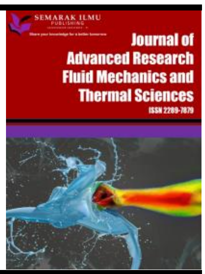
SEMARAK ILMU PUBLISHING

Journal of Advanced Research in Fluid Mechanics and Thermal Sciences

Journal homepage: https://semarakilmu.com.my/journals/index.php/fluid_mechanics_thermal_sciences/index
ISSN: 2289-7879



Review of the Green Composite: Importance of Biopolymers, Uses and Challenges

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ARTICLE INFO

Article history:
Received 30 July 2023
Received in revised form 25 October 2023
Accepted 4 November 2023
Available online 15 November 2023

Keywords:
Green polymer; bioplastics; green composite; uses and challenges

ABSTRACT

Polymers can be utilized for a wide variety of applications since they are lightweight and inexpensive, and their mechanical qualities are usually more than enough. Polymers often undergo a petrochemical production process and have a relatively lengthy elimination time. Green chemistry and green production are crucial in today's technology, which relies increasingly on non-toxic polymers made from natural ingredients. Biopolymers are a type of organic polymer that can break down naturally and pose no threat to human health or the environment. Here, we will take a quick look at the polymer structures that go into making eco-friendly composites in the future. Important polymer types and engineering studies for material manufacturing have been uncovered as a means of avoiding green production's negative effects on the environment. Possible future use of biopolymers as binders in composite materials and their effects on the environment.

1. Introduction

Composite materials are more diverse than previously used materials. It is widely used in industrial areas due to its ability to provide. In this area, the most common of the composites used is glass fiber. In Glass Fiberglass Plastics (CTP) manufacturing, methods such as hand-injection, vacuuming, and infusion are used [1]. However, because of the low wear resistance and the use of scratches on the surface, the area is limited [2,3]. Composite materials are becoming increasingly common. It must be used in its original form and after the composite has served its purpose, its remains must be destroyed, as it is the shortest way without damaging the environment. The importance of recycling into nature and the importance that waste is biodegradable has been studied in this review. Composites, metal, ceramic, or ceramic, according to the purpose of use and

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https://doi.org/10.37934/arfmts.111.1.194216

production technique of the material, can be made of polymer material. Composite materials with metal matrix are formed from various main materials composites with metal and metal alloys. For materials made of metal matrix, in its metal-based structure, the buried supplementary elements can be different geometrically. Metal-based materials depend on the materials they use, and their characteristics can be changed. A high elasticity module of ceramics with the characteristics of plastic shape can change the metals. It can be combined with strong wear resistance and high-tension strength materials. (d = 1.5 - 3.0 g/cm^3). When working at high temperatures, composite materials are preferred. They are hard and fragile, have low molarity and stiffness, and are also resistant to thermal shocks. Therefore, they are mostly covered with lights. It has a very high elasticity and very high they have working temperatures. Ceramic composites have extremely good resistance to high temperatures, have a rough structure, and are excellently electrically insulated [4-6].

Biopolymers are produced in the natural environment by biomass in a natural process. When broken down by microorganisms, it will not cause environmental pollution. It is divided into components and categorized within the concept of green materials and polymers. Materials are generally divided into three groups: metal, ceramic, and polymer, as seen in Figure 1. These three groups of materials have predominant and weak sides [7-9]. Composite materials consist of two or more components joining along the intersection. When composite structures are created, components usually have their properties, and they are the protectors [10-12].

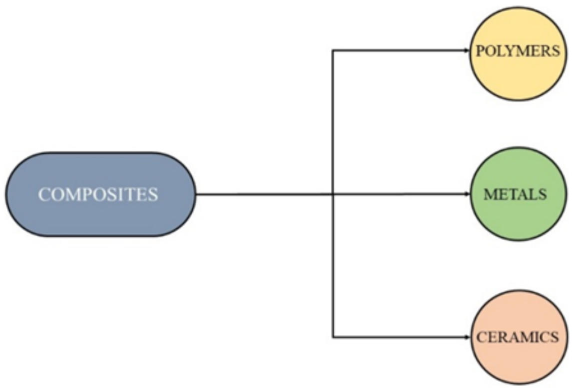

Fig. 1. Composite materials

As a result of the innovations that our era has brought, the need for materials with superior characteristics is increasing. Requirements have been the main factor for the development of composite materials production of fiber-added polymer matrix composite materials. They have been used for years in aviation, defense, home tools, and work equipment in the construction sector, food sector, corrosion-resistant products, and electricity, and used in a wide range of industrial fields, such as electronics, marine and automotive, has increased considerably [13,14].

Biopolymers became critical due to their wide applications in many fields such as biology, chemical and biomedical, etc. Recently, many biopolymers have been used in biomedical applications. For example, collagen was reported to be used as wound dressings and bone fillers, and chitosan was demonstrated as an antioxidant and antimicrobial [15-17]. The biopolymers were prepared by using different preparation techniques, with different shapes such as beads, fibres, gel and solution, etc [18-21]. Biopolymers as fibers were reported as important materials to be used in medical applications and biological applications [22,23].

This study aimed to develop a comprehensive framework in order to comprehend all of the potential elements of polymers, including biopolymers, their uses, and the potential challenges that may be associated with their various applications. The application of polymers in green chemistry, as well as green composites, is the primary focus of the study, as is their effectiveness in these areas.

2. Polymers

Polymer is not only lightweight and affordable, but it is also simple to form. It may be utilized for a variety of applications without corroding, such as in the manufacturing industry. Polymer is preferred in many industries worldwide, and its day-to-day needs keep increasing. Polymers have desired properties according to the need, from the ease of molding extending to electric cables, and can be used in a wide range of applications [24,25].

Commercially used polymers, such as natural gas and oil, account for 5% of the world's end-of-life resources. They also have superior mechanical and thermal properties. Polymers have become the preferred material in many fields. Polymers are natural and environmental damage from extinct resources such as unrecyclable petroleum resources and are known. They can only be destroyed by costly operations. New organic polymers in the polymer manufacturing industry both in terms of continuity and environmental compliance [26,27]

The main component of the main chain of most of the polymers used in everyday life is the carbon atom. The structures of organic polymers are carbon, usually hydrogen, oxygen, nitrogen, and halogen atoms. A large proportion of synthetic and natural polymers are organic has been formed. The sequence of atoms in the polymer chain is of the same type, comprised of the "homo chain" of different types. The “hetero chain” is called a polymer. Polyethylene, polyesters, polyamides, polypropylene, and natural polymers such as rubber, proteins, and cellulose are examples of organic polymers [28].

3. Biopolymers

A significant portion of natural polymers are usually found in the structure of living organisms, such as selenium. Natural polymers can be found in the structure of nails, wool, hair, and protein, and also, in organisms, carbohydrates are found in polymeric structures, deoxyribonucleic acid, and ribonucleic acid. These polymers are responsible for the characteristics of living beings, such as mobility, aging, and senses. They are called biopolymers [29]. Green polymers and biopolymers are studied today by many researchers. Biopolymers: in nature, by enzymatic reaction, bioplastic polymers can be divided into small components such as carbon dioxide and water [30,31].

Green plants, animals, bacteria, and fungi are defined as naturally produced polymers during their life cycle [32,33]. It is expressed in the form of naturally occurring polymers. Based on this information, after the breakdown of microorganisms in natural life by biomasses, biopolymers cannot harm the environment and act as a green material [34].

The synthetic polymers used are of petrochemical origin, and most are not biodiesel. Therefore, considering the damage to the environment in place of petrochemical-derived polymers in nature, it is recommended to use biopolymers. Production of biopolymers, an unprocessed biological structure, is used, as seen in plants like corn. It can be found in microorganisms such as bacteria and germs. Biopolymers are generally CO_2-neutral, and their mass-energy cycles are closed. After they leave, they return to the carbon cycle. The fossil growth in recent years, the protection of non-processed materials from the source and the reduction of dependence on petroleum are major advantages. Biopolymers can become waste in agricultural land, reducing the need for chemical fertilizer. Biopolymers are still produced even though they are quite expensive. Costs are expected to fall as production increases [35-39].

As the use of biopolymers increases, the need for oil will decrease, and an ecological environment will be created [40,41]. Biopolymers can be used in the packaging and coating materials sector, automotive and white goods sector in composites, insulation materials in the construction industry, medical surgical materials and implants in cosmetics and textile products [42-45].

The products of renewable sources have shown significant development in recent years. The Green Composite industry today represents a billion-dollar business area. The polymer sector is the fastest-growing sector in green composites, as shown in Figure 2. Green materials are usually used in automotive, packaging, and construction when these sectors are used and used in consideration, called the "Renewable". There is a lot of attention in the marketplace, as shown in Figure 2.

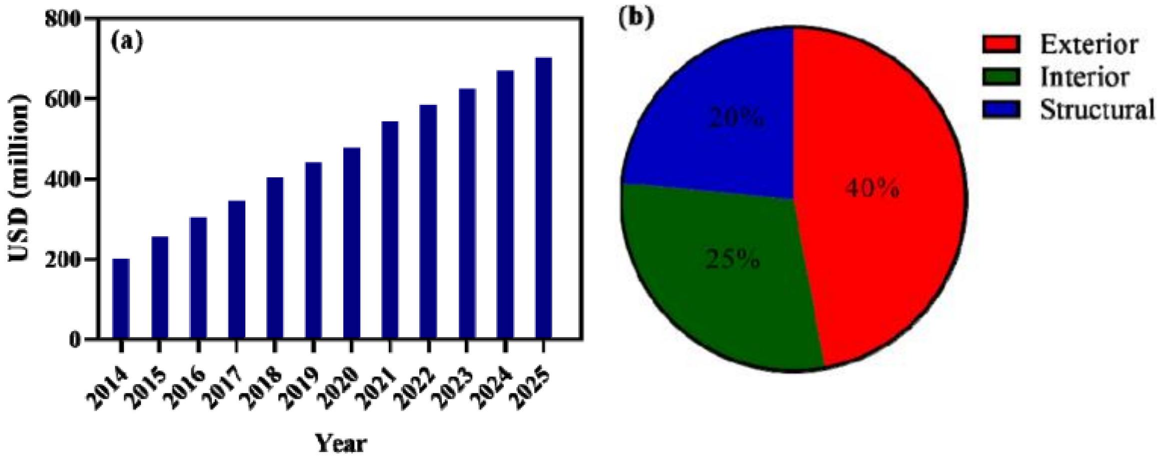

Fig. 2. (a) market income for polymer composite in united states from 2014-2025, (b) positions of polymer composites in car industry [40,46]

Biopolymers are not only materials that are naturally polymerized. The high molecule formed by the polymerization of natural compounds by biological or chemical means that it also contains heavy materials. Polyamides are obtained from renewable sources like polysaccharides, polyesters, polyethylene esters, poly anhydrides, polyphenols, and other polymers. Its derivatives and composites can also be classified as biopolymers [47,48].

Biopolymers are of two types: natural and synthetic. Biopolymers are natural materials based on polysaccharides/disasters, alginate, chitin/chitosan, or proteins (soya, fibrin, silk), and they can be classified as natural fibrils used as reinforcers/supporters. Synthetic Biopolymers are produced under controlled conditions and, therefore, generally exhibit the behavior. They can be predicted; degradation speed, tension resistance, elastic module, and such physical and mechanical characteristics are replicated [49-53].

Polysaccharides can be easily found in nature from corn, nuts, and rice. It is highly biodegradable and can help in producing low-cost green polymers. A mixture of nitrates and synthetic polymers mainly produces the basic component of the production of biopolymers. The characteristics of biopolymers can be adjusted by changing the ratios of synthetic polymers and nitrates. This approach is based on a plastic material called Mater-Bi® manufactured by Novamont. Mixture with more than 85% nitrate in injection molding and foam manufacturing can be used [54-56].

Polymers of cellulose plants and bacteria are found in abundance worldwide. They are also called biopolymers [57,58]. They are formed by cellulose and repeated β-D-glucopyranose units. Each hydroglucose molecule contains three hydroxyls in repeated units. It holds the group. This structure of cellulose has chirality, biodegradation, and high functionality, and it is one of the most important factors in having characteristics such as hydrophilia [59,60].

Chitin/Chitosan chitin, with binding of 2-acetamide-2-deoxy-β-D-glucose monomers β-(1,4), is a biopolymer that binds. Mucopolysaccharides are found in abundance in the natural environment. It has its own structure and is the second most sustainable biopolymer found in nature after cellulose [61,62].

4. Uses of Biopolymers

Biopolymer production progresses daily. In 2001, the whole of Europe's consumption of biologically separated plastics was 20,000 tons, and in 2003, it was estimated to be worth 40,000 tons. This value is that the field of biopolymer production is growing, it shows. The primary uses of biopolymers are in the medical and food industries. England, The Netherlands, and Italy are among the leading countries in the production of bio-emballage [63].

According to research carried out in the production sectors related to biopolymers, in 2020, biopolymers will make up 25-30% of the plastic manufacturing industry. By 2007, the biopolymer plastic industry was worth $1 billion, and in 2020, it was predicted to be worth $10 billion. It was estimated in 2007 that there were five hundred biopolymers enterprises, and five thousand enterprises were expected to grow in 2020 [64,65].

4.1 Biofeed Food Packaging Films

The food and drinks in everyday life are in contact with polymers, such as single-use pots, knives, beverage containers, salad contains, plates, packaging papers and thin films, pipettes, mixers, covers, boxes, channels, and fast food. The packaging is usually recycled and focused on ecology. Interacting with acidic and fatty foods storage of packaging films at room temperature or above about 60°C, the packaging films are used to protect it. Finally, the last few can be recycled and compounded from sustainable sources for years. This makes biopolymers even more important [66-70].

4.2 PHA Food Packaging

PHB used in most food packaging sections is similar to PP. However, it is harder than PP. Polyhydroxide with less hardness and intensity can be used for butyrate-co-β-hydroxy valeride (PHBV) packaging. PHBV can resist microbes for 5-6 weeks [71]. In 1998, researchers produced PHA from different types of food waste with immaculate different physical and mechanical properties such as polymer flexibility, traction resistance, and a viscosity [72]. PLA Food Packaging: Researchers find PLA has less than 6% depending on the ratio of L-lactite/D-lactate, and their qualities can be quite different. The quality of semi-crystalline polymer PLA containing D-lactate showed performance. In addition, it contains 12% D-lactate containing amorphic PLA. Its easy shape is suitable for the food packaging industry along with developing technology. The characteristics of PLA are similar to PS. PLA has begun to be used in the commercialization of various companies [73].

4.3 Biomedical Applications

Polymers are mostly used in surgical and clinical medical inspections. Materials in contact with the tissue are called “polymeric biomaterials” [74,75]. Applications of biomaterials are single-use products (spray, blood bag, catheter), surgical operating materials (Pulver and filling materials), and tissue replacement prostheses (inside the eye), temporary or permanent, such as lens, dental implant, breast implant, artificial kidney, artificial heart, artificial vessel [76-79]. Usually, in these areas, non-toxic, inert, and biocompatible materials are used [80,81]. Recently, there are two main reasons for the tendency to use biomass polymers:

(i) Bioplastic polymers are biologically suitable.
(ii) These polymers are both mild and do not pose an infection hazard.

4.4 Surgical Use

They are usually used for sewing in surgical areas. From animal intestines, the resulting collagen is used after the chroming process. The other areas of surgery are hemostasis, adhesive, and wound-cleaning materials. The biomaterials used in this field are gelatin, collagen, chitosan, cellulose, carboxymethyl cellulase, fibrin, and trombone [82].

4.5 Agricultural Applications

Its primary uses in agriculture can be seen in silk films and erosion and in controlling systems and cranes [83]. In the agricultural business, the most important thing is the protection of trees. Thus, the use of DYPE-based mold films is increasing daily. To reduce the temperature of the soil and prevent erosion, it is preferred to reduce the use of pesticides and wild herbs. As they are biodegradable and are made from renewable sources, the production of malt film has begun to replace oil-based products [84].

4.6 Automotive Applications

The percentage of polymers used in the automotive industry in terms of mass is approximately 12 percent per car. The amount of pollen in the car is 114 kg. In this sector, the most common polymers are polypropylene (PP), polyamide (PA), polyurethane (PU), and acrylonitrile-butadiene-styrene (ABS). The substitution of petroleum-based polymers for biopolymers in the automotive sector was completed, and patents were obtained, especially with natural fiber. Biopolymers are used in indicator panels, door panels, light bulbs, and grids in the automotive industry [85].

4.7 Cosmetic Applications

Polymers are the second main ingredient used in cosmetics. Polymers in the cosmetic industry are stabilizers and, destabilizers, modifiers. It is used as a diluent, emulsifier, and antimicrobial additive [86].

5. Renewable Sources

Everything is derived from living, renewable sources, such as plants and animals. Biopolymers derived from plants include poly(lactic) acid (PLA), hydroxyalkanoates (PHA), poly-3-hydroxybutyrate (PHB), polyhydroxyvalerate (PHV), and polyhydroxyhexanoic acid (PHH), whereas chitin and proteins are derived from animals. The use of monomers derived from natural sources of synthesis produced polyethylene (PE), polypropylene (PP), and nylon [87]. Plastics such as polypropylene (PP), polyethylene (PE), and polytri(methylene terephthalate) (PTT) are not biodegradable despite containing bio-based components (see Figure 3) [88].

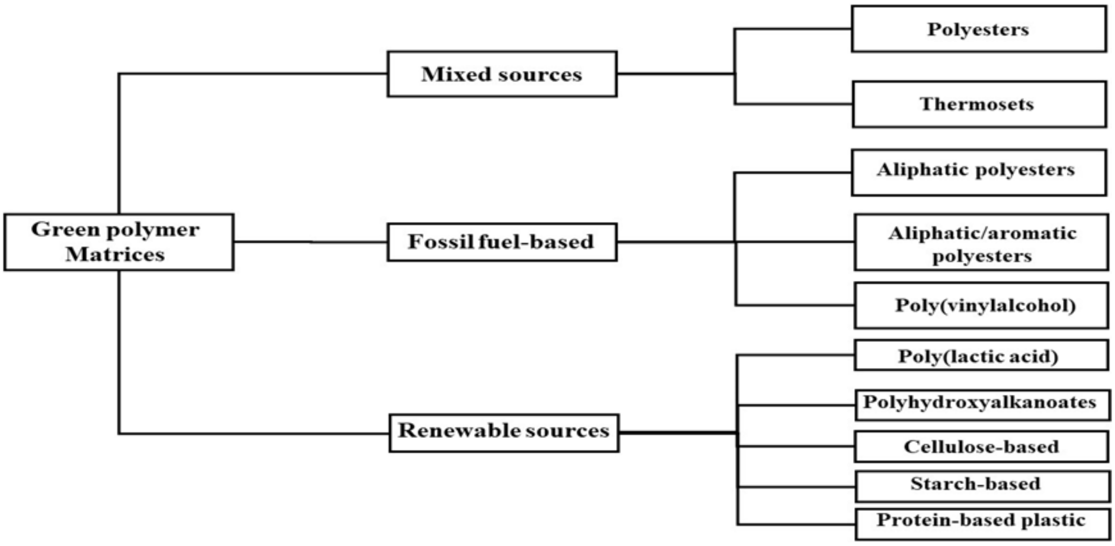

Fig. 3. Classification of green polymeric matrices based on sources

6. The Green Composite

A composite material has been introduced to the world in recent years. It has become indispensable in many areas, such as automotive and sports goods. Often composite materials, although they can be designed in various forms such as epoxy, polypropylene, or polyethylene vs a polymer matrix of glass, carbon, aramid, or ultra-high, are made by the addition of molecular weight polyethylene (UHMWPE) fibers. Composite materials are materials used for the benefit of increased use. It consists of two different (liquid and matrix) materials of the composite material, making it difficult to return [89,90]. As a green composer, environmental studies introduce that composite materials are made from renewable sources [91,92]. In ancient times, sheep were added to herbs. Considering this, it can be assumed that the composite material existed long ago. In the modern era, Henry Ford, in 1938, produced the first fiber-added car body panel, Soya-Fasulya, using raw vegetables [93,94].

The most widely known uses of green composites are construction, automotive, furniture, and packaging, construction and furniture [95]. More trees in the packaging sector need to meet expectations. Cheap trees are preferred at the initial construction of the car. In other applications, high success is expected from green composites in such designs. Hemp, jute, banana, bamboo, kenaf, and fibers are used to access the desired qualities [95-97]. They are environmentally friendly, and the weight of land vehicles is 10-30%. They are preferred because they provide less fuel consumption and are lighter [98]. Daimler-Benz, since 1991, has researched natural fibers to replace synthetic fiber [99]. Indian coconut fiber composites were successfully made during the “Beleem project” in 1996. In that year, the door panels of Mercedes E-Class vehicles were manufactured from life-enriched composites [100,101]. It is the first car of the leading car brands, along with Mercedes-Benz. Is used [102,103]. The European Union European Directive 2000/53/EC of the European Parliament and of the Council on Vehicles Manufactured in Europe as of 2005 stated that at least 85% of the mass can be renewed, and after 2015, at least 95% can be recovered. Production of materials is mandatory [104]. This indicates that the green composite will be among the indispensable materials of the future century, and the expectation will always be at the highest level [105].

The matrix, the reinforcement, and the interphase are the three fundamental components that make up the vast majority of eco-friendly composites. The matrix is the continuous phase of the green composite, and it plays an important part in the process of defining the overall qualities of the material [106,107]. By maintaining consistent spacing between each pair of fibers, the matrix ensures that the fibers are shielded from attrition and the development of new surface defects [108,109]. In addition to this, the matrix acts as a connection that helps to maintain the placements of the fibers. Matrix materials that perform effectively under stress need to have the ability to deform quickly, transmit stress to the fibers, and distribute stress concentrations fairly. Matrix materials can be composed of nonbiodegradable polymers such as polypropylene (PP), polyethylene (PE), and epoxies, or biodegradable polymers such as polylactic acid (PLA), polyhydroxybutyrate (PHB), etc. [110,111]. To further strengthen the basic resin system's mechanical qualities, the matrix is often supplemented with reinforcements, the second most important component after the matrix. Because different materials are constantly present in either mixed or blended conditions, there is always a continuous zone that acts as the interface between the matrix and the green fibers. However, there are times when an unusual extra phase, also known as a coating or a reactive phase, takes place in the area next to it to increase the amount of moisture [112,113]. This phenomenon is known as an interphase. The individual components do not share certain interface properties, yet those traits are present in the interface nevertheless. This phase comes immediately after the matrix and just before the reinforcement. It is of critical importance in the process of identifying the characteristics of the completed composite [114,115]. The matrix material and the green fibers must have a good capacity for wetting. In order to improve the wettability of green fibers, a number of different surface treatments and coupling agents, such as silane, acetone, and alkali treatment, may be used. It is necessary to achieve the required qualities in a composite material to move the load that is being applied from the matrix to the fibers over the interface [116,117]. The many kinds of natural fibers and biodegradable polymers used in the production of eco-friendly composites are shown in Figure 4.

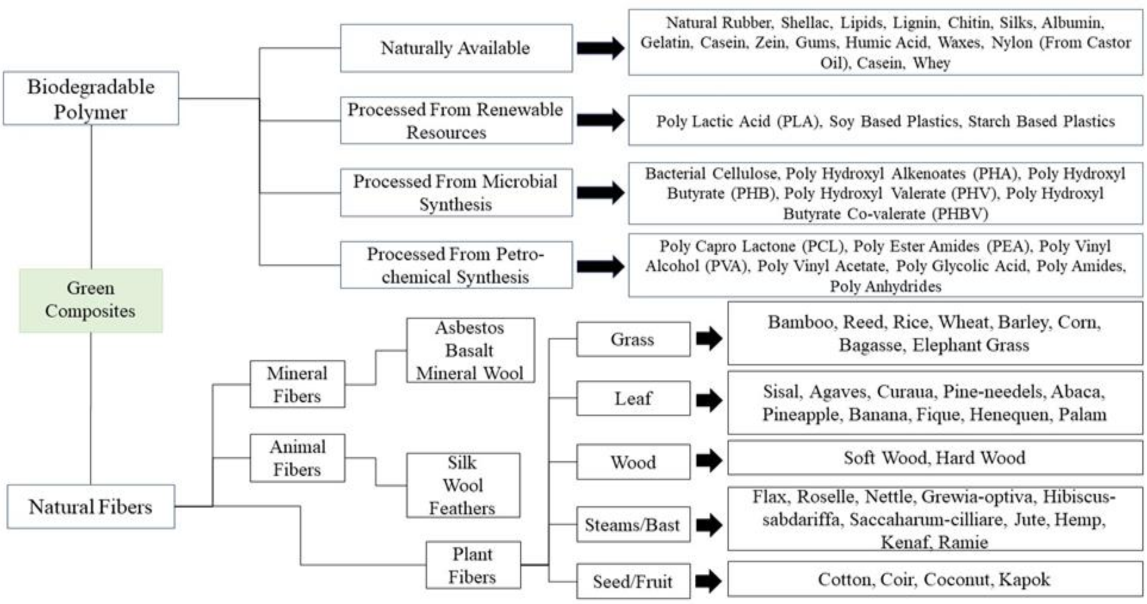

Fig. 4. Constituents of green composites

7. Green Chemistry

Currently, there is a unanimous need for technological and industrial growth to promote sustainable development and, consequently, improve the quality and harmony of life. The great goal, or rather, the great challenge to be overcome, is the perspective of evolution, with the reduction of environmental problems. This challenge can be overcome, initially by raising awareness and also by rethinking chemical conduct with regard to process refinement, generating minimum amounts of waste [118-120]. The new look at these processes can be conceptualized as Green Chemistry or Sustainable Chemistry, attributing to clean technology [121].

Green Chemistry involves reducing the risks of the chemicals used to the environment and human health, synthesizing them and improving the production processes. With the use of cleaner chemical techniques and methods, the damages caused by substances such as raw materials, products, by-products, solvents and reagents during use can be reduced or eliminated [122-124]. Green Chemistry is the most critical tool to prevent pollution. Looking at the definition of Green Chemistry, one of the most emphasized points is the "design" phase. By considering the effects expected from chemical products and chemical processes as a design criterion, Green Chemistry inextricably presents hazards as a performance measure [125,126]. Two other important terms of Green Chemistry are usage and production. Rather than focusing only on waste materials unintentionally generated in a process, Green Chemistry deals with all substances formed throughout the entire life cycle. Therefore, Green Chemistry means more than a tool for efficiency optimization and waste minimization. Green Chemistry can also respond to changing issues such as regulation, packaging and transportation, known as the consequences of using hazardous substances [127,128].

8. Production of Composite Materials

8.1 Hand-Lay-Up

Supplement made of fabricated or broken fibers amid the mouth of the hand. It is moisturized with clay, and in the middle of it is placed a mouthpiece of clay. Elijah: Before cleaning the surface, the surface quality of the material is improved. After the gel is hardened, the layers of the fiber are laid on the jackpot. In the final stage, it is rubbed, and here, the resin must penetrate the fiber to fabric in the best way. The Polyester Technique is used in vinyl esters and phenolic resins. Hand Working Method is highly expensive but is preferred for small quantities [129].

8.2 Spray-Up

This method is made with mechanical components of the hand-insert method. Crushed fibers are applied on the surface of the mold. Together with rust, they are mixed with hardener and sprayed with a special gun. Fiber cutting is located on the special gun, and separate from the gun, it is made with a working cutter. Any issues that may occur on the surface after spraying will be fixed with the help of a roll [130].

8.3 Filament Winding

It is a series of products with a special shape of the fiber winding method used for production. This method constantly warms the fiber with resin and rolls. It is made up of a drawn-back shape. When the elevators hang on the roof, changes in the angles affect the mechanical properties of the product. By embracing the increase of their layers, the product hardens, returns and leaves. This method usually uses materials such as tanks and pipes with geometry [131].

8.4 Resin Transfer Molding RTM Injection

More than this method of hand-inserting system, a two-part mold is used in the RTM method to ensure that it is fast and long-lasting. The other material, steel, is more expensive. It is made of composite materials. In this method, a smooth material uses gel code or gel code-free materials. As a supplement element, goat, cloth, and both are used together. Before the mouth, the material is placed to fill the shape. The insides of the fiber are covered with late-dissolved resins inside the matrix to prevent it from dragging. Under pressure, rice is pumped in a quite time-consuming process. Matrix injection in cold containers can be used up to 80 times. In this way, the air inside and the fiber are drained. It can be vacuumed for the resin to penetrate thoroughly. Installation of the fiber is sufficient. Because it is a long and attentive process, it requires a master's work. The shutdown is closed, and the harmful gases are reduced and used in the manufacture of complex parts [132-135].

8.5 Profile Traction/Pultrusion

It is a composite profile with a continuous fixed-cut filtration process. The cost of the products is a low-cost mass production method. Pull and Extrusion are formed by the union. A continuous supplementation material is forming from being heated up to 120-150 degrees. It is placed in the bathroom before mounting. The molds are mostly chromium-coated steel. Through this way, the direction of the fibers affects the strength of the material [136].

8.6 Compression Molding (SMC, BMC)

Glass fiber in ready molding, as a resin, additives, and filling materials containing mold-ready molding compounds, the so-called composite structures (SMC, BMC) are the creation of a new structure with hot press molds. Bu complex forms can be produced by the method and different thicknesses can be obtained. The surfaces of the product it is built. Other methods cannot obtain different structures such as holes. The storage in the refrigerator of molding compositions the large size of the produced parts, and the production cost of using this method is a disadvantage [137].

8.7 Vacuum Bonding/Vacuum Bagging

A large sandwich structures placed primarily in a mold. The vacuum bag is placed on top, keeping the air in the bag. One atmospheric pressure is applied to the material. All the composition is put into the oven during the curing process. This method is often associated with fiber wrapping and laying techniques and the repair of Composite Materials (Figure 5) [137].

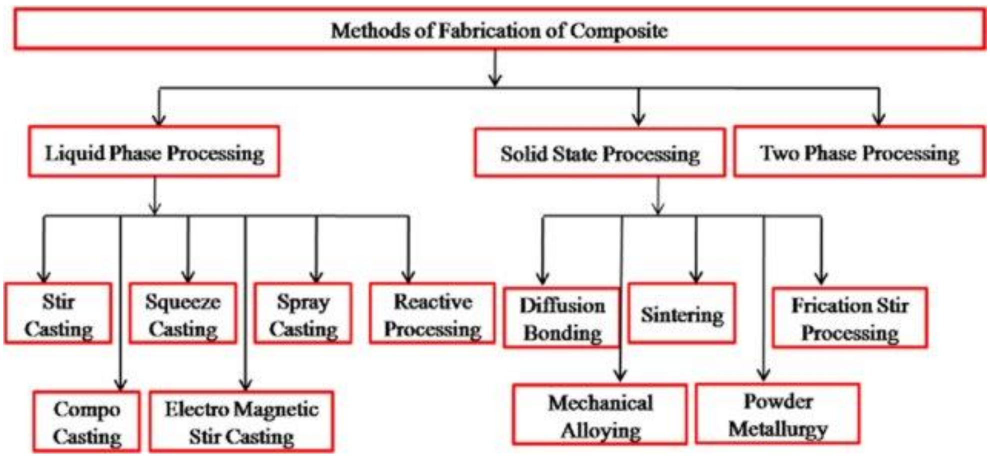

Fig. 5. Production of Composite Materials [138]

9. 3D/4D Printing of Biopolymers

Three dimensional printing, also known as additive manufacturing (AM), enables the printing of a sequence of materials in a layer-by-layer manner, enabling the control of the shape and quality of each layer. Typically, the structure that emerges from a 3D printer is intricate, user-specific, and durable. This structure was originally conceived as an image within a digital brain. There are five primary categories of additive manufacturing: inject printing, binder jetting, extrusion-based printing, selective laser sintering (SLS), and stereolithography (SLA). These are only a few subcategories of additive manufacturing [139-142].

This cutting-edge processing technology has numerous significant advantages over conventional methods in the past. Although biopolymer 3D printing is viewed favorably by scientists, the process is frequently hampered by a lack of dynamism and reactivity. The 3D-printed structure as a whole does not exhibit a dynamic pattern of form change over time, such as enlargement, self-repair, self-assembly, multifunctionality, and shape-shifting characteristics [143-146].

The absence of dynamism, however, has a negative impact on biomimicry, weakening it. As a result, four-dimensional printing was created and eventually refined to replicate structures inspired by nature. 4D printing allows for the structural configuration of printed materials to be enhanced. This enhancement is a result of time. 4D printing makes effective use of computer science, chemistry, materials science, and biomedical engineering in the development of cutting-edge materials. The building elements of the 4D printing technique are stimuli-responsive biomaterials that can be classified as physical, chemical, or biological [147-150].

Physically responsive materials are sensitive to changes in temperature, light, humidity, electricity, and magnetic fields, while chemically responsive materials respond to changes in pH and ion concentration. Components of biological stimuli are sensitive to the traction forces of cells, glucose, and enzymes [147,151-155].

As with 3D printing, the foundation of 4D printing is a mathematically sound model of the structure or image to be reproduced. Similar to three-dimensional printing, four-dimensional printing can be broken down into its component technologies, namely selective laser lithography (SLA), fused-deposition modeling (FDM), powder bed, and inkjet head 3D printing. The chosen technique will be determined by the mechanical properties, flexibility, and printability of the biomaterials [154-159].

10. The Future of the Chemical Industry

Green chemistry refers to the development of novel compounds, materials, and processes that are less detrimental to human health and the natural environment. It includes utilizing resources that do not deplete as rapidly as well as reducing waste and energy consumption. There are numerous applications for green chemicals, including the chemical and industrial sectors, the food and beverage industry, automotive manufacturing, the packaging industry, construction, agriculture, and personal care products [124,160-163].

Twelve fundamental principles have been defined by the American Chemical Society (ACS) as the basis of green chemistry. Prevention, atom economy, less hazardous chemical synthesis, designing safer chemicals, use of safer chemicals and auxiliaries, design for energy efficiency, use of renewable feedstocks, reduction of derivatives, catalysis, design for degradation, real-time analysis for pollution prevention, and safer chemistry for accident prevention are among these principles. Green chemistry is founded on these tenets [164-167].

Green compounds are advantageous to the environment because they are derived from plant and animal detritus and renewable resources. The rising environmental concerns caused by the excessive use of fossil fuels and the depletion of conventional resources increase the market demand for biodiesel and bioethanol. These fuels can be substituted for traditional petroleum and diesel [168-171]. Due to their reduced raw material requirements, affordable manufacturing costs, and more user-friendly disposal options, bio-based packaging materials are gaining pervasive use in numerous industries, including food and beverage, personal care, and others [167,172,173].

As a result of research and development efforts pertinent to biofuels, biodiesel, bioplastics, and other chemicals, market participants will have significant expansion opportunities in the years to come. The future of green chemistry appears promising as businesses and governments become increasingly aware of the need to reduce the negative impact their activities have on the surrounding environment.

11. Challenges

In the past ten years, the most difficult aspect of producing nanocomposites is overcoming the incompatibility between a hydrophobic (water-repelling) polymer matrix and hydrophilic (water-absorbing) fibers. This issue has led to poor mechanical quality and an uneven distribution of fibers throughout the matrix. Chemical coupling agents or compatibilizers (malleated polyethylene [MAPE], carboxylate polyethylene [CAPE], titanium-derived mixture [TDM], maleic anhydride polypropylene [MAPP], corono discharge), calendaring, stretching, thermo treatment, reaction with methanol melamine, isocyanates, triazine, silane, and mercerization have improved the affinity and adhesion between fibers and thermoset matrices. Gaining a deeper comprehension of the molecular structure, the interfacial contact between the matrix and the fibers, and the relationship between structure and property would be a significant advancement in this area of study [174-178].

Another intriguing challenge is the search for truly eco-friendly polymers with desirable mechanical properties to be used as matrix material. Due to their enormous particle size, biopolymers, such as starch that has poor water resistance, feeble tensile properties, and a high degree of brittleness. In order to process biopolymers such as starch at high temperatures and pressures, plasticizers such as glycerol are required. The plasticizers increased ductility, but there was nothing else noteworthy. When plasticizers are added to starch, the matrix's ability to adhere to natural additives is also diminished, as evidenced by the presence of residual sugar in the matrix [179-182].

However, PLA stands out due to its many exceptional properties, such as its high mechanical strength, low toxicity, and exceptional barrier characteristics. Due to their low glass transition temperature, poor thermal stability, poor ductility and durability, and low modulus above their glass transition temperature, PLA composites have limited potential applications. In general, modifiers have been utilized to accelerate the rate of degradation, reduce costs, and increase the rigidity of materials exposed to high temperatures. Since PLA is the most promising biopolymer presently in use, it requires the most attention. Other biopolymer sources include cellulose, gelatin, chitosan, and plant-based lubricants; however, they are more difficult to obtain, and their production is more time-consuming and expensive [183-187].

In nanotechnology, it is essential to partition infill particles into the correct shape and layer structure. For these particles to have the best potential properties, they must have an extremely narrow width (500 nm) and an extremely thin thickness (1 nanometer). This enormous task requires high-pressure homogenizers, inline dispersers, and other specialized machinery. However, despite the fact that technological advancements have made this possible, it has been observed that efforts to acquire nanosize particles result in vast size ranges, leading to disparities. Due to recent technological advancements, this has become possible. The tensile properties of nanocomposite materials may also be influenced by particle orientation. Although it is challenging to account for nanoscale fiber orientation, it has been demonstrated that orientation has a significant impact on micromechanics. Nanomaterials and additively manufactured fibers have a significant impact on the mechanical properties of composite materials. Now under investigation is the correct orientation of the particles in the matrix [188-191].

12. Conclusion

Economic development progresses in proportion to the development of the industry. The advancement of the industry helps the countries to grow and prosper. But this growth must take action to reduce the damage to the environment when it occurs.

The materials required for production are usually cheap, lightweight, easy to shape, and mechanical. To be able to meet their technical needs in terms of their characteristics is desired. Through the years, studies have followed each other, and as a result of developments, the combination of many materials with different techniques has been discovered. Materials are produced and the characteristics of each material are combined into one. Composite materials with better characteristics have been produced. More research on the environmental problems to create these materials is needed. The advanced technology prefers a non-composite production method. Environmentally friendly green compounds began to be produced. Because creating an environmental problem means additional waste for the production plant, it means cost assessment. Green compounds are often used in everyday life. It can be used in a wide range of fields, such as surgery, cosmetics, food, agriculture, and automotive. For example, the material that will be used in the surgical area requires biocompatibility. In contrast, another area requires high impact resistance of the material used in the automotive industry and reduced fuel consumption. It is recommended that the parts be produced lightly. The most common use of green composites is in the food industry. For example, plastic spoon pots, packaging, pipettes, and storage containers prefer natural materials for the production of these materials to return to nature. It is being given. As a result, a country can develop, rebuild, and progress. Environmental balance because the products of nature are used and recovered by nature will be destroyed. Ensuring ecological stability and sustainability, the use of biopolymers in the production of compounds is among the indispensables of the future.

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