STUDY ON NATURAL FIBER REINFORCED POLYMER COMPOSITE AND ITS APPLICATIONS

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ABSTRACT:

Natural fibers are attracting attention from researchers and educators for their use in polymer composites due to their eco-friendly nature and stability. Furthermore, it provides the texture of various surface medicines applied to normal strands and their effect on the properties of NFPCs. Simple fiber-reinforced polymer composite is changing rapidly up to their advanced applications and major research. They are inexhaustible, humble, completely or incompletely recyclable and biodegradable. These alloys have low thickness and cost due to simple composite access and stability of raw materials. Characteristic strands were selected as opposed to engineering fiber in transport, for example, cars, railroad guides and aviation. Various applications include military, building, bundling, customer goods and development ventures for roof framing, segment sheets. This paper conducts an audit of various common fibers with its assembling mechanisms and especially the polymer film coated with coir and hemp fiber.

***Key words**: Natural fiber, processing, testing of composites*

1. Natural fibers:

natural fiber composites incorporate coir, jute, baggase, cotton, bamboo, hemp. Regular filaments originate from plants. These strands contain dialect cellulose in nature. Normal filaments are eco-accommodating; lightweight, solid, sustainable, modest and biodegradable. The characteristic strands can be utilized to fortify both thermosetting and thermoplastic lattices. Thermosetting gums, for example, epoxy, polyester, polyurethane, phenolic are normally utilized composites requiring better applications. They give adequate mechanical properties specifically solidness and quality at acceptably low value levels. Late advances in regular fiber improvement are hereditary building. The composites science offer huge open doors for improved materials from inexhaustible assets with upgraded support for worldwide manageability. Common fiber composites are appealing to industry as a result of their low thickness and environmental focal points over ordinary composites. These composites are picking up significance due to their non-cancer-causing and bio-degradable nature. Regular fiber composites are financially savvy material particularly in building and development, bundling, car and railroad mentor insides and capacity gadgets [14].These composites are possible contender for substitution of significant expense glass fiber for low burden bearing applications [23]. Regular filaments have the benefits of low thickness, minimal effort and biodegradability. Nonetheless, the principle weaknesses of common fiber composite are the relative high dampness retention. Thusly, concoction medicines are done as such as to alter the fiber surface properties. [1] Development and portrayal of PLA-based green composites With expanding natural mindfulness and biological hazard, green composites have increased increasingly more examination consideration, as they can possibly be appealing than the customary oil based composites which are poisonous and non biodegradable. Due to their lightweight, well disposed handling and acoustic protection, green composites have been utilized generally running from aviation division to family unit applications. [2] An audit on the properties of characteristic strands and its profile composites: Effect of salt treatment. Because of the commanding favorable circumstances of common filaments, for example, biodegradability, eco-neighborliness, ostensible cost, low thickness and high explicit quality, they are being utilized inverse to manufactured strands in numerous modern applications. [3] Effect of ecofriendly covering and treatment on mechanical, warm and morphological properties of sisal fiber [4] Investigations on jute fiber-fortified polyester composites: Effect of salt treatment and poly(lactic corrosive) covering. the current examination is to conquered the confinements of jute fiber-strengthened polyester composite. [5] Lowering in water assimilation limit and mechanical corruption of sisal/epoxy composite by sodium bicarbonate treatment and PLA covering. The items get ready by these biocomposites have been utilized in the different applications. Be that as it may, their uses are not discovered reasonable in the applications where high quality and high water opposition are required. [6] PLA-covered sisal fiber-fortified polyester composite: Water ingestion, static and dynamic mechanical properties. a novel physical treatment (PLA covering) of sisal filaments and its impact on the water ingestion, static and dynamic mechanical properties of its composites has been introduced. [7] Poly(lactic corrosive)/thermoplastic polyurethane/wood flour composites: assessment of morphology, warm, mechanical and biodegradation properties.

II. CLASSIFICATION OF NATURAL FIBERS

Fibers are a class of hair-like material that are constant fibers or are in discrete extended pieces, like bits of string. They can be spun into fibers, string, or rope. They can be utilized as a segment of composites materials. They can likewise be tangled into sheets to make items, for example, paper or felt Natural strands incorporate those produced using plant, creature and mineral sources [19].

Regular filaments can be grouped by their starting point as:

1) **Animal Fibers**: contains fleece, silk, avian fiber. It incorporates sheep's fleece, goat hair, horse hair, quills and plumes fiber.

2) **Mineral fiber**: Mineral filaments are normally happening fiber or marginally changed fiber acquired from minerals. These can be additionally classified as asbestos, Ceramic, Metal fiber.

3) **Plant fiber**: Plant strands are for the most part included fundamentally of cellulose. This fiber can be further sorts into following.

a) **Seed fiber**: Fibers gathered from the seed and seed case for example cotton and kapok.

b) **Leaf fiber:** Fibers gathered from the leaves for example sisal and agave.

c) **Skin fiber:** Fibers are gathered from the skin or bast encompassing the stem of their separate plant. These filaments have higher elasticity than different strands. Accordingly, these strands are utilized for strong yarn, texture, bundling, and paper. A few models are flax, jute, banana, hemp, and soybean.

d) **Fruit fiber:** Fibers are gathered from the product of the plant, for example coconut (coir) fiber.

e) **Stalk fiber**: Fibers are really the stalks of the plants, for example, straws of wheat, rice, grain, and different yields including bamboo and grass. Tree wood is likewise such a fiber.

III. PROPERTIES OF NATURAL FIBER COMPOSITES :

Physical and mechanical properties of composites depend on the single fiber chemical composition (Cellulose, hemicelluloses, lignin, pectin, waxes, water content and other minors) according to grooving (soil features, climate, aging conditions) and extraction/ processing methods conditions. Grooving conditions is recognized as the most influent parameter for the variability of mechanical properties of the fibers. The chemical composition of several natural fibers is summarized in Table 1,

Fiber	Cellulose %	Lignin %	Diameter (µm)	Hemicellulose %	Elongation %
Coir	37	42	100-450	0.15	47
Banana	64	5	50-250	6-19	3.7
Sisal	70	12	50-200	10-14	5.1
Pineapple	85	12	20-80	16-19	2.8
Jute	71	13	15.9-20.7	13-20	3.0

Table 1: Chemical composition of natural fibers [10]

Many factors influence mechanical properties of natural fibers. In many cases, the experimental conditions are different. The mechanical properties of the natural fiber material depend largely on lengths and diameters of individual fibers. The density and tensile properties are tabulated in table 2.

Fiber	Density (g/cm^3)	Tensile strength (MPa)	Young's modulus (GPa)	Elongation at break (%)
OPEFB	0.7-1.55	248	3.2	2.5
Flax	1.4	88-1500	60-80	1.2-1.6
Hemp	1.48	550-900	70	1.6
Jute	1.46	400-800	10-30	1.8
Ramie	1.5	500	44	2
Coir	1.25	220	6	15-25
Sisal	1.33	600-700	38	2-3
Abaca	1.5	980	–	–
Cotton	1.51	400	12	3-10
Kenaf (bast)	1.2	295	–	2.7-6.9
Kenaf (core)	0.21	–	–	–
Bagasse	1.2	20-290	19.7-27.1	1.1
Henequen	1.4	430-580	–	3-4.7
pineapple	1.5	170-1672	82	1-3
Banana	1.35	355	33.8	53

IV. NATURAL FIBER REINFORCEMENT COMPOSITE

The ongoing region of examination is focused on plant fiber composites, which are mixed with gums. The common fiber composites are viewed as expected materials for some building applications. The coir, jute and bagasse are talked about in subtleties as follows: A. Coir fiber strengthened composite Coir originates from the husk of coconut natural product fiber. Coir has more life contrasted with other characteristic strands because of its high lignin content [10, 21]. Coir fiber strengthened with both thermoset and thermoplastic saps. The mechanical property of the composite relies upon interfacial grip of fiber to the grid material. Coir fiber demonstrated extremely high interfacial bond under dry conditions. The interfacial bond attributes of coir fiber with polyester framework were tried diverse maturing arrangements [8]. Coir fiber strengthened polymer composites produced for modern and financial applications, for example, car inside, framing and material as building materials, stockpiling tank, pressing material, caps and postboxes, reflect packaging, paper loads, projector spread, voltage stabilizer spread [9],[8],[10],[23]

Fig2: coir fiber

Coir filaments are more productive and better in fortification execution when thought about than other support composites [17]. Be that as it may, the principle impediments of coir filaments are high dampness content. It very well may be controlled with substance treatment. The interface between the fortifying specialist and the grid are the key issue as far as generally speaking execution. The exhibition of coir fiber strengthened epoxy composites are relies upon soluble base treatment and fiber length. Coir strands were treated with sodium hydroxide (NaOH) 2,4,6,8 and 10 % for 10 days. Fiber length was 10,20 and 30 mm. Soluble base treated composite alongside expanded fiber would be wise to affect quality (27 KJ/m2). Coir fiber length 30 mm and 8% antacid focuses would be advised to results [12]. Pretreated coir based composite performed preferred in mechanical properties over untreated coir based composite [19], [20]. Coir fiber fortified polypropylene composite was tried. Flexural properties of coir fiber pp composite were fulfilled in the middle of 40 to 60 wt%. Further addition of coir fiber content the flexural quality declines. The primary purposes behind lower flexural quality were inadequate network to cover all the outside of the coir fiber. Ideal composite board definition for car inside applications was blend of 60 wt% coir fiber, 37 wt% PP powder and 3 wt% MAPP [8].

B. Jute fiber reinforced polymer composite:

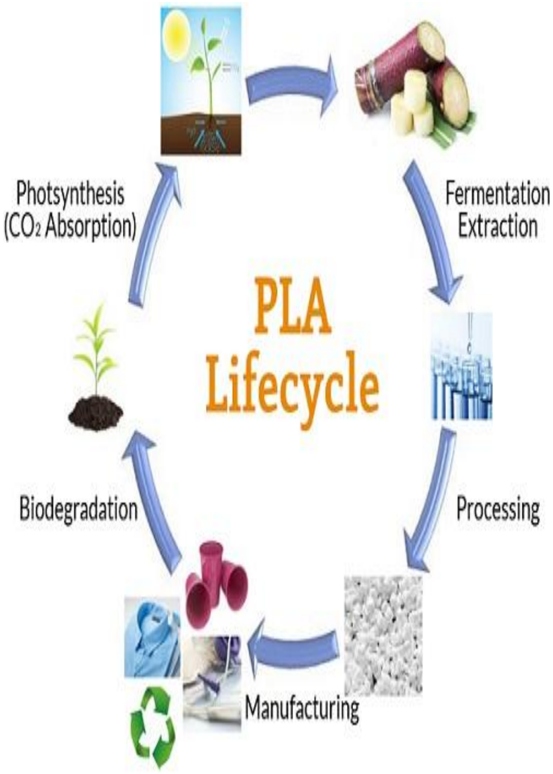
Jute has wood like characteristics as it is a bast fiber. Jute fiber has a high aspect ratio, high strength to weight ratio, good insulation properties. Jute fiber reinforced polymer composite has tested for door, window, furniture, corrugated sheet, I-shaped beam, trenchless rehabilitation of underground drain pipes and water pipes, false roofing, floor tiles [18],[22].

Fig 3: jute fiber

The jute fiber strengthened polypropylene composites mechanical properties were investigated. These are impact of fiber treatment by washing, mercerization and dying. Elasticity and malleable modulus were expanded with expanding % weight division and NaOH level of filaments in the pp framework. The most noteworthy rigidity and elastic modulus were 31.48 Mpa and 277.77 Mpa separately [20]. Jute fiber fortified epoxy composites were broke down with impact of fiber direction. The fiber directions were 0/90°, 15°/ - 75°, 30°/ - 60° and 45°/ - 45°. The higher quality and solidness were found at 0/90° fiber direction. Compressive trial of jute composite were tried and it discovered higher quality when contrasted with bamboo fiber strengthened epoxy composites [21]. The soluble base treated jute fiber fortified epoxy composites indicated improved mechanical properties. The improvement was most extreme for the composite arranged with 4 hrs soluble base treated jute filaments [22]. Jute strands were strengthened with polypropylene and polyethylene. Jute fiber of 1 mm and 3 mm fiber length were utilized to manufacture utilizing pressure forming process. Debasement rate was assigned as far as weight reduction for the two composites [23]. Crossovers composites are more than one strengthening stage and a solitary network stage or single fortifying stage with different framework stages or numerous fortifying and various grid stages. They have better adaptability when contrasted with single fiber containing composites [18]. Cross breed composites are incorporates various fortifying, for example, regular just as manufactured fiber. The normal filaments included coir, jute, sisal, banana, bamboo, abaca. The impacts of hybridization of coir-jute, sisal-jute and coir-sisal fiber with polyester gums were broke down. The outcome shows hybridization assume significant job for improving mechanical properties of composites [12], [15]. Half breed composites may supplant or diminish use of manufactured strands in utilization of car, building ventures, airplane [13]. Jute-coir half breed composites find into railroad mentors for sleeper compartment backing, for building insides, entryways and windows other than in transportation division as sponsorships for seat and backrest in transports [16].

PLA: A sustainable polymer

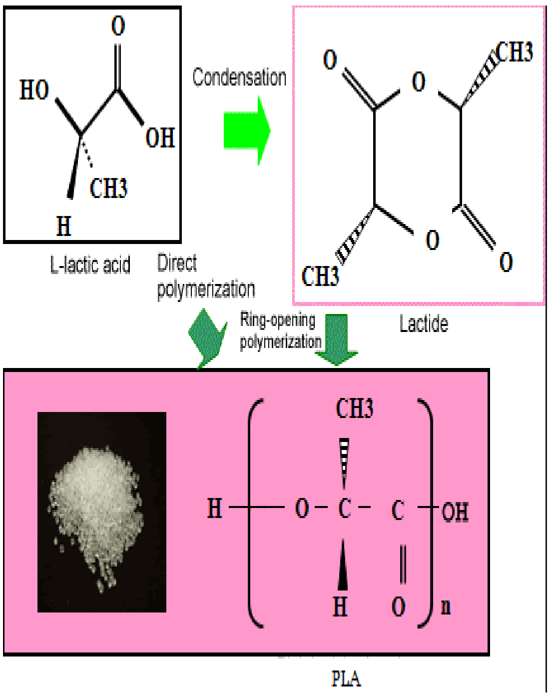
Conventional plastics are resistant to biodegradation, as the surfaces in contact with the soil in which they are disposed are characteristically smooth.[26] Currently, biodegradable polymers are attracting a great attention from researchers and industries as these polymers are designed to degrade upon disposal by the action of living organisms. Biopolymers derived from renewable resources such as corn, cellulosic, soy protein and starch are attracting the attention of scientists to replace traditional petro-based plastics in designing green composites.[27] shows the biodegradable polymers obtained from various resources. PLA is a thermoplastic biopolymer which can be semicrystalline or totally amorphous in nature. PLA is produced from lactic acid through fermentation of agricultural products like corn. PLA can be prepared by both direct condensation of lactic acid and ringopening polymerization of the cyclic lactide, Cargill Dow LLC has developed a low-cost continuous process for the production of lactic acid-based polymers.81 In PLA synthesis, first of all, corn (or rice, potatoes, sugar beet, agricultural wastes, etc.) is converted into dextrose. Lactic acid is obtained through fermentation of dextrose which is converted into lactide in the presence of catalyst. After purification by vacuum distillation, lactide is converted into PLA polymer through polymerization in the presence of suitable catalyst. PLA is a fully sustainable polymer as it is derived from annually renewable raw materials and it is fully biodegradable. After composting, PLA-based materials are converted into water and carbon dioxide which are consumed in growing more agricultural products for further conversion to PLA. Steps of PLA synthesis and life cycle of its materials is shown in Figure 3.



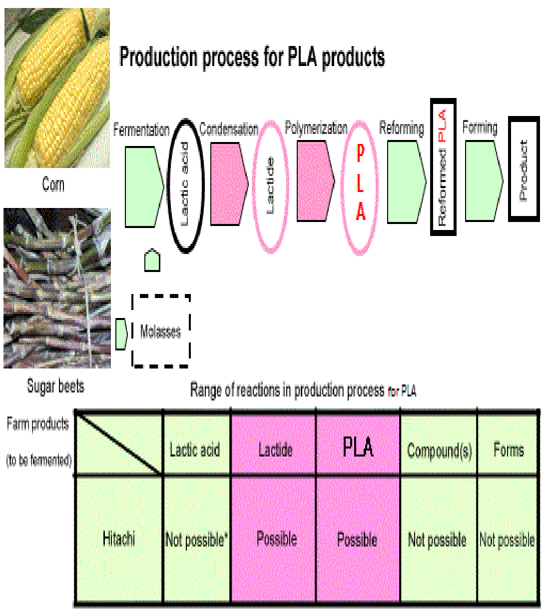
PLA has good mechanical properties that are comparable to polyethylene terephthalate and PP which are the most common materials used in automobiles. The temperature at which PLA can be melt processed with available standard processing equipment is safe for natural fibers because natural fibers do not degrade at the processing temperature.[28] Also, PLA is a hydrophobic polymer because of the incorporation of the CH3 side chain.[29] Because of all these favorable properties, PLA has strong candidacy among the biopolymers for the matrix material to be used in green composites. Cargill Dow LLC, a joint venture between Cargill Corporation and Dow, the largest current producer presently manufactures an estimated 95% of the world's production of PLA. There are many other manufactures of PLA and lactide worldwide like Biomer, Birmingham Polymers, Inc., Boehringer Ingelheim, Galactic, Hycail, Mitsubishi Plastics, Inc., Purac and Shimadzu Corporation.[30]

Processing of PLA green composites

Most of the green composites are fabricated using the same processes as used for traditional synthetic FRP matrix composites which are broadly classified as open mold process and closed mold process. Hand layup, spray up, tape layup, filament winding and autoclave method come under open mold processes. The compression molding, injection molding and transfer molding are closed mold processes. Alexandre Gomes et al.46 developed fully green composites by reinforcing a cornstarch-based biodegradable resin with curaua fibers through three fabrication methods which are as follows: (a) direct method (DM); (b) preforming methods (PF) and (c) prepreg sheet method (PS). In DM, a sliver of curaua fibers was inserted into a metallic mold with the resin, poured directly into them and the material was pressed slightly at 150C for 1 h and then the heating process was stopped. During the cooling process, a pressure of 3.27 MPa was applied until the temperature nearly reached room temperature. In PF, the composite was produced by hot pressing preforms of resin-pasted fiber slivers. Preforms of curaua fiber.



Range of process response



V. CONCLUSION:

Current survey centers around the development of common fiber reinforced alloys. Businesses are under constant scrutiny over new materials to reduce costs and overall revenue. Because of the difficulties of oil-based goods and the need to find inexhaustible assets. Ordinary fibers have the same cost and brilliance as traditional reinforcing fibers such as glass and carbon. Currently one day exploration improves bio-composites to replace ritual materials. A mixture of different characteristic strands has been found to give better mechanical and physical properties. Some obstacles must be overcome in order to abuse the maximum capacity of normal strands. Legitimate fiber surface treatment must be created and implemented from the outset. The properties of the compounds depend very much on the volume rates of the strands and the soap. The quality of the fiber framework interface needs to be improved. The current test is to make them smarter. Attempts to create financially attractive composite components have brought about some of the inventive assembling strategies currently used in the composite business.

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