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Biodegradation Of Natural Fiber & Glass Fiber Polymer Composite-A Review

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Abstract— Hybrid composites are advance conceptual composite materials. These are that materials which contains two or more non similar types of natural/synthetic fiber in one of the fiber could neutralize the deficiencies in the other. Due to hybridization high corrosion resistance property of natural fiber increases as compare to the synthetic fibers like glass fiber have improved chemical & mechanical properties. In this paper there is setting a review on hybrid polymer composites reinforced with glass and natural fiber as bamboo fiber based on their biodegradability. The importance of biodegradability is to develop composite materials which are ecofriendly.

***Key Words*: Biodegradability , Natural fibers, Hybridization , Synthetic fibers, Tensile modulus**

1. Introduction

As per environmental prospect natural fibre has many advantages such as lower pollutant emissions, lower green house gas emissions and end of life biodegradability of components. Recently studies proven that performance of natural fiber as per environment prospect is far better than glass fiber[1] over its specific applications. In many application natural fiber shows superiority over the glass fiber composite due to having more fibre content and low impact on environment. It has also another properties like low weight density and less emission when they are going to use. As decay in carbon credit & energy it causes biodegradability in natural fibre.

1.1 Importance of Bamboo Fiber

The reason why bamboo fibre is more prefer over another natural fibre is that its ecofriendly nature as rate of growth high, low carbon emission and easy availability.The properties of bamboo arehigher strength and low weight more stiffness.It has also roots and leave which keep the soil together and protect it against the sun respectively. Because of these properties bamboo can be used traditionally for manufacturing of living utilities. For reinforced composite materials base bamboo can be used on extracting appropriate fibers in suitable manner. Bamboo is the last sustainable plant resource which has not been used vastly .Studies have done over natural fibre as reinforcements for both synthetic polymers and biopolymers. The Plant fibers have cellulose fibrils dispersed in a matripilx of lignin and hemicelluloses. They also have small amounts of free carbohydrates, proteins, extractives, and inorganics. For plant fibers cellulose is the basic structural component and the most abundant naturally-occurring polymer on earth. Hemicelluloses are polysaccharide polymers comprised of shorter polymer chains than cellulose. Lignin is an amorphous polymer of phenol-propane units. It can be a trusting agent which gives their rigidity to cell walls of plant. The content of lignin in bamboo is more than many other natural fibers, which make it brittle.

1.2 Comparison between Glass fiber & bamboo

The bamboo is also called natural glass fiber because of its strength. The remarkable properties of bamboo fibers as its low density & strength stiffness can be compared with glass fibers. The hybrid composites treated with alkali bamboo fibers were possess higher flexural properties. The surface changes in bamboo fiber will effectively removing the impurities and bond between fibers in which the various compositions classified in the different percentage will get the different results of testing. This is due to the hydrophilic nature of bamboo fiber, where the different methods required for improving interfacial surface adhesion. This means that by understanding the fiber structures and characteristics which influence to composite performance, it can lead to the highly development of additives, coating, binders, or sizing of the natural fiber and a assortment of polymeric matrices. When specific modulus is considered for lignocelluloses fibers, it shows the values which are comparatively better than glass fibers.

Table 1: COMPARISON OF BAMBOO AND GLASS FIBER

Property	Bamboo	Glass Fiber
Density	Low	Higher than Bamboo glass fibre
Cost	Low	Higher than Bamboo glass fibre

Disposal	Biodegradable	Non-Biodegradable
CO_2 absorption	Yes	No
Recyclability	Yes	No
Renewability	Yes	No
Energy for extraction	Low	High

2. Hybrid composites

In polymer composites system, hybrid composites are those in which one kind of reinforcing material is merged in a mixture of different matrices or two or more reinforcing and filling materials are present in a single matrix or both approaches are combined. The incorporation of two or more lingo cellulosic fibres into a single matrix has led to development of hybrid composites. The behavior of hybrid composites is a weighed sum of the individual components in which there is more favorable balance between the inherent advantages and disadvantages. While using a hybrid composite that contain two or more types of fiber, the advantages of one type of fiber could complement with what are lacking in the other. As a consequence, a balance in cost and performance could be achieved through proper material design. The strength of the hybrid composites is dependent on the properties of fiber, the aspect ratio of fiber content, length of individual fiber, orientation of fiber, extent of intermingling of fibres, fibre to matrix interface bonding and arrangement of both the fibers and also on failure strain of individual fibers. Maximum hybrid results are obtained when the fibers are highly strain compatible. R.Sakthivela and D.Rajendran (Experimental Investigation and Analysis a Mechanical Properties of Hybrid Polymer Composite Plates, 2014). In this project natural fiber and glass hybrid composites were fabricated by using epoxy resin combination of hand lay-up method and cold press method. A significant improvement in tensile strength was indicated by the woven fiber glass hybrid composites. In this hybrid composite laminates banana-glass-banana (BGB) and glass-banana-glass (GBG) exhibit higher mechanical properties due to chemical treatment to natural fibers.

3. Bamboo/glass Hybrid Composite

In spite of several merits, natural fibers show lower modulus, lower strength and poor resistance when compared with the composites reinforced with synthetic fibers such as glass, carbon and aramid. These limitations can be reduced by introducing hybrid composites where in two or more fibers are reinforced to a single matrix. The interlinking of of Bamboo with glass fibers produces an advanced composite which have the properties like low weight, good mechanical properties and tribological properties. Due to the low density, the natural fibers are widely used as reinforcing agent as it is high biodegradability.

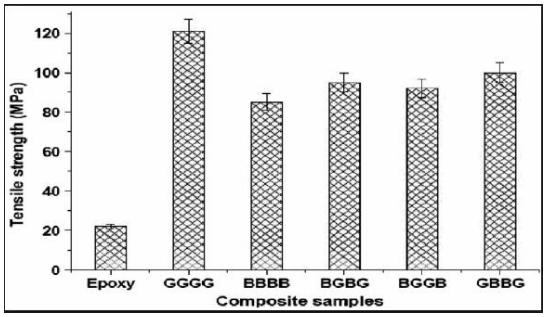

Fig 1: Tensile Strength comparision of bamboo glass hybrid composite

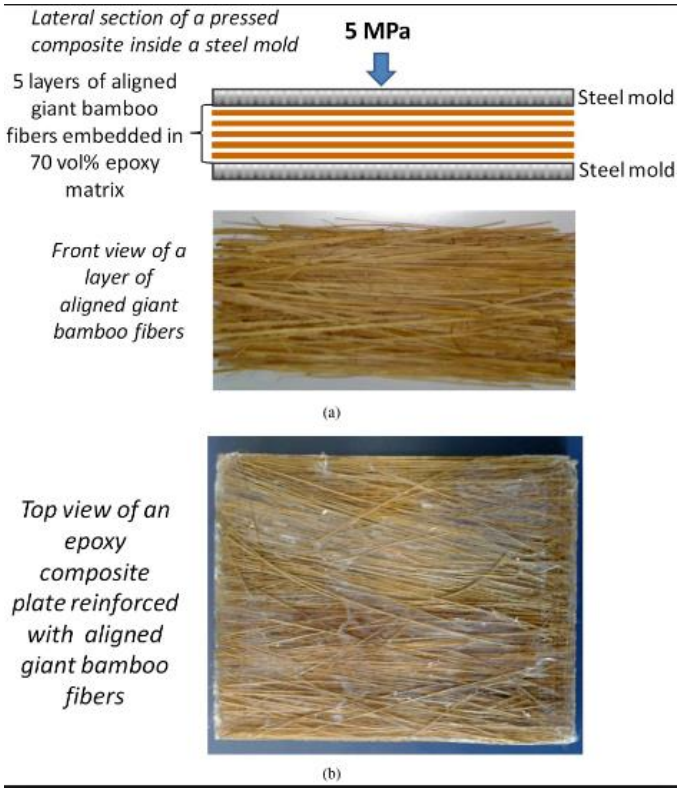

Fig 2: Bamboo glass hybrid composite with epoxy

4. BIODEGRADABILITY OF POLYMERS

This may be defined as degradable plastics are those which follow a significant change in chemical structure under certain environmental conditions. [2] The changes results in a loss of physical and mechanical properties, as measured by LCA (Life cycle Assessment). Plastic which is biodegradable degrades as per trhe effect of the microorganisms like bacteria, algae and fungi.The plastic having resistive properties over the biodegradation is conventional plastic, as the surfaces which is in contact with the soil in which they are disposed are characteristically smooth. Microorganisms of soil cann't consume a portion of the plastic, which would, [3] in turn, cause a more rapid breakdown of the supporting

matrix. The polymer matrix which is derived from natural fiber reinforcements are biodegradable. Microorganisms can consume such materials in their entirety for leaving carbon dioxide and water as by-products. When examining polymer materials from the scientific point of view, there are certain ingredients that must be present in order for biodegradation to occur. Most importantly, the active microorganisms (fungi, bacteria, actinomycetes, etc.) must be present in the disposal site. The organism type determines the appropriate degradation temperature, which usually falls between 20 to 60oC. The biodegradation of material occurs in many steps. At first, the macromolecules which are digestible join for forming a chain having an experience a direct enzymatic splitting. The split portions of the metabolism follows and it is preeminent to a progressive enzymatic dissimilation of the macromolecule from the end of chain. Oxidative cleavage also occurs instead of leading to metabolization of the fragments. Either way, the fragments of chain be short more enough to be converted by microorganisms. Ideally, the biopolymer will be disposed in a bio waste collection, and later composted. This process will finally left behind water and carbon dioxide as byproduct which are environmentally friendly.

4.1 Biodegradablityof Hybrid Composites

In polymeric material biodegradation is like chemical degradation due to the action of naturally occurring microorganisms such as bacteria and fungi through enzymatic action into metabolic products of microorganisms. It is the chemical dissolution or breakdown of materials. It occurs because of enzymatic action and involves living micro and macro organisms. Molecular degradation is activated by enzymes and can occur under aerobic and anaerobic conditions, leading to complete or partial removal from the environment. Linear polymers are generally more biodegradable than branched polymers. The biodegradability of natural polymer composite has been examined in various environments such as in the soil, compost and weather. The biodegradable natural fiber polymer composite could be used as an alternative to the synthetic fiber polymer composites. These polymers composite can be disposed in safe and ecologically sound manner, through disposal processes like putting compost, soil application, and biological waste water treatment. Based on its importance the research the application of biodegradable natural fiber in polymers reinforced composites is going on day by day. In order to prove the nature of its biodegradability the bio-composites were technically buried in garbage dump land, which consists of cellulolytic bacteria

4.2 Bamboo Hybrid Biocomposite

Recently, bamboo fibers is making attention to be hybridized with more corrosion-resistant synthetic fibers such as glass and carbon fibers in order to tailor the composites properties according to the desired structure under consideration. Since synthetic fibers degrade at a much slower rate or does not degrade at all, inclusion with natural fibres may lead to green environmental balances with improvement in performances.Hybrid bamboo-glass fibers composites exhibit improvements in terms of stiffness, strength and moisture resistance properties. But the durability of bamboo-glass fibres composites under environmental aging was improved compared to pure composites. Capability of bamboo to produce seven types of shapes encompasses silver, stripes, laths, veneer, particles, strands until bamboo fibers gives a huge impact in creating valuable hybrid biocomposites based on bamboo for various applications. The hybrid approach glass fibre with bamboo fibre is an effective way to improve the strength and durability of bamboo. But it becomes ecofriendly by its biodegradation when it is added with proper biodegradable polymer. The common matrix added to bamboo glass fibre is polyester, polypropylene, Epoxy resin and vinyl ester.

4.3 Bamboo/glass polypropylene Hybrid composites

Bamboo/glass polypropylene Hybrid composites of polypropylene reinforced with bamboo and glass fibers (BGRP) were fabricated using an intermeshing counter rotating twin screw extruder followed by injection molding. The effect of hybridization makes efficient fiber matrix interfacial adhesion. The storage modulus is higher for PP based bamboo/ glass fiber. The biodegradability [4] test progressed over time up to 700 days, the hybrid composites biodegradability enhanced with increasing RH content because the cellulose is easily attacked by microorganisms. The observations show that for PP/EG/naturalfibre hybrid composites, with treatment, it shows better biodegradability rate. This is due to good interactions between molecular structure of matrix, fibers and NaOH in each case. The results suggested that it is possible to blend the non-degradable Polypropylene polymer and E-glass synthetic fiber with any natural fibre in order to improve its biodegradability. Bamboo could be utilized as biodegradable filler at end of use in polymeric composite materials to minimize environmental pollution rather than produce strong reinforcing fillers.

4.4 PLA as a biodegradable polymer

Poly lactic acid (PLA) is one of the most common biodegradable plastics for food packaging applications, which is the largest volume of plastic materials consumption. According to the discoveries by the previous studies revealed that anti-microbial properties as well as the biodegradation process of materials were influenced by the biodegradable reinforcing fibers. There are many different polymers from renewable sources poly lactic acid (PLA), cellulose esters, poly (hydroxyl butyrates), starch and lignin based polymer materials. Among them PLA has given high priority among other biodegradable polymers. This is linear aliphatic thermoplastic polyester, produced from renewable resources with good biocompatibility, non-toxic byproduct and high

strength and modulus. One of the [5] methods to improve the mechanical and thermal properties of PLA is the addition of fibers or filler materials. PLA/plant fiber green composites were widely investigated and it has been found that they exhibit increased fiber reinforcement. It is often observed that the increase in fiber loading leads to an increase [6] in tensile properties.PLA can be synthesized by the polymerization of D- or L-lactic acid or ring-opening polymerization of the corresponding lactide. Under specific environmental conditions, PLA can degrade to carbon dioxide, water and methane over a period of several months to two years, a distinct advantage compared to other petroleum plastics that need much longer periods. The final properties of PLA strictly depend on its molecular weight and crystallinity. In short PLA resins [7] are nowadays marketed for different applications.

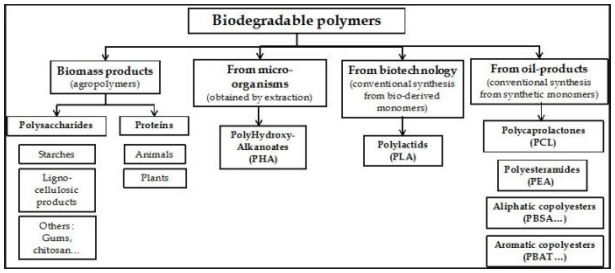

Fig 3: Classification of Biodegredable Polymer

4.5 Bamboo Fiber/PLA Bio-Composites

In the preparation of Bamboo/PLA, bamboo fiber is treated with silane, then the composites can be prepared by melt blending and compression molding. Okubo [9] developed hybrid bio-composites based upon a biodegradable (PLA) matrix reinforced with microfibrillated cellulose and bamboo fiber bundles. [10].They found that by adding just 1 wt% of MFC with a high degree of dispersion an increase in fracture energy of nearly 200% was obtained. Lee prepared bamboo fiber-filled (PLA) eco-composites by mechano-chemical compositing with bamboo fiber (BF)-esterified maleic anhydride in the presence of dicumyl peroxide as a radical initiator.

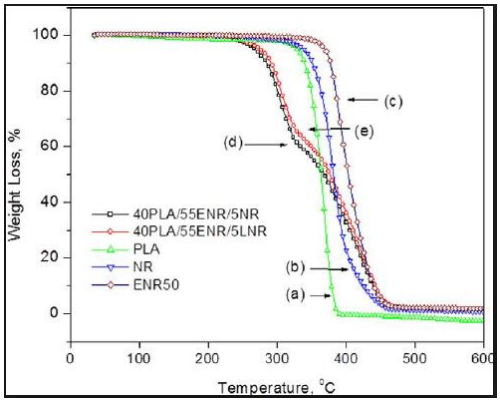

Fig 4: Comparision of weight loss % and temperature of PLA and other composite

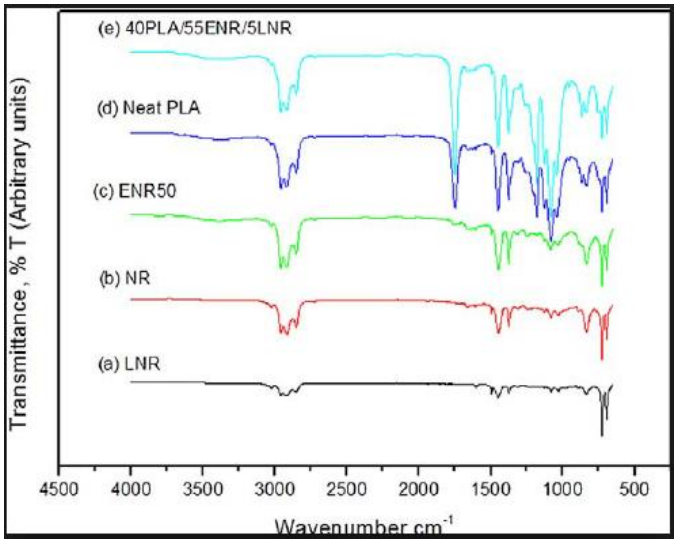

Fig 5: Comparision of Transmittance % and wave number of PLA and other composite

5. Conclusion

Natural fibers reinforced PLA composites are a fully renewable materials with an effective degradability as compared to non renewable petroleum based products. Both PLA and natural fibers are hydrophilic in nature and is assumed that this property will facilitate a better adhesion. In this review attempts are made to search the possibility of developing a hybrid biodegradable polymer made of bamboo/glass along with polylattic acid. This can be applied to various fields such as household items, automobiles and food packaging systems. By using this type of polymers an ecofriendly atmosphere can be created and thus hazardous effects can be reduced.

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