA) blend

PAM is well-known hydrophilic polymer and has been greatly used in the field of agriculture and biomedicine [35, 36]. The electrical and mechanical properties of the ethylene propylene diene monomer (EPDM) and nitrile rubber (NBR) blended with polyacrylamide (PAM) were studied [37]. PAM is a polymer of biomedical and pharmaceutical interest widely studied as hydrogel for blood compatible applications [38]. Polymers of acrylamide are well known for their hydrophilicity and inertness that make them a material of choice in large number of applications in medical and pharmacy [39].

Many researchers have studied the use of PAM hydrogels for controlled release of fertilizers, pesticides or possibly in medicine [40]. Also, it was used for the decontamination of waste water containing radioactivity [41]. Polyacrylamide-based polymers have received a great extent of utility in industry because of their high molecular weight, water soluble property, and ability to receive diverse modification on chemical structure [42, 43]. When PAM dissolved in solvents, the linear structure formed in solution by these macromolecules reduces the drag coefficient, thereby, facilitating the transport of viscous liquids over long distances [44, 45]. When cross-linked, the polymer is insoluble in water and forms a hydrogel system that is capable of absorbing and retaining large quantities of water. The linear form and solubility properties also offer unique applications such as stabilizing soil matrices, reducing erosion, and improving soil aeration [46, 47].

Poly vinyl alcohol (PVA) films are known to posses high tensile and impact strengths, a high tensile modulus, and excellent resistance to alkali, oil, and solvents [48]. PVA has gained increasing attention in the biomedical field because of its bio inertness [49, 50]. Vargas et al. investigated poly Vinyl Alcohol (PVA) for the phase behavior [51]. Fritz and Breitsmer developed ionically conducting polyelectrolytes based on PVA due to its bio-compatibility and wide spread use in biomedical fields [52]. Because of its superior mechanical properties and better ionic conduction, it has some technological advantages in electrochromic devices and fuel cells, etc [53]. Hydrophilicity of PVA is an advantage for its applications, and also a limiting factor in its characterization because its molecules are prone to aggregate through hydrogen bonding due to its poly hydroxyl groups [54].

Blends of polyvinyl alcohol (PVA) with other polymers have been mechanically characterized by many researchers [55]. PVA and PAM are two well-known polymers and their individual biomedical, mechanical and other properties have been thoroughly investigated [56-58]. PVA is a water soluble, non-toxic, non-immunogenic polymer with a remarkable film forming property [59, 60]. However, its weak mechanical strength restricts its use in those applications where the material has to withstand prolonged stress. Thus, the introduction of other polymeric components into the PVA matrix could improve its mechanical properties [61]. PVA is widely used as a basic material for a variety of biomedical applications [62-64].

The chemical resistance and physical properties of PVA have led to its broad industrial use. Chemically cross linked PVA hydrogels have received increasing attention in biomedical and biochemical applications because of their permeability, biocompatibility and biodegradability

[65-68]. Horia M Nizam El-din et. al. undertaken to investigate the miscibility of PVA with PAM in various proportions [69].

The selection and use of polymers can potentially form hydrogen bonds when two polymers mixed, as well as the study of blends properties, are of importance to find further applications of the resulting blend materials for biomedical and pharmaceutical devices [70].

1.5.3. Poly acrylamide (PAM) and Poly ethylene oxide (PEO) blend

Polyacrylamide (PAM) is highly water-absorbent, forming a soft gel when hydrated. It is used in manufacturing of soft contact lenses, in potable water treatment industry etc [71]. Polyethylene oxide (PEO) is becoming increasingly important in a variety of fields as the most suitable material for optical and electrical applications, because of its advantages such as water solubility, low glass transition temperature, large dipole moment, low cost and easy processability [72, 74]. PAM and PEO may be utilized in many applications established industrially due to their useful physical properties.

1.5.4. Poly methyl methacrylate (PMMA) and Titanium Dioxide (TiO_2)

In recent years, studies on optical and electrical characteristics of polymers have fascinated much consideration in their application in optical and electronic devices [75, 76]. The optical properties of the polymers can be correctly customized by the addition of dopant depending on their reactivity with host matrix. Optical parameters (e.g. refractive index, optical band gap, etc.) of poly methyl methacrylate (PMMA) depend on its molecular structure and they can be modified. Titanium dioxide or titania (TiO_2) is a harmless white material widely used in photo electrochemical solar energy conversion and environmental photo catalysis (treatment of polluted water and air) including self cleaning and anti fogging surfaces [77, 78]. It is also commonly used as a high refractive index material in optical filter applications and sensors [79, 80]. Nanostructured TiO_2 is used in solar cell research and displays [81]. TiO_2 thin films are valued for their good durability, high dielectric constant, high refractive index, excellent transparency in the visible range and biocompatibility. In polymer light emitting diode devices, mixing TiO_2 nanoparticles into poly[2- methoxy-5-(20-ethyl-hexyloxy)- para-phenlenevinylene] MEH-PPV results in increased current densities, radiances and power efficiencies [82, 83].

1.6. Spectroscopy in Polymer Science

Spectroscopy is defined as science of interaction between electromagnetic radiation and matter. Polymer spectroscopy deals with the application of a wide range of spectroscopic methods to study polymers which have higher molar mass and formed by linking of monomers. The basic information obtained by spectroscopy is always consisting of energy difference, additionally consisting band shapes, intensities and in some cases polarization of signals. Polymer spectroscopy provides two types of information, related to the structure and dynamics of polymers (**Table 1.1**). Information on chemical structure is the main aim of analytical application of polymer spectroscopy as it gives information at molecular level which is very helpful to study other properties of polymers. Polymer spectroscopy and non spectroscopic methods are combining to produce well and pure characterized polymer samples.

Table 1.1 Information obtained by spectroscopy relating to structure and dynamics of polymeric systems.

Structure	**Dynamics**
Chemical structure and Tacticity	Movements of polymer chain, segments and side groups
Conformation	Phonons
Crystallinity	Excitons
Electronic Structure	Complex formation and related phenomena

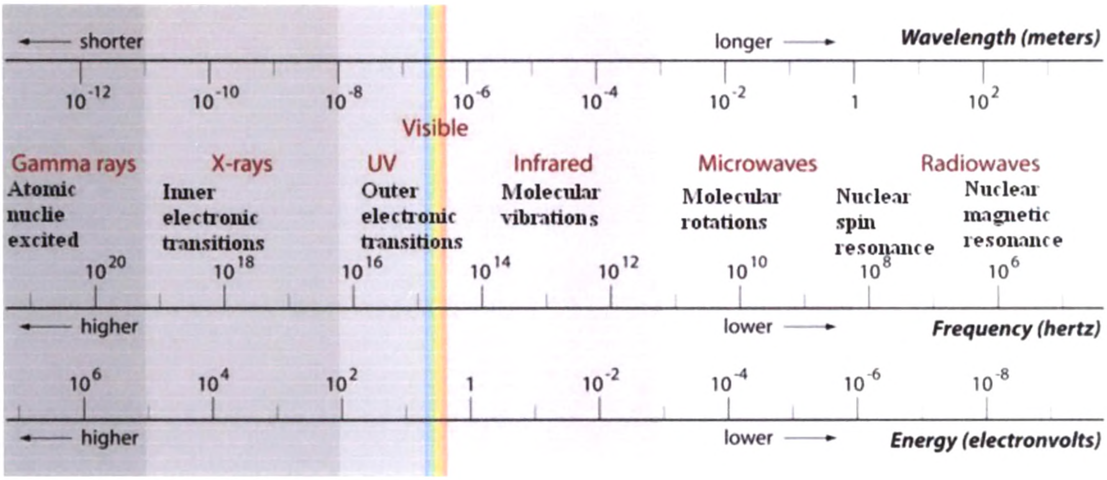

Figure 1.1 Spectral Range of Spectroscopic methods used in spectroscopy.

Information on chemical structure is the main aim of analytical application of polymer spectroscopy. Spectroscopy gives precise information at the molecular level. Polymer spectroscopy involves the investigation of monomers or oligomers and also their interaction with surrounding molecules. In order to get maximum useful information, polymer spectroscopy should be combined with non-spectroscopic methods to study different polymer properties. Spectral range of spectroscopic methods used in polymer spectroscopy is shown in the above **Figure 1.1.** Whole range can be divided into three parts conveniently [84]:

1. Electronic spectroscopy (ESCA and UV-Vis)
2. Vibrational spectroscopy (IR and Raman)
3. Spin resonance spectroscopy (ESR and NMR)

1.7. Objective of the work

To study the mechanical, optical, structural and thermal properties and surface morphology of pure, blends and composites polymer films using spectroscopic techniques. Also to study the effects of different concentrations on the properties of blends and composites polymer films using spectroscopic techniques such as FTIR , Raman, UV- Vis, TGA, and DSC. These studies enable us to understand the issues related to the processing and structure-property relationship for pure polymer and polymer blends/composites.

The motivation for this work is that nobody was tried to correlate mechanical properties, thermal properties and optical properties studied by conventional methods with spectroscopic investigation using FTIR, Raman and UV-Vis spectral studies. But spectroscopic study may be able to provide quick, more reliable and in depth details than the other techniques. Hence decided to study the influence of different concentrations of polymer blend and composite on different properties of pure, blend and composite polymer films with conventional methods and correlate their result with spectroscopic results.

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