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Review Article

Advance in Environmental Waste Management & Recycling

Nanopolymers Types, Classification, Properties, and Uses

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Abstract
Nanopolymers have come to play an essential and holistic role in everyday life due to their unique properties, They are essential materials in everyday industrial sectors, such as adhesives, building materials, paper, apparel, fibers, plastics, ceramics, concrete, liquid crystals, photoresists, and coatings. Nanopolymers are also present in most soil components, plants, and living organisms. They are important in nutrition, mechanical engineering, the structure of organisms, medicine, computers, space exploration, health, and the environment. The word plastic or elastomers is used incorrectly to refer to Nanopolymers, while Nanopolymers include a huge variety of synthetic and natural materials with varying properties. Natural inorganic Nanopolymers include diamond, graphite, sand, asbestos, garnet, flint, feldspar (aluminosilicate), mica, quartz, and talc. Natural organic Nanopolymers include polysaccharides such as starch, cellulose, amino acids, and proteins. Inorganic synthetic Nanopolymers include boron nitride, concretes, many high-temperature superconductors, and many glassware. Siloxanes or polysiloxanes are organometallic synthetic Nanopolymers.

Keywords: Nanopolymers, Polymer Synthesis, Physical Properties, Spatial Uniformity, Spatial Uniformity, Polymer Composition, Intermolecular Forces, Properties of Nanopolymers, Nanopolymers and Environmental Pollution

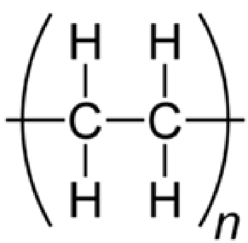
1. Introduction

A polymer (or polymer) Is a high molecular weight compound composed of repeating subunits, these materials may be organic, inorganic, or mineral-organic, and may be natural or synthetic in origin. [1, 2]. Nanopolymers have come to play an essential and holistic role in everyday life due to their unique properties. [3, 4]. They are essential materials in everyday industrial sectors, such as adhesives, building materials, paper, apparel, fibers, plastics, ceramics, concrete, liquid crystals, photoresists, and coatings. Nanopolymers are also present in most soil components, plants, and living organisms. They are important in nutrition, mechanical engineering, the structure of organisms, medicine, computers, space exploration, health, and the environment [5]. The word plastic or elastomers is used incorrectly to refer to Nanopolymers, while Nanopolymers include a huge variety of synthetic and natural materials with varying properties. Natural inorganic Nanopolymers include diamond, graphite, sand, asbestos, garnet, flint, feldspar (aluminosilicate), mica, quartz, and talc. Natural organic Nanopolymers include polysaccharides such as starch, cellulose, amino acids, and proteins. Inorganic synthetic Nanopolymers include boron nitride, concretes, many high-temperature superconductors, and many glassware. Siloxanes or polysiloxanes are organometallic synthetic Nanopolymers [6]. Synthetic Nanopolymers save energy when compared to metals. Its light weight reduces fuel consumption in vehicles and aircraft. It is superior to most metals in relation to its strength-to-weight ratio. Nanopolymers have been developed and have good properties and have become economical in manufacturing. It can also be used for engineering purposes, so we use gears, rollers, and structures made of Nanopolymers [7]. Label and the science of Nanopolymers originated and developed in an industrial environment, so it is natural for each polymer to have a common name, and a name based on its structure determined by the International Union of Pure and Applied Chemistry. Most Nanopolymers are identified by their initials. For example, polystyrene has the symbol PS from its name (polystyrene). Many companies use brand names to identify their polymer products. For example, Furrell-polyester is polyethylene terephthalate or PET fiber. The polymer may have a generic name such as rayon, polyester, and nylon [8].

2. Polymer Synthesis

Nanopolymers consist of structures consisting of identical repeating building blocks. These units, in turn, are made up of smaller molecules called monomers or monomers (plural of monomers) [9]. The monomers react with each other to form a polymer. The profile shows a propylene monomer and the repeating unit that makes up a polypropylene [10]. With the exception of the terminal group in the polypropylene chain, it consists entirely of this repeating unit [11]. The number of such units (n) in the polymer chain is called the degree of polymerization or DP [12]. Other Nanopolymers, such as proteins, can be described by writing the approximate repeating unit as in the following figure [13].

Where the nature of R is variable (replaced by an atom or group of atoms) [14]. The changes that occur in the monomers affect the properties of the polymer such as elasticity, solubility, or tensile strength of the polymer [15]. These changes in the proteins can enable the polymer to have the appropriate structure, rather than a random coil [16]. Although most Nanopolymers are organic (that is, they are composed of a carbon chain), there are also inorganic Nanopolymers, and their chains are often based on a silicon origin [17]. The term polymer covers a wide range of molecules, including materials such as proteins and filaments that have high tensile strength such as Kevlar filaments [18]. The basis for differentiating Nanopolymers from other macromolecules is the presence of repeating units (monomers) in the polymer chains [19]. This occurs in the process of polymerization, in which the monomers are linked together to form a long polymer chain [20]. For example, the process of forming polyethylene or polyethene involves entangling thousands of units of molecules of the two together to form a chain with the repeating unit -CH2, Nanopolymers are often named after the constituent monomers of the polymer [21]. For example, polyethylene is represented as follows:



And because the distinction between Nanopolymers is often based on their constituent monomers, the polymer chains in any material do not have the same length [22]. This is unlike other molecules that consist of a certain number of atoms, and each molecule has a specific molecular weight [23]. The lengths of the polymer chains vary because the chains end in a random manner during the evolution of the polymerization process [24]. Proteins are nothing but amino acids in the form of a polymer [25]. From about a dozen to several hundred monomers that make up the chain, the sequence in which a protein is formed determines its properties and activity [26]. However, in these proteins there are so-called active regions, which are surrounded by what are believed to be structural regions, whose primary role is to display this active region(s) [27]. Therefore, the original sequence of the amino acid is of little importance, as long as these active regions can be accessed efficiently [28]. Since the formation of polyethylene occurs randomly, those who manufacture vital proteins and nucleic acids must have a catalyst (a substance that facilitates or speeds up a reaction) [29]. Since the 1950s, catalysts have played a major role in the manufacture of Nanopolymers [30]. With more control over the polymerization reactions, they made Nanopolymers with unique properties, such as the ability to emit colored light [31]. In order to obtain good properties of the polymer, several factors must be controlled [32]. This is because the polymer is actually made up of distributions of chains of different lengths, and each chain is made up of monomers that affect the properties of the polymer, some of these factors are described below [32].

3. The Physical Properties of Nanopolymers

The physical properties of Nanopolymers include the degree of polymerization and molar mass distribution [33]. Fork Branching can occur during the process of evolution of polymer chains [34]. In the polymerization of radicals, this occurs when a chain winds back and bonds to an earlier part of it [35]. When this coil is broken, small fragments are left as buds in the main carbon chain [36]. Branched chains cannot line up as closely together as unbranched chains [37]. This leads to less contact between the atoms in the different chains, and this reduces the chances of permanent dipoles occurring or induction can occur [38]. There are also parts of the chains with a low density [39]. Evidence for this is the low melting points and weak tensile strength of the resulting polymer, because the intermolecular forces are weak and can be easily broken [40].

4. Spatial Uniformity

Stereo regularity or regularity describes the "isomeric" arrangement of functional groups on the carbon chain [41]. Chains that have an isotactic form are known to have the active groups present on one side of the chain [42]. This enables them to line up close together and form crystalline regions, resulting in a polymer with high hardness [43]. Conversely, the chains that have an atactic form, the groups in which are randomly distributed on the sides of the chain [44]. As a result, the chains are not linked together in a good way, and the intermolecular forces become weak [45]. This results in a lower density and poor tensile strength, but a high degree of flexibility [46]. Clusters can also be distributed in a "syndiotactic" manner, in which the clusters are distributed in an inverse but uniform manner [47]. Since this is a type of regularity, the syndiotactic chains can organize themselves close to each other but of course not to the degree that they do in the isotactic chains [48]. Syndiotactic Nanopolymers have higher compressive strength and more than isotactic Nanopolymers because they have higher elasticity due to weaker intermolecular forces [49].

5. Polymer Composition

Copolymerization , contribution is multiplied Copolymerization is a polymerization with two or more types of monomers [50]. An example of this is the monomers of the amino acids mentioned above, which make up proteins [51]. Copolymerization of different monomers results in Nanopolymers with different properties [52]. For example, two-to-low-density copolymerization of hex-1-ene is a method for producing Linear Low Density Polyethylene LLDPE (read Polyethylene) [53]. C4 branchings produced from hexene reduce density and prevent the formation of crystalline regions in the polymer as happens In High Density Polyethylene (HDPE), this means that LLDPE can withstand tensile forces while remaining flexible [54]. The next figure shows a specific type of copolymerization called capacitive polymerization [55]. In this particular type a small molecule is released during polymerization [56]. In the following reaction form a water molecule is released and nylon is formed [57]. And the type of nylon (its name and properties) can be controlled by the two groups R, R' used. Radical polymerization cationic polymerization Anionic polymerization condensation polymerization [58]. Chemical properties of Nanopolymers intermolecular forces [59].

6. Intermolecular Forces

The attractive forces between polymer chains play a major role in determining polymer properties [60]. Because the polymer chains are so long, the attractive forces between the molecules are greater than the normal intermolecular forces [61]. Long chains are also amorphous (the way they are oriented is random) [62]. The shape of the Nanopolymers can be visualized as if they are long, many, tangled strands, and the greater the tangle, the more difficult it is to separate one of its strands [63]. These intermolecular forces lead to high tensile forces and raise melting temperatures [64]. Intermolecular forces are determined by the dipoles between the monomers [65]. Nanopolymers containing amide groups can form hydrogen bonds with neighboring chains [66]. The positive hydrogen atoms in the N-H groups of one chain are strongly attracted to the oxygen atoms of the C=O groups of the other chain [67]. These hydrogen bonds lead to, for example, an increase in the tensile strength and melting point of Kevlar. Polyesters have dipole-dipole bonding between oxygen atoms in C=O groups and hydrogen atoms in H-C groups [68]. Dipole bonding is not as strong as hydrogen bonding, so the melting temperature and tensile strength of polyethylene are lower than Kevlar, but polyesters have higher elasticity [69]. Polyethylene generally does not have a permanent bi-polarity [70]. The attractive forces between polyethylene chains result from weak van der Waals forces [71]. As if the molecules were surrounded by a cloud of negative electrons [72]. When two polymer chains approach each other, the electron cloud in each pushes against the other [73]. This reduces the electron density on one side of the polymer chain, resulting in a small positive charge on that side [74]. This charge is sufficient to attract the other polymer chain [75]. Van der Waals forces are very weak, therefore, polyethylene melts at lower temperatures [76].

7. Properties of Nanopolymers

Several laboratory techniques are used to determine the properties of a polymer, such as large-angle X-ray scattering, small-angle X-ray scattering, and small-angle neutron scattering, which are used to determine the crystal structure of a polymer [77]. A gel-transmission chromatography technique is used to determine the average molecular weight number, and the average molecular weight and multiple-dispersion infrared spectroscopy using Fourier transform is used to determine the composition [78]. Thermal properties such as the glass transition temperature can be determined using differential scanning calorimetry, and mechanical and motion analysis [79]. Pyrolysis followed by analysis of small components is another technique for determining the potential composition of a polymer [80]. The polymer known as the polymer material is used in making banknotes in Australia and New Zealand and is used in commemorative banknotes in some countries [81].

8. Idea about Nanopolymers

Plastics started from nature, such as gum arabic and natural rubber [82]. And in the 19th century, scientists began trying to imitate nature [83]. In the twentieth century, when the need for rubber increased in World War II, German scientists were able to produce synthetic rubber [84]. It gives the same specifications as natural rubber and almost the same chemical composition [85]. Nanopolymers are chemical compounds that are characterized by chain length, but the chain length that causes the large molecular weight of the compound results from the repetition of similar units in the same order along the chain [86]. Hence the compound is called a polymer [87]. The basic unit of a polymer may be composed of one or more substances [88]. The repeating unit of a polymer is called a monomer i.e. a lone unit [89]. For example, material A can react with itself under certain conditions and give the polymer A + A = A-A [90]. Among these examples is polyethylene used in the manufacture of plastic bags and so on, resulting from the interaction of ethylene with itself under conditions of high pressure and high temperature in the presence of a catalyst for the reaction, which is often from Metals The reaction is as follows: n $CH_2=CH_2 \rightarrow (CH_2\text{-}CH_2)_n$ [91]. The molecular weight of ethylene is 28, but with the interaction of thousands of molecules together, a compound whose molecular weight may reach millions is produced [92].

9. Nanopolymers and Environmental Pollution

Nanopolymers have become materials of great importance to modern life due to the diversity of purposes in which they are used and their suitability for these purposes, and the accompanying manufacturing possibilities for disposal in construction so that the output matches a specific function [93]. However, these materials are foreign to the natural environment, and therefore they are not subject to biodegradation, and if they are transferred to the environment, they remain in it, a form of pollution whose effects are exacerbating day after day [94]. Nanopolymers contribute to the distortion of nature as a result of the accumulation of waste, and may be a hotbed for the growth of insects and rodents [95]. Its waste has spread in the seas and oceans, and the movement of water has transported it to remote areas, and it has become a threat to fish [96]. The problem of disposal of these materials remains, as burning them leads to air pollution, in addition to the fact that this process is not complete and its effectiveness is not complete, for example, rubber tires burn, giving off thick smoke and bad smells. As for polyvinyl chloride, harmful hydrogen chloride gas is released from it [97].

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