BIOCOMPOSITES: A REVIEW

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Abstract

In recent years, lot of research has been done in order to develop the sustainable material such as "Bio-composites" due to increase in awareness among such kind of materials. As conventional materials spreading a lot of carbon foot prints and the recycling problems of synthetic composites forces the researchers to develop the bio-composites which do not have any negative impact on the environment. This critical review provides an insight about the types of bio-composites, different matrix material and various reinforcement used to that bio-composite for various applications. It also describes the steps adopted to enhance the mechanical properties by adding different coupling agents. It also gives an insight on various advantages and applications of bio-composites.

1. INTRODUCTION

Composite contain two (or more) different phases or components, which have totally different properties from the individual constituents. Generally, a stiff, and strong reinforcement (filler), surrounded in a continuous matrix make a manmade composite. The matrix is usually weaker and more compliant than the reinforcement fibers. The matrix mainly transmits shear stresses at the interface to the reinforcement. In addition, matrix protects the reinforcement from environmental damages and chemical attacks. The coupling between reinforcements and matrix provides the structure with higher stiffness and strength depending upon the fibers [1].

Generally, fiber reinforced plastics (FRP) are stiff, and have high strength. Their properties can be optimized by gaining more alignment of fibers along the load paths. These are the reasons that make composites a successful material for several applications [2].

2. BIOCOMPOSITES

Bio-composites are composite materials consisting of one or more constituents formed from a renewable resource. The reinforcement could be selected from natural plant fibers such as flax, cotton, Kenaf, hemp, jute and so on. Bio fibers derived from waste papers, or recycled wood, and also by-products from food crops are in category of wooden fibers. This definition contains regenerated cellulose fibers such as viscose and rayon as well, because they are also derived from biological origins similar to natural nano fibrils of chitin and cellulose.

Matrices commonly used with natural fibrs at the present time are fossil derived polymers. Examples of these matrices are thermoplastic polymers such as polypropylene (PP), Polyethylene (PE) and Polyvinyl Chloride (PVC) and thermosets polymers such as phenolics, epoxies etc. In bio-composites, the ideal matrices are of renewable origin such as from starches and vegetable oils. [1].

3. REINFROCEMENT/FILLER

Strength and stiffness properties of fibers make them suitable materials for reinforcement in fiber reinforced composite materials. Generally composite properties are governed by the inherent properties of the reinforcement fibers in them.

Comparing stiffness, specific tensile strength, elongation at break of natural fibers with synthetic fibers, make natural fibers potential substituent fore-glass fibers. Because of the great importance of E-glass fibers in composite industry. It can be considered as reference reinforcement [1].

The use of natural fibers to reinforce thermoplastics such as polypropylene and polyethylene as an alternative to synthetic or glass fibers has been and contnues to be the subject of research and development. The potential advantages of using natural fibers have been well documented and are generally based on environmental friendliness as well as health and safety factors [2]. There are 3 different kind of natural fibers; vegetable, mineral and animal fibers. Vegetable fibers can be subdivided into wood and non-wood fibers. Based on the origin of non-wood fibers in the plant, they can be classified into leaf, bast and seed hair fibers. On the other had subdivision of wood fibers is between softwood and hardwood. All kind of vegetable fibers, however consists of three major cell wall polymers: lignin, cellulose and matrix polysaccharides. Beside these main components, there are a few non-structural components, such as inorganic salts, waxes and nitrogenous materials [1].

4. MATRIX

The fibers in a fiber-reinforced composites are held together by the matrix. Applied forced to the composite, are transferred to the fibers via matrix. Another important function of matrix is to protect fibers from mechanical and environmental damage. In traditional composites, the matrix mainly consists of either a thermoset or thermoplastic polymer. Examples of thermosets and thermoplastics are unsaturated polyester and polyethylene respectively.

The bio-composites manufacturers demand that the matrix mainly be prepared from renewable origins, even through the current biopolymer technologies show that synthetic thermoset and thermoplastic polymers dominate commercial bio-composite fabrication. Consequently polypropylene (PP) and polyethylene (PE) are extensively used in wood-plastic composites (WPCs). However, biocomposite based WPC, are now receiving a considerable amount of interest and are in widespread commercial production, especially in North America. Till now large group of thermoplastic biopolymers that have been used mainly for the packaging industry do not meet the material properties requirements for other fiber reinforced composites. Their properties such as high processing viscosity and the overly high elongation at failure are harmful for many applications. There is significant need for development of thermoset polymers from renewable origins due to the limitations of thermoplastics. Thermosetting resins derived from vegetable oils have been emplyied as the building blocks and are usually modified in order to produce cross-linkable molecules, examples being maleates, epoxides, isocyanates or aldehydes.

5. ADDITIVE/IMPACT MODIFIER

PLA is inherently a very stiff and brittle material. A previous study has shown a significant improvement of mechanical properties and processability of the PLA composites by adding plasticizer to PLA [3].

Biomax strong 120 is a petroleum based ethylene acrylate copolymer. This material acts as an impact modifier for PLA composites and also has good compatibility with PLA [4]. Few studies show that 1 to 4% loading of biomax strong reduces extruder drive power, melt temperature, while increases energy efficiency. It is also shown that addition of only 1-2% of this modifier considerably increases the toughness [5]. Biomax strong benefits are as following:

a) Increase toughness
b) Reduce Brittleness
c) Enhance Flexibility
d) Improve impact strength

6. ADVANTAGES OF BIO-COMPOSITES

There are some attractive properties of PLA, which make it a potential future material for commercial packaging applications. Examples being are its production from renewable resources, its good mechanical characteristics, and the capability of recycling or composting of the material. Incineration and land-filling are the existing methods of disposal for these polymers. The composting process efficiency closes the disposal loop by returning the materials to the soil, the place in which biodegradable takes place [3].

The other features such as greater environmental concerns, public awareness and the reduction of petrochemical based polymers provide a driving force to the growth of new products derived from natural fiber and biopolymer resources. Establishment of laws by governments in some countries encourages people in use of products which are recyclable and/or biodegradable known as green products.

7. APPLICATIONS OF BIOCOMPOSITES

Until the last decade, factors such as high cost, low availability and limited molecular weight had restricted the uses of PLA to medical applications. Some of the examples include surgical implant devices, tissue culture, internal sutures, wound closure, and controlled release systems. Recently, development of new techniques allowed const effective production of high molecular weight PLA polymer, hence its application have broadened. The other examples of conventional products which are made by PLA are thermoformed cups, and containers, support trays, electrical/electronic applications such as (housing for laptop computers), candy wrap, optically enhanced films, shrink labels, and various food packaging products [6].

8. CONCLUSION

Many problems have been associated with the utilization of petroleum based products such as increasing costs and environmental degradation due to extraction, processing and disposal. Therefore researchers have recently focused attention on bio-composites. Natural fibers offer a possibility to developing countries to use their own natural recourses in their composite processing industries. Natural/Bio-fiber surface modifications, development of bio-plastics as a suitable matrix for composite fabrication and processing techniques all play vital roles in designing and engineering bio-composites of commercial interest.

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