State of the art Overview of Applications of Polymer Based Bio Composite Materials

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Abstract:

Dueto their excellent properties and less weight, Composite materials are considered as a significant part of our day to day life. The structure of the composite material consists of two or more macroscopically identifiable components that work together to attain a better property. Composite materials such as metal matrix composites and ceramic matrix composites, polymer based composites are characterized by minimum cost, processing methods, and applications ranging from house hold items to highly precision electronics and advanced medical. Due to their ecofriendly nature and sustainability, natural fibers are getting attention from researchers and academician. This review article provides a review of the widely used natural fiber reinforced polymer composites and their applications. Drawbacks of natural fibre composites such as higher water absorption, low fire resistance, and mechanical properties limited its applications. The applications of natural bio composites in automobile, construction, marine, aerospace industry are demonstrated.

Keywords: Polymer, Composites, Biomedical, Processing, Applications

A composite material consists of two or more macroscopically identifiable components that work together to attain a new property. Composites consist of dispersed phase and a matrix phase. These composites offer different characteristics and vary from other materials [1]. Now a day's recent research has been paid attention to composite materials because of their promising properties. Polymer composites are widely used in the medical industries such as dental, tissue engineering [2].

A bio composite material is a combination of matrices such as polymer and reinforced natural fibers. These composites mimic the morphology of the living materials with excellent biocompatibility. The polymer matrix protects the fibers from mechanical damage and environmental degradation. Moreover, biofibers are natural fibers produced from biological origins such as wood, crops, and regenerated cellulose. Bio composites enhance the safety in their production [3]. They are environmentally friendly, lighter in weight, cheap, completely recyclable in specific cases, and renewable sources of composites [4]. Bio composites are divided into wood and non woodfibers, which all contain lignin and cellulose. Wood fibers have a low degree of cellulose crystallinity and include hardwood and softwood fibers.

Based on the concept of the matrix phase, several reports have reported the classification of composites into metal matrix composites, ceramic matrix composites, and polymer matrix composites[5]. According to the basis of reinforcement, they are classified into fibrous, particulate, and laminate composites. Fibrous ones are classified into synthetic fiber and natural biofibers. Biofiber composites can be divided on the basis of degradable and non-biodegradable matrixes [6]. Bio based composites made from biodegradable polymers and natural biofibers are referred to as green composites. These are again classified as textile and hybrid composites. In addition, hybrid ones consist of a mixture of two or more kinds of fibers. Here, we will illustrate in detail the polymer matrix composites, including fabrication techniques and biomedical applications [7].

2. Natural Fiber Reinforced Composites

Natural fibre polymer composites are a composite material consisting of polymer matrix embeds with natural fibers such as knef, jute, oil palm, sisal flax [8]. In general polymers classified into thermoplastics and thermosets plastics. The thermoplastic polymers can be defined as highly cross-linked polymers which cured using only heat, or using heat and pressure which in turn high flexibility for tailoring the mechanical properties, great strength, and modulus [9].

3. General Characteristics of NFPCs

The properties of natural fiber composite are different to each other according to previous studies, because of different kinds of fibers, sources, and moisture conditions. The performance of NFPCs relies on some factors, like mechanical composition, microfibrillar angle, structure [10], defects, chemical properties and also the interaction of a fiber with the matrix [11]. Since every product in market has drawbacks, similarly, natural fiber reinforced polymer composites also have drawbacks. The couplings between natural fiber and polymer matrix are problem taken into consideration, as a result of the difference in chemical structure between these two phases. This leads to ineffective stress transfer during the interface of the NFPCs. Thus, the chemical treatments for the natural fiber are necessary to achieve good interface properties. The reagent functional groups in the chemical treatments have ability to react on the fiber structures and alter the fiber composition [12]. Natural fibers include a functional group named as hydroxyl group which makes the fibers hydrophilic. During manufacturing of NFPCs, weaker interfacial bonding occurs between hydrophilic natural fibre and hydrophobic polymer matrices due to hydroxyl group in natural fibres. This could produce NFPCs with weak mechanical and physical properties.

3.1. Mechanical Properties of Bio Composites

There are considerable enhancement and suggestions for the natural fibers that can be implemented in order to enhance their mechanical properties resulting in high strength and structure. Once the base structures are made strong, the polymers can be easily strengthened and improved.There are number of aspects that effects of composite are performance level or activities, of which to name a few are the following; (a) orientation of fiber, (b) strength of fibers, (c) physical properties of fibers, (d) interfacial

adhesion property of fibers [13] and many more. NFPCs are such composites whose mechanical efficiency is dependent upon the interface provided by fiber-matrix along with the stress transfer function in which stress is transferred to fiber from matrix. This has been reported by many investigators in several researches. Characteristic components of natural fibers such as orientation, moisture absorption, impurities, physical properties, and volume fraction are such features that play a constitutive role in the determination of NFPCs mechanical properties. Mechanical properties of PLA, epoxy, PP.

4.1. Natural Fiber Composites Applications in the Interior Car.

Most of the car companies in the world have done a lot ofinvestigation in order to insert the NFPCs in their products.The car manufacture in Europe has done various researchesto increase the applications ofNFPCs in automotive industry,especially in car interior such as seat backs, parcel shelves,boot linens, front and rear door linens, truck linens, anddoor-trim panels . Beside the use for car interior partsin automobile industry, natural fiber embedded in polymershas been used for high requirement applications for xteriorrauto body components, such as the middle section betweenthe headlights above the fender of a passenger bus [14].

German auto companies (BMW, Audi Group, Ford,Opel,Volkswagen, Daimler Chrysler, and Mercedes) utilize thecellulose fibers composites in various automobile part, shownsuch as using coco nut fibers rubber latexcomposites for the seats of the Mercedes Benz A-class modeland using fax-sisal fiber mat reinforced epoxy door panelsof Mercedes Benz E-class model. Audi company usesflax/sisal mat reinforced polyurethane composite with a mixto make door trim panels. Ford is using kenaffibersimported from Bangladesh in their “Mondeo” model and thedoor panels of the Mondeo are manufactured from kenafreinforced PP composites while using flax in floor trays.Kenaf and flax mixture has gone into package trays and doorpanel inserts for Opel Vectras. Volkswagen Company used [15]

4.2. The Natural Fibber Applications in the Industry

Otherthan the car industry, the applications of NFPCs are foundin building and construction,aerospace, sports, and more,such as partition boards, ceilings, boats, office products, andmachinery.Themost applications of NFPCs are concentrated on non load bearing indoor components in civil engineeringbecause of their vulnerability to environmental attack.Green buildings are wanted to be ecologically mindful,suitable, and healthy place to live and work. Bio compositesisconsidering one of the major materials utilized as a partof green materials at this time. It could be categorized,with regard to their application in the building market,into two principle products: firstly, structural bio composites,which include bridge as well as roof structure, and secondly,non-structuralbio composites which include window,exterior construction, composites panels, and door frame.The wide advantages of natural fibres reinforced compositessuch as high stiffness to weight ratio, lightweight, andbiodegradability give them suitability in different applicationin building industries[16]have shown that good properties of thin walled elements suchas high strength in tension and compression, made of sisal fiber reinforced composite, give it a wide area of application,for instance, structural building members, permanentformwork, tanks, facades, long span roofing elements, andpipes strengthening of existing structures.

4.3 Applications of Natural fibre composites in Marine

In boat construction, the resins used in fibre reinforced plastic (FRP) structures are mainly thermosetting (polyester, epoxy, vinylester, etc.). Thermoplastic resins (polyamide, polypropylene, PET, PBT, etc.) have only recently started being used for boat-building or fittings. Recently, the composition of resins has evolved in two ways: both low emission and low styrene content resins are now available on the market. More recently, bio-based resins have started to appear, but their use is still very limited in the nautical sector. The environmental benefits of bio-based resins and adhesives lie in the elimination of toxins in general, the focus on human health and the environment, the reduction of hazardous and toxic materials and waste, the reduction of polluting air emissions, and their recycling capacities. Regarding fibres, natural fibres are also beginning to enter the composite market, but their use in structural elements is limited due to their relatively poor physical properties. Currently, they are used predominantly for filling functions. Glass fibres represent 89% of the worldwide volume of fibres used in composites, while only 10% are natural fibres [17]. At the same time, numerous R&D studies for the use of natural fibres are under way and should allow for greater industrial applications in the midterm future.

Conclusion

The automotive industry requires composite materials that meet performance criteria as determined in a wide range of tests. Typical market specification includes ultimate breaking force, elongation and flexural properties. The complete characterization of the mechanical properties of ecological composites is an essential step for their common and widespread use. Several families of ecocomposite, consisting of a "green" matrix reinforced with natural fibers, have been produced and experimentally tested. These results have been compared with experimental data from "traditional" composites. The characterization of these materials' mechanical properties is an important factor for their application in real cases. In fact, mechanical properties such as flexural and tensile resistance can largely limit the use of green composites in industrial applications. The use of hybrid laminates, together with sandwich solutions, can offer an interesting practical solution. In this investigation, use of fibers of mineral (basalt) and plant (flax) origin as the reinforcing fibers are assembled in a green thermoset matrix in sailing applications, offering low environmental impact. It can be concluded that natural fiber-reinforced biodegradable polymer composites can offer a valid response to the desire for sustainability over a wide range of applications, including sailing applications.

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