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A Review Paper on Natural Fiber ReinforcedLaminated Composite Materials

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Abstract-Fiber reinforced composites were in use since ancient times. Due to the drawback of the synthetic and fsiber glass as reinforcement, the use of fiber reinforced composite increased the interest of the researcher or the scientist. This review article investigates the use of various fibers as reinforcement incomposites. With the innovation in science and technology the new means of depiction and evaluation of physical, chemical, thermal and mechanical properties of the composite have been used that have explored the new scope of utilizing them for various purposes. The term „Composite" may be defined as a mixture of two or more distinct constituents or phases. However this definition is not sufficient, there are some conditions which have to be satisfied before a material is to be said as composite.

introduction

First, both constituents have to be present inreasonable proportions, say greater than 5%. Secondly, it is only when the constituent phases have different properties, and hence the composite properties are noticeably different from the properties of the constituents, that we have come to recognize these material as composites. We know that composite have two or more phases on a macroscopic scale, separated by a distinct interface. The constituent that is continuous and is often but not always, present in greater quantity in the composite is termed as „Matrix". A composite have ceramic, metallic or a polymeric matrix. Reinforcement is the part of the composite that provides strength, stiffness, and the ability to carry a load. In many cases the reinforcement is harder, stronger and stiffer than the matrix. Wood is an interesting example of a natural fiber composite comprising of cellulose fibers in a matrix of lignin with varying spiral angle [34]. In manufacturing, fibers are the most commonly used reinforcement that defers Fiber Reinforced Composite (FRC). The reinforcement is embedded into the matrix. Commonmatrixes include mud (wattle and daub), cement (concrete), polymers (fiber reinforced plastics), metals and ceramics. The most common polymer-based composite materials include fiberglass, carbon fiber and synthetic fibre. Fiberglass is probably one of the most familiar reinforcing composite materials that were introduced in 1940, consisting of glass fiber reinforcement of unsaturated polyester matrix [1-3]. This glass fiber had numerous problems that led to search for alternate substitute as reinforcement. Fiber as reinforcement to the composite had outstanding physical, chemical, thermal and mechanical performance, durability and biodegradable nature that highlighted and promoted its scope. The starting of

composite materials may have been the bricks formed bythe ancient Egyptians from mud and straw. The ancient brick-making method can still be seen on Egyptian tomb paintings in the Metropolitan Museum of Art. Commercialization of the composites could be traced to

early century when the cellulose fibers were used to reinforce phenolics, urea and melamine resins. Composites in the world of today have wide range of applications, wherever high strength-to-weight ratio remains and important consideration for use. Its principal use is found in automotive, aerospace, marine and construction industries. In majority of cases, requiring high performance in the automotive and aerospace industries, the discontinuous phase or filler is in the form of a fiber. In most cases, composite matrix is the thermosets having carbon and ceramics for high temperature applications. Thermosets (epoxy,polyester, phenolics etc.) and thermoplastics (polyetherether ketone, polypropylene,PLA etc.) due to high strength and performance are found to be for research and industrial applications.The use of natural fiber as reinforcement in composite was achallenging job. Ferreria et al. [4] enhanced the fatigue strength by using hybrid fiber composites with a polypropylene hemp layer next to the bond interface which was expected to produce more uniform stress in temporary regions. A major drawback of natural (plant) fibers compared to synthetic fibers is their non-uniformity, variety of dimensions, and their mechanical properties (evenbetween individual natural (plant) fibers in the same cultivation) [5]. Due to their high specific strength andmodulus, natural fibre reinforced polymer composites are receiving widespread attention. Keeping these things in mind, this paper is focused on microwave processing ofpartially and fully bio-degradable composites. The advantage of microwave processing is that, it leads to significantly faster curing times compared to thermal processing. Natural fibres like coir, rattan and bamboo are experimented as reinforcement [6, 7]. Richardson and Zhang [8] applied flow visualization experiments using resin transfer molding for developing a better understanding of the mold filling process for hemp mat reinforced phenolic composites. Eucalyptus urograndis pulp used as the reinforcement for thermoplastic starch showed an increase of 100% in tensile strength and more than 50% in modulus with respect to non-reinforced thermoplastic starch [9]. Fiber reinforced composite materials offered a combination of strength and modulus that are either comparable to or better than many traditional metallic materials. Increase in the flax and jute fiber content in polyurethane based composites increased the shear modulus and impact strength. However, increasing the micro void content in the matrix decreased its strength [10]. Jayaraman and Bhattacharya [11] reported the mechanical performance of wood fiber waste based plastic composites and observed that tensile strength does not generally change with fiber content. Zulkifli et al. [12] prepared Natural Rubber (NR) - Polypropylene (PP) composites by increasing the amount of NR in PP by 5-20% increase in its composition, inter- laminar fracture properties as well as the resistance of material to delaminate crack propagation. With increase in NR amount of this inter-laminar fracture the toughness of composite material decreased. Thwe and Liao [13] studied the resistance of bamboo fiber-PP hybrid composites to hygrothermal aging and their fatigue behavior under cyclic tensile load. The use of maleic anhydride polypropylene as a coupling agent suppressed the moisture absorption and degradation in such composites. Herrera- Franco and Valadez-Gonzalez [14] reported that fiber matrix adhesion promoted the fiber surface modification on alkaline treatment and matrix pre-impregnation e.g. use of silane as coupling agent in case of henequen fiber-HDPE composite. The increase in mechanical strength was found to be raised between 3–43% for longitudinal tensile and flexural properties whereas in transverse direction, the increase was greater than 50% with respect to the properties of composites made of untreated fiber. Increase in stiffness was approximately 80% of the calculated values.

Electrical properties of the wood polymer composites from agro-based materials such as banana, hemp and agave fiber using novolac resins have been reported by Naik and Mishra[15]. Mitra et al. [16] treated the unwoven jute fiber with precondensate like formaldehyde, melamine formaldehyde and polymerized cashew nut shell liquid-formaldehyde, prior to its use as reinforcing material for the preparation of composites. The treatment reduced the moisture absorbance of the jute. Kandola et al. [17] reported the fabrication of novel glass reinforced epoxy composites containing phosphate. Eichhorn and Young [18] studied the deformation in micro mechanics of natural cellulose fiber networks and composites. Kaith et al. [19, 20], Singha A.S et al. [21] prepared a polymer matrix based composites using flax-g-copolymers, flax fiber and mercerized flax as reinforcing agent. It was observed that the reinforcement increased the endurance of the composite to higher loads as compared to pure polystyrene. Mercerized fiber was found to be more effective reinforcing agent for wear resistance, tensile strength and compressive strength as compared to the grafted fibers. However, reduction in moisture absorbance and increase in the chemical resistance on graft copolymerization was observed. Recently, a group of scientists were extensively involved with the pultrusion technique for a large scale production of kenaf fiber reinforced composite samples, as reported by [25, 26, and 27]. Orientation of fibres is having very important role in the strength. Presently only layered fibres arranged in sindirection was used. Thestrength values may improve if mesh type structure of fibres were used [24].It has been shown that etherification improves the dispersion of fibers in a polymer matrix, as well as the dimensional stability and interface of the final composites [28, 29].

Chauhan A [22] utilized the Hibiscus sabdariffa (Roselle) stem as reinforcing agent in phenol formaldehyde matrix based composites. Roselle fiber was graft copolymerizedwith monomers like methyl acrylate, ethyl acrylate, butyl acrylate and acrylonitrile and used these graft copolymer as reinforcement in the composite. The embeded fiber and composites were characterized by SEM, XRD and TGA, evaluated for physico-chemico-thermal properties [23]. Itwas observed that the tailored grafted fiber integrated into the composite improved the physico-chemico-thermo- mechanical competence. Since, the grafted monomer acted as a coupling agent. The mechanical valuation was done on the basis of wear, tensile, compressive strength test, flexural strength, young‟s modulus and hardness. On the other hand,some discrepancy was seen in few cases but in most of the cases the strength gets better. The better mechanical behavior could be accounted due to compatible fiber-matrix interaction and orientation of the fiber. However, some deviation in the results could be justified by other governingfactors for overall mechanical performance like nature and amount of matrix and fiber, orientation, distribution of the fiber with respect to the matrix axis, form of reinforcement used (woven or non-woven, grafted or ungrafted), strength of the interfacial bond between the fiber and matrix, length of the fiber (continuous or discontinuous), aspect ratio that on mere imbalance may lead to de bonding and cracking [22,30].

So, we have seen above that various researchers have used the low weight and high strength of fibers like hemp, flax, jute as reinforcement to form fiber reinforced composite. These reinforcements have developed the strength and properties of composites if used after the graft co- polymerization of the fiber like Roselle. We are blessedwith variable natural resources and fiber but very less has been investigate and utilized as yet. Fiber reinforced composites are one of the resources to utilize the natural resources. But, with the passage of time, these renewable resources and fiber will soon diminish. So, there is a great need to maintain and procure them for the future use. We should look for more abundant means to explore the maximum potential and utilize the natural fiber for the advancement of science and technology.

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