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BEHAVIOUR OF POLYMERS: A VIEWPOINT

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Abstract

Depending on their chemical makeup and processing techniques, polymers, both natural and synthetic, can have differing levels of tensile strength, flexibility, and elasticity. The behaviour of a material when it is subjected to external forces or loads is characterised by the substance's mechanical characteristics. In the fields of engineering and materials science, these qualities are crucial for the design and analysis of various structures and components. When a material is subjected to an external force or load, this causes the substance to experience stress, which can be defined as the internal resistance of the material to deformation. In most cases, it is expressed as a measurement in terms of units of force per unit area, such as Pascals or Megapascals. There are numerous kinds of stress, the most common of which are tensile stress (also known as stretching), compressive stress (often known as compression), and shear stress (also known as sliding). The degree to which a material is deformed as a result of being subjected to stress is referred to as the material's strain. It is typically stated as a ratio of the change in length (deformation) to the material's initial length, and it does not have a dimension of its own. Tensile strain involves stretching, compressive strain involves pressing, and shear strain involves twisting. The ability of a material to return to its original shape and size after the removal of a force or load that was applied is referred to as the material's elasticity. Materials that have a high elasticity can withstand deformation without suffering any kind of irreversible harm, but materials that have a low elasticity may distort in a way that cannot be undone.

Keywords: Polymer, Science, Behaviour.

Introduction

Polymers are incredibly adaptable materials because they may be moulded, extruded, spun, or treated in a variety of ways to produce a broad range of products. The processing and manufacture of polymers involves a variety of procedures that are used to transform raw polymer materials into finished products that have the desired forms, characteristics, and functionalities.

The particular procedures that are utilised are determined by the type of polymer, the application that is planned, and the properties that are needed in the finished product. The manufacture and processing of polymers involve several fundamental aspects, which are as follows:

Polymerization: The process of chemically linking monomers together to generate long-chain polymers is referred to as polymerization. Polymerization is typically the first step in the production of polymers. This can be accomplished using a variety of processes, such as addition polymerization (used, for example, to make polyethylene) and condensation polymerization (used, for example, to make polyester).

Extrusion is a popular procedure that is used to shape polymers into continuous forms such as sheets, films, pipelines, and profiles. Extrusion is sometimes known as "extrusion." Extrusion is a manufacturing process in which polymer pellets or granules are melted and then pressed through a die in order to produce the desired shape. Equipment for cooling and shaping is employed to achieve precise control over the final dimensions.

Injection Moulding: Injection moulding is a process that is commonly used for the production of intricate and precise three-dimensional parts, such as those used in the manufacturing of consumer goods, medical devices, and automotive components. When molten polymer is poured into the cavity of a mould, the polymer immediately begins to cool and solidify, taking on the shape of the mould as it does so.

Blow Moulding: Blow moulding is a technique that

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is used to manufacture hollow things like bottles, containers, and components for automobiles. In order to give the material the desired shape, this technique entails inflating a heated polymer parison, which is a hollow tube, inside of a mould cavity.

Compression Moulding: Compression moulding is a technique that can be used to manufacture products that have complex geometries and varied thicknesses. Some examples of these products include rubber gaskets, tyres, and electrical components. The polymer material is put into a mould that has been heated, and the mould is then closed so that heat and pressure may be applied to cure it.

Rotational Moulding: The process of rotational moulding is utilised in the production of big hollow products such as playground equipment, canoes, and tanks. After the polymer powder has been poured into the mould, it is placed in the oven and rotated. Because of the heat, the polymer will coat the inside of the mould evenly, which will result in a product that is seamless.

The production of thin sheets and films of polymers that have a smooth surface finish can be accomplished using a technique known as calendering. Adjusting the thickness and smoothness of the polymer melt requires the process of passing the melt or sheet of polymer between a sequence of heated rollers.

Thermoforming is a process that takes flat sheets of thermoplastic polymers and moulds them into three-dimensional items, such as packing trays, disposable containers, and components for the inside of automobiles. When the sheet is heated, either a vacuum or pressure is used to push it into a mould.

Casting and Casting Polymer Composites: Casting is the process of creating solid objects or components by pouring liquid polymer resins into moulds to form the desired shape. Casting is another method that can be utilised in the production of polymer composites. This method involves embedding fibres or particles into the polymer matrix.

Additive Manufacturing: Additive manufacturing, sometimes referred to as 3D printing, is quickly becoming one of the most popular methods for the production of polymer parts and prototypes. It includes constructing items out of polymer filaments or resins in a layer-by-layer fashion, resulting in more design freedom and decreased material waste.

Post-Processing: Following the original production stage, polymers may be subjected to post-processing activities such as machining, surface treatment, painting, or assembly in order to fulfil particular requirements and improve their aesthetics.

Control of Quality: Quality control procedures are conducted at every stage of the production process to guarantee that the finished goods satisfy the required specifications for dimensions, characteristics, and performance. These standards might be very specific.

The choice of processing method is determined by a number of criteria, including the type of material being processed, production volume, economic concerns, and the desired qualities of the final product. Additionally, developments in polymer processing methods continue to stimulate innovation in a variety of industries, which in turn leads to the creation of novel materials and applications. [2, 3]

Comprehending the characteristics and actions of both natural and artificial polymers is essential for customising their uses, creating novel materials, and tackling issues related to sustainability and the environment. Scientists are still looking for novel approaches to enhance the characteristics of polymers and create environmentally acceptable substitutes for synthetic polymers.

Review of Literature

Arrakhiz (2013) [1] However, in order to use these materials, compatibility difficulties between the fibers & the polymeric matrix had to be resolved, which was a challenge for many businesses and researchers in the field. In this study, the mechanical and thermal characteristics of Doum-fibers that are used to reinforce a low density polyethylene (LDPE) composite are investigated in order to investigate the effect of incorporating fibers into polymer matrices. Alkali was used to treat doum-fibers in order to clean the fiber surface and increase the adherence of the polymer to the fibers. After being extruded as continuous strands, the Doum-fibers were first compounded in LDPE matrix at varying contents before being extruded. There was shown to be an improvement in the mechanical properties of composites. This improvement included a gain of 145% in Young's modulus when compared to neat polymer at 30 wt.% fiber loading, a gain of 135% in flexural modulus when compared to neat polymer at 20 wt.% fiber loading, and a gain of 97% in torsional modulus when compared to 0.1 Hz. The thermal characteristics were analyzed, and the results showed that there was a marginal decline as the amount of Doum that was added increased.

Vaish (2020); natural fibers are attracting the attention of academics and academicians as a potential material for use in polymer composites due to the ecofriendliness and long-term viability of natural fibers. The purpose of this article is to provide a complete assessment of the natural fiber reinforced polymer composites (NFPCs) and the applications for which they are most commonly employed. The most appropriate natural fiber reinforced polymer composites are also the most regularly utilized ones. In addition to this, it provides an overview of the numerous surface treatments that may be applied to natural fibers and how these treatments affect the qualities of NFPCs. The qualities of NFPCs change depending on the type of fiber, the source of the fiber, and the structure of the fiber. The impact of a variety of chemical treatments on the mechanical and thermal properties of natural fiber reinforcements in thermosetting and thermoplastic composites were investigated. The composites were examined for their mechanical strength and temperature resistance. NFPCs had a variety of limitations that limited their applicability, including higher water absorption, lesser fire resistance, and lower mechanical qualities. These were just some of the issues. In addition, the effects of chemical treatment on the properties of NFPCs such as water absorption, tribology, viscoelastic behavior, relaxation behavior, energy absorption, flame retardancy, and biodegradability were emphasized. It is demonstrated how NFPCs can be applied in a variety of industries and applications, including the automotive and construction industries. The study came to the conclusion that the chemical treatment of the natural fiber improved adhesion between the fiber surface and the polymer matrix, which ultimately led to an improvement in the physicomechanical and thermochemical properties of the NFPCs. [14, 15]

Analysis

Natural polymers are abundant in the natural world and can be harvested from there. The addition polymerization or the condensation polymerization processes were responsible for the formation of these polymers. Additionally, our bodies are made up of many different types of natural polymers, such as proteins and nucleic acids. Condensation polymerization typically results in the formation of natural polymers, with water being the by-product of this process. According to Dang and Leong (2006) and Lehr et al. (1992), certain natural polymers, such as DNA and RNA, play an extremely important role in the metabolic activities of all living creatures. Natural polymers include things like cellulose, chitin, pectin, and proteins, amongst others. The many kinds of polymers and the substances from which they are made are outlined in Table 1.

The problem of utilising natural polymers or inventing novel biomaterials is not only to comprehend their mode of action in nature, but also to accurately coordinate the complex interplay of chemistry, biology, physics, and engineering. This is a challenge that must be overcome in order to be successful. Because not only pure polymers on their own but also diverse mixes thereof are examined, as well as the option to even insert chemical procedures to further functionalize and tailor the final material qualities, the number of conceivable parameters appears to be unlimited. This is due to the fact that pure polymers on their own are considered. However, the primary challenges that are currently being faced are the low-cost manufacturing and the scale-up of surface modifications (such as micro- and nanopatterned) in order to mimic nature's choice of materials (such as the promising adhesion mechanism of geckos or frogs) and to use them in a different environment (such as a wet environment) in order to provide new solutions in the fields of biomedicine and tissue engineering.

On the other hand, we should anticipate the development of new materials in the near future. Both the human body and the marine environment are water-based saline systems, which is one of the ways in which they are comparable. Because of this, the ocean should serve as a rich supply of ideas for a wide variety of biomedical uses, such as scaffolds for tissue engineering and adhesives in drug delivery systems.

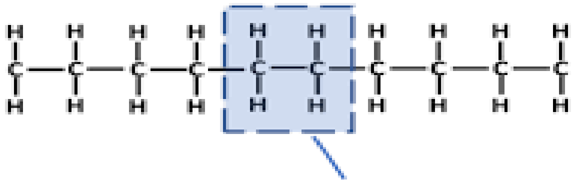
Table 1: Natural Polymers with Their Origin

S.No.	Natural Polymer	Sources
1	Cellulose	Cell walls of plants
2	Collagen	Connective tissue present in the skin of human beings
3	Latex	Rubber trees and found in variety of plants
4	Starch	Grains, cereal and potatoes
5	Pectin	Cell walls of terrestrial plants
6	Chitin	Waste of fishing industry
7	Carrageenan	Red edible seaweeds
8	Gelatin	Hydrolysis of collagen which is extracted from the skin, connective tissues and bone of animals

9	Alginate	Brown seaweed
10	Xyloglucan	Plant cell wall

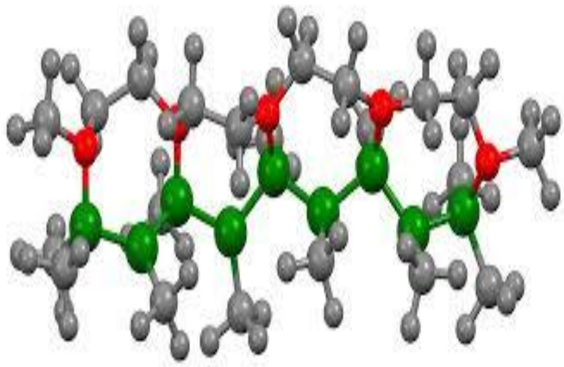
Investigating the characteristics and actions of both natural and artificial polymers is crucial for a number of disciplines, such as biology, chemistry, engineering, and materials science. Monomers, which are repeating components, make up polymers, which are huge molecules. They are quite useful and play a significant part in our daily lives. Natural polymers, such as cellulose and proteins, are sourced from biological sources and are frequently biodegradable; as a result, they are beneficial to the environment. Because of their origin, their qualities can vary quite a bit from one another. Because of their naturally hydrophilic and biocompatible properties, they are well-suited for use in medical applications. On the other hand, they often possess a lower level of mechanical strength.

Synthetic polymers are man-made materials that may have their attributes such as strength, durability, and adaptability precisely controlled. Examples of synthetic polymers are polyethylene and PVC. They are cost-effective for a variety of businesses and are resistant to the effects of the environment. However, the majority of them are not biodegradable, which adds to the concerns about the environment for the long run. Research is focused on finding ways to make them more recyclable and environmentally friendly. The choice between natural and synthetic polymers is one that must be made based on the requirements at hand, as well as the costs and effects on the environment. Now let's examine the characteristics and actions of synthetic and natural polymers:



Conclusion

Depending on their composition, polymers can either be resistant to or sensitive to chemical deterioration. Certain synthetic polymers, for instance, can withstand exposure to acids and bases, whereas others could break down. The ability of a material to tolerate contact with a variety of chemical compounds without suffering significant deterioration or damage is what we mean when we talk about the material's chemical resistance. In many different industries, such as manufacturing, construction, medicines, and the chemical process industry, the degree to which a material is resistant to the effects of chemicals is an essential factor to take into account. The chemical makeup of a substance, its structure, and the physical qualities of the material are important elements that affect how resistant a material is to chemicals. The following is a list of significant elements of chemical resistance:



Chemical Compatibility The degree to which certain chemicals are compatible with certain materials varies depending on the material. It is possible that a substance that is chemically compatible with one material is not compatible with another material. In order to assess whether or not a substance will be suitable for a certain chemical environment, compatibility charts and databases are frequently used.

Chemical attack is the term used to describe the deterioration of the qualities of a material that occurs when that substance is subjected to certain chemicals. This degeneration might show itself as swelling, cracking, softening, blistering, or even just a change in the material's mechanical properties. The severity of the chemical attack is determined by a number of variables, including temperature, concentration, and length of exposure.

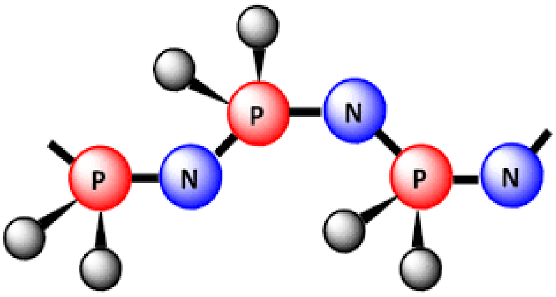
Resistance to Acids and Bases: The ability of a material to withstand the effects of acids and bases is an important quality to look for in a variety of applications. The term "acid-resistant" refers to the strong resistance of certain materials to acidic settings, while the term "alkali-resistant" refers to certain materials' ability to survive alkaline conditions.

Compatibility with Solvents: Materials that are used in laboratories, the manufacturing of pharmaceuticals, and the processing of chemicals often need to be able to withstand damage from a wide range of solvents. It is imperative that materials be compatible with the solvents they will be exposed to in order to prevent the leaching of pollutants and the weakening of the materials.

The effects of temperature include the fact that temperature can have a considerable impact on the chemical resistance of a substance. Temperature increases can hasten the progression of chemical reactions, which in turn can heighten the risk of a chemical assault. On the other hand, temperatures that are lower can slow down the rate at which chemical reactions take place and may make a material more resistant.

Concentration: Another factor that might influence the resistance of a material is the chemical's concentration. There are some materials that may be resistant to low concentrations of a particular chemical, but if they are subjected to large quantities of the chemical, they may deteriorate.

The length of time that an individual is exposed to a chemical can have an impact on the severity of the reaction that it causes. It's possible that exposure for a shorter period of time will have a different effect than exposure for a longer period of time or that is continuous.



Material Selection: When designing equipment, pipelines, and structures for use in industries where frequent contact with chemicals is unavoidable, it is essential to choose materials that have the required level of chemical resistance. Glass, stainless steel, and some types of plastics (such PTFE) are examples of substances that are well-known for their resistance to chemical reactions.
Protective Coatings: There are times when it is possible to safeguard materials that do not naturally have a high level of chemical resistance by applying coatings or linings that are manufactured from chemically resistant materials. For instance, a chemically resistant polymer can be used to line the inside of a metal tank in order to prevent the tank from being damaged by corrosive substances.

Laboratory tests and standardised testing methods are utilised in order to determine the level of chemical resistance possessed by a material. As part of these tests, the material will typically be subjected to a variety of chemicals under carefully monitored settings, after which its performance will be evaluated.

Resistance to Corrosion: Resistance to corrosion is a subcategory of chemical resistance that refers to the capacity of a substance to withstand deterioration brought on by chemical reactions such as oxidation or reduction. Corrosion resistance is a specific feature of chemical resistance. In applications that include contact with corrosive substances, it is usual practise to make use of materials that are resistant to corrosion.

When selecting materials for any application in which there is a risk of exposure to chemicals, chemical resistance is an important attribute to take into consideration. The selection of materials that have the proper level of chemical resistance can assist in ensuring the durability, safety, and dependability of equipment and buildings in a variety of different industries.

Conflicts of Interest

The authors declare there are no significant competing financial, professional, or personal interests that might have influenced the performance or presentation of the work described in this manuscript.

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