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A Study on Rice Husk-Polymer Matrix

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***Abstract:-* In this investigation rice husk (RH), a waste product agriculture industry is used as filler to be reinforced in to the polymer matrix of p-nitroaniline (PNA) and of m-aminophenol (MAP). A pre-polymer of PNA and MAP was prepared by the condensation polymerization method in presence of formaldehyde as condensing agent and 2N-Sulphuric Acid.RH at different wt% of 10,30, 50 was reinforced into the polymer matrix by heating to 80^{0}C for 8hrs to get the biomass composite. The composite was sonicated in presence of 2N sulphuric acid for 20min at room temperature to get the nanocomposites. The solubility parameters of the resin was found out which gives encouraging result. XRD of the nanocomposites reveals the particle size to be 7-80nm. Form the XRD data the % crystallinity and elastic strain was found out.**

INTRODUCTION

The use of natural fibers for textile materials began before recorded history. The oldest indication of fiber use is probably the discovery of flax and wood fabrics at excavation sites of the swiss lake dwellers (7th and 6th centuries BC). Several vegetable fibers were also used by prehistoric peoples. Hemp, Presumable the oldest cultivated fiber plant, originated in southeast Aisa, then spread to China, where reports of cultivation dated to 4500BC. The art of weaving and spinning linen was already well developed in Egypt by 3400BC, indicating that flax was cultivated sometime before that date. Reports of the spinning of cotton in India dates back to 3000BC. The manufacture of silk and silk products originated in the highly developed Chinese culture the invention and development of sericulture (cultivation of silk worms for raw-silk production) and of methods to spin silk dates from 2640BC.[1,2]

With improved transportation and communication, highly localized skills and arts connected with textile manufacture spread to other countries and were adapted to local needs and capabilities. New fiber plants were also discovered and their use explored. In the 18th and 19th centuries, the Industrial Revolution encouraged the further invention of machines for use in processing various natural fibers, resulting in a tremendous upsurge in fiber production.[3] The introduction of regenerated cellulosic fibers formed of cellulose material that has been dissolved, purified and extruded, such as rayon, followed by the invention of completely synthetic fibers, such as nylon, challenged the monopoly of natural fibers for textile and industrial use. A variety of synthetic fibers having specific desirable properties began to penetrate and dominate markets previously monopolized by natural fibers. Recognition of the competitive threat from synthetic fibers resulted in intensive research directed toward the breeding of new and better strains of natural fiber sources with higher yields, improved production and processing methods and modification of fiber yarn or fabric properties.[4] The considerable improvements achieved have permitted increased total production although natural fibers, actual share of the market has decreased with the influx of the cheaper, synthetic fibers requiring fewer man-hours for production.

Following examples of nature and from history, researchers began searching for a material that can reproduce properties of interest. This search was an attempt to find more advanced materials whose properties like mechanical strength, thermal stability dielectric behavior etc are superior to those of individual components and that will meet the demands of the modern market. There has been an increasing interest for materials that are stiffer and stronger yet lighter in fields such as aerospace, energy, civil constructions etc.

Currently, polymers are the materials most commonly used as matrices for composite materials. Empty resins and polyesters have been used for decades, however, some advanced thermoplastic such as polyamides and polysulphones have also received special attention mainly because of their attractive properties at elevated temperatures (>3000^{0}C). The characteristics of such polymers, their easy handling and stability corrosion led to great developments in key industrial sectors, such as chemical production, food processing, shipping and air transport and manufacturing electrical and electronic equipment. In order to replace the synthetic fibers natural fibers which are materials of ecological interest and are economic have been extensively studied in recent years as reinforcements in thermoplastic and thermosetting polymer matrix.[5] As such our research involves the study of composites using rice husk which is commonly available in Orissa as a by product of Agriculture industry.

At present importance is given by researchers to developing and commercializing composite materials based on constituents derived from renewable sources, so as to reduce the dependence on non-renewable sources both from environmental and economic point of view. Materials containing lignocelluloses such as agricultural residues, food processing wastes, wood, municipal solid wastes etc are considered as low cost anD abundant raw materials for being converted to suitable thermostable composite. Thermoplastics and rubber compounds containing cellulous materials are less frequently used as they degrade and decompose at the processing temperature. Their use decreases shrinking during moulding which gives improved impact strength to finished product. The starch based thermoplastic polymer containing good amount of cellulose which is separated from rice husk (Oryza sativa) is chemically modified by polymerizing with substituted aniline prepolymer. Orissa state situated in the eastern part of India has rice as its principal agricultural product which is plentily grown through the eastern coastal region. Rice milling industry generates a lot of rice husk during milling of paddy which comes from the fields. This rice husk is mostly used as a fuel in the boilers for processing of paddy and for power generation.[6]

COMPOSITE MATERIALS:

Composite is a multiphase structure comprising a combination of materials that differ in composition and or share on a micro scale size resulting in improved material properties and characteristics. Their constituents retain their identities, features and synergistic properties which are better than the components acting alone. Composites consist of one or more discontinuous phases which are embedded in a continuous phase. The discontinuous phase is usually harder and stronger than the continuous phase is termed as the ‘Matrix’. On general, the mechanical properties of the matrix are enhanced by the presence of the reinforcing agent. The matrix has a role in maintaining the structural integrity of the composite by simultaneous connection with the dispersed phase owing to their adhesive and cohesive characteristics. It’s function are also to transfer the load for the dispersed phase and protect it against possible environmental attacks. Properties of composites are strongly dependent on the nature and characteristics of their constituent materials, their distributor and the interaction among the constituents. The constituents may interact in a synergistic way resulting in improved properties. Apart from the nature of the constituent materials, the geometry of the reinforcement (shape, size and size distribution) as well as the concentration, distribution and orientation of the reinforcement affect the properties of composite material.[7]

The shape of the discontinuous phase which may be spherical, cylindrical, or rectangular cross-sectioned prisms or platelets), the sizes and the size distribution (which controls the texture of the material)and also volume fraction determine the interfacial area, which plays an important role in determining the extent of the interaction between the reinforcement and the matrix, concentration, usually measured as volume or weight fraction, determining the extent of the interaction between the reinforcement and the matrix concentration, usually measured as volume or weight fraction determines the contribution of a single constituent to the overall properties of the composites. It is not only the single most important parameter influencing the properties of the composites.[8]

The main advantages of composite materials are their high strength and stiffness combined with low density. When compared with bulk traditional materials the composites allow for a weight reduction in the finished part composite materials are designed to deliver better thermal, mechanical properties and superior characteristic performance when compared to traditional engineering materials. The need for of stronger, stiffer, relatively cheaper and more lightweight materials in structural applications increased the use of composite considerably in recent years.

1.design flexibility2.damage tolerance3. corrosion resistance4High strength

5.specific strength and stiffness.6.Less co-efficient of thermal explosion

7.Good fatigue resistance8. Cost component Potentialty9.Small fabrication cost.

Applications of composite materials include aerospace, transportation, marine goods, sporting goods and more recently infrastructure, with construction and transportation being the largest. In general, high performance but more costly carbon fiber composites are used where high strength and stiffness along with light weight are required. In military aircraft, low weight is “King” for performance and payload reasons, the composite often approach 20 to 40 percent of the airframe weight. For decades, helicopters have incorporated glass fiber-reinforced rotor blades for improved fatigue resistance, and in recent years helicopter airframes have been built largely of carbon-fiber composites. All future Airbus and Boeing aircraft will use large amount of high-performance composites.[9]

Composites are also used extensively in both weight-critical reusable and expendable launch vehicles and satellite structures. The major automakers are increasingly training to composite to meet performance and weight requirement thus improving fuel efficiency cost is a major driver for commercial transportation, and lower maintenance cost.

Recreational vehicles have long used glass fibers, mostly for their durability and weight saving over metal.

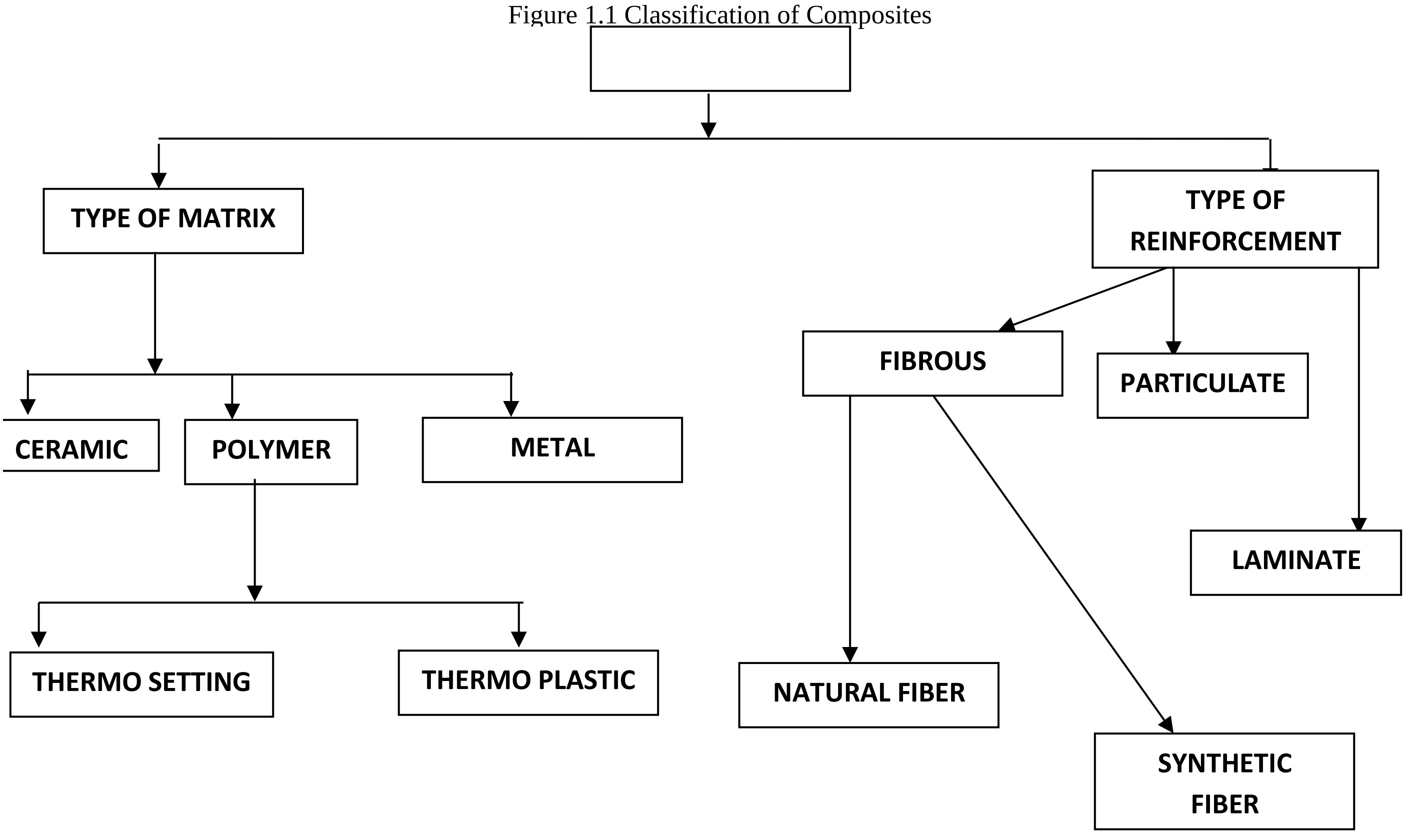
For high-performance formula -1 racing cars, where cost is not an impediment, most of the chassis, including the monocoque, suspension, wings and engine cover, is made from carbon fiber composites. Hulls of boats ranging from small fishing boats to large racing gouts are routinely made of glass fibers and polyester or vine ester resins. [10]

More recently, the topside structure of many naval ships have been fabricated from composites. Many of the World’s roads and bridges are badly corroded and in need of continual maintenance or replacement. Composites offer much longer life with less maintenance of replacement. Composites offer much longer life with less maintenance due to their corrosion resistance. Wind power is the World's fastest growing energy source. The blades for large wind turbines are normally made of composites improve efficiency of generation of electrical energy. [11]

COMPOSITES AND CLASSIFICATION:

Composites material is essentially composed of two elements such as matrix and reinforcement working together to produce material properties that are different to the properties of those elements on their own. In practice, most composites consist of a bulk material (the matrix) and a reinforcement of some kind, added primarily to increase the strength and stiffness of the matrix. The classification of composites is represented in figure (1.1).

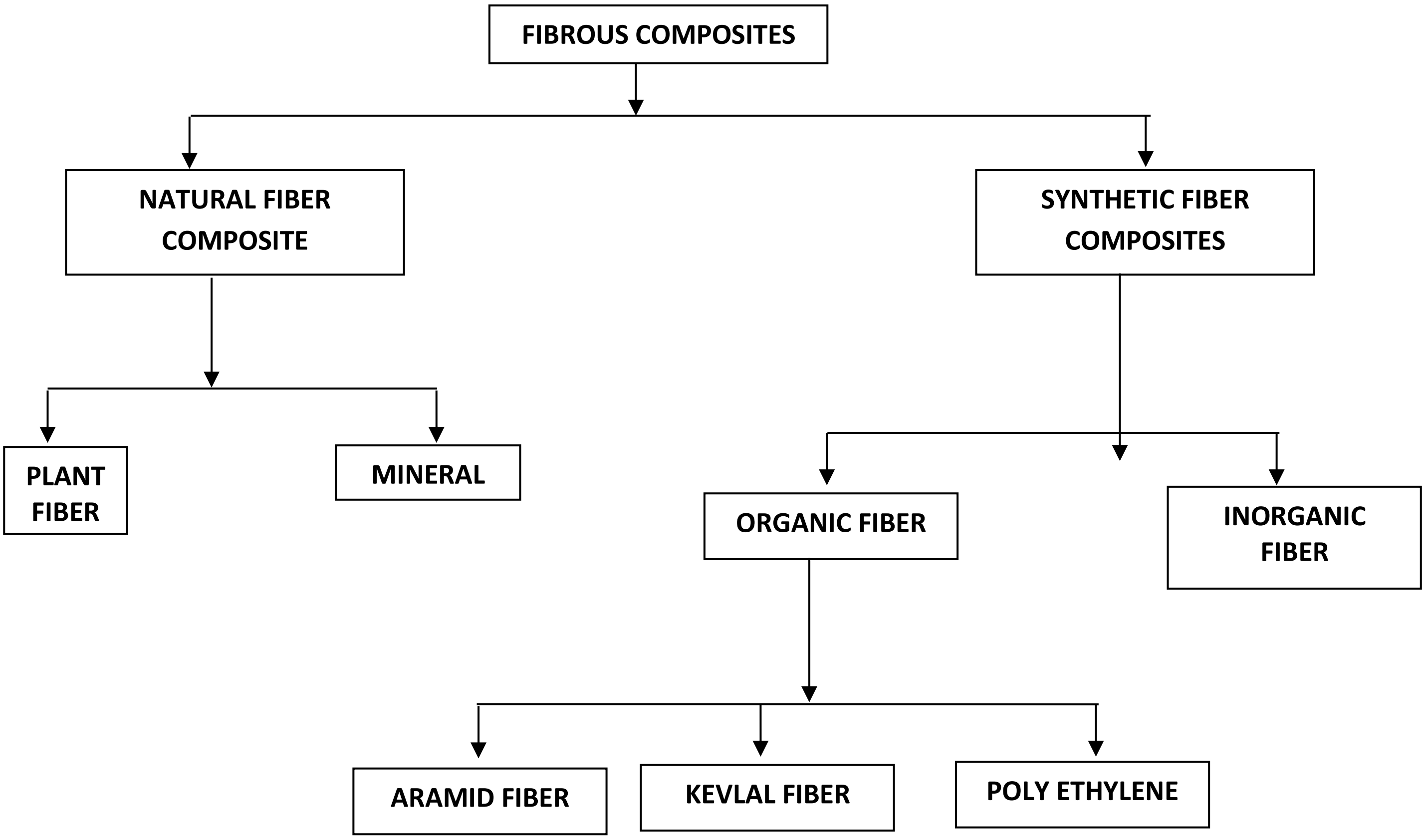
Figure 1.1 Classification of Composites



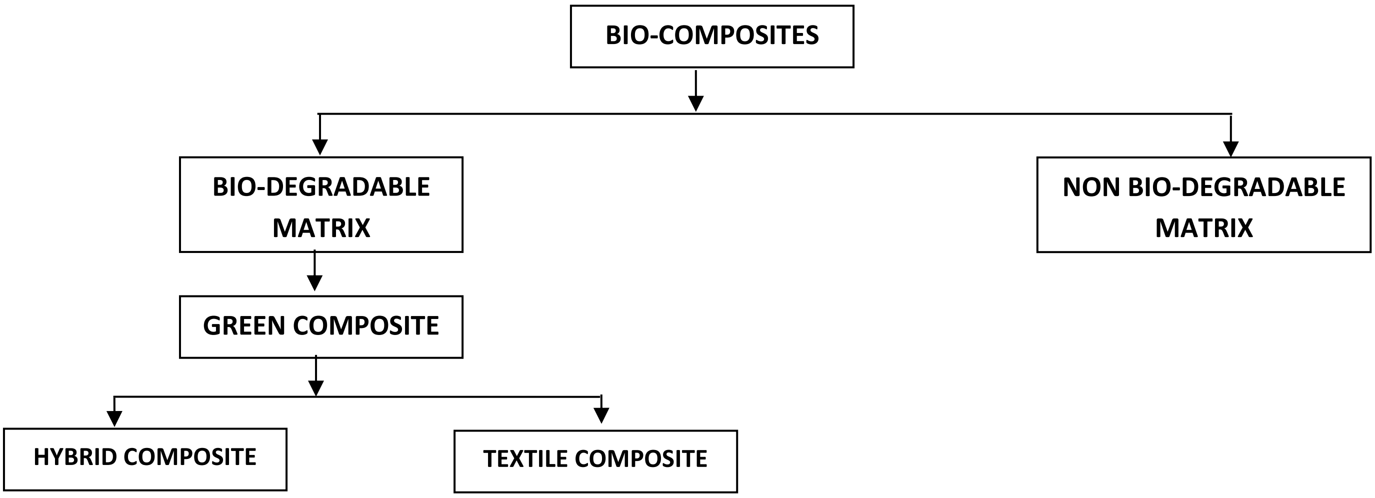
Composites can be mainly categorized on the basis of matrix and type of reinforcement. The classifications according to matrix type are ceramic-matrix composites polymer matrix composites are widely used that can be further sub-divided into two classes based on the type of polymer matrix i.e. thermoset or thermoplastic. The classification according to type of reinforcement are particulate composites compassed of particles fibrous composites (composed of fibers) and Laminate composites (Composed of laminates). [12]

BIO-COMPOSITES:

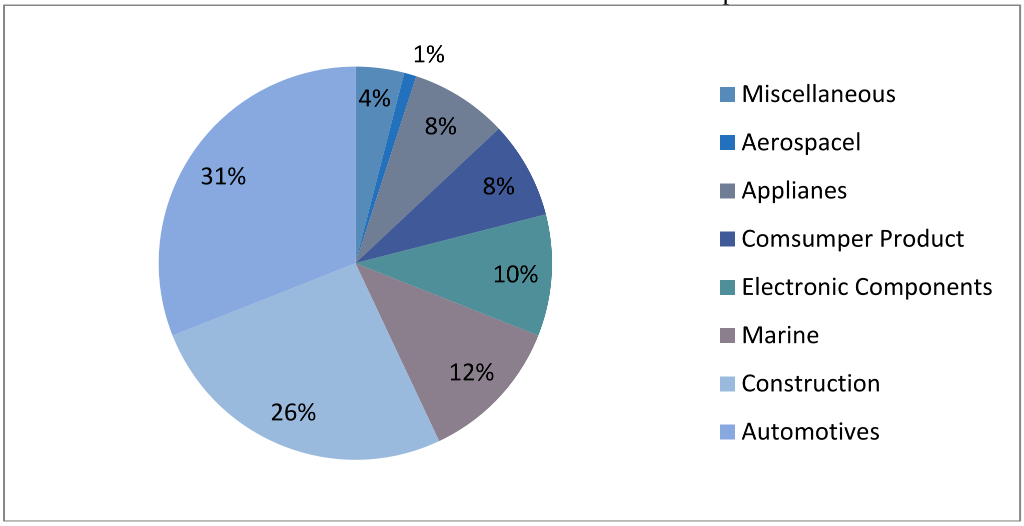
Fibrous composites can be further sub-divided on the basis of natural fiber or synthetic fiber. The detail classification is given in figure 1.2.



Composites having natural fiber as reinforcement are known as bio composite Bio-composites can be again divided on the basis of matrix i.e. non biodegradable matrix and biodegradable matrix. Bio-composites made form natural fiber and biodegradable polymers are referred to as green composites. These can be further sub-divided as hybrid composite and textile composite. Hybrid composite comprises of a combination of two or more type of fibers. The classification of bio-composite is represented in figure 1.3.



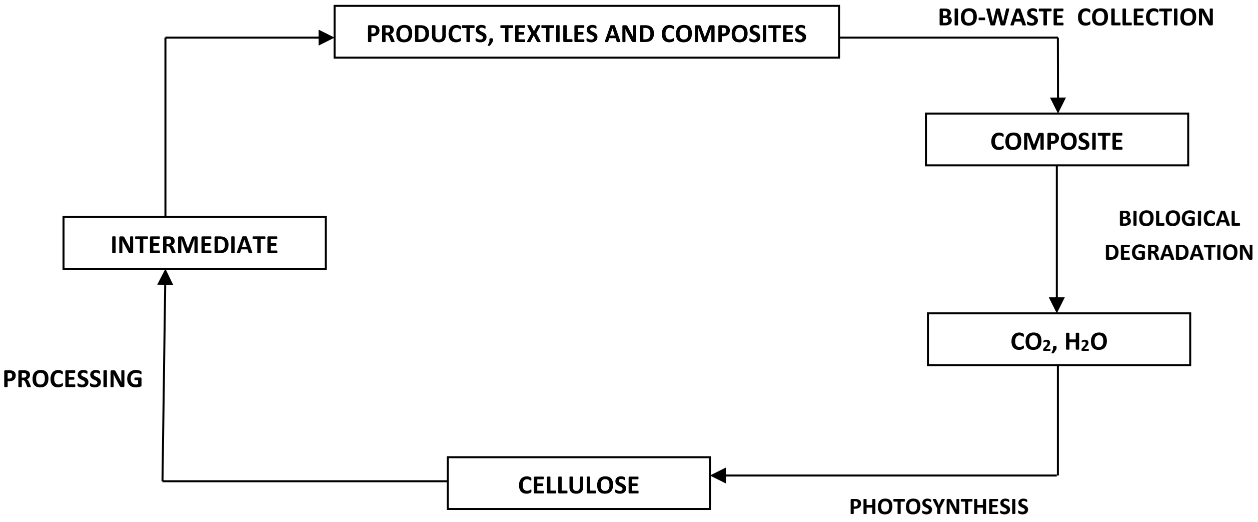
In fibrous composite, fibers are the main load carrying members, while the surrounding matrix keeps them in desired location and orientation. The matrix acts as a load transfer medium, provides shape to the composite structure and protects the fibers from environmental damage. The matrix also gives toughness and compression strength to the composite.[13] The selection of suitable fibers is determined by the required value of stiffness and tensile strength of the composite other deciding factors for selecting the fibers are thermal stability adhesion of fibers and matrix, dynamic and long term behavior price and it’s processing costs. Fiber-reinforced plastic composites began with cellulose fiber in phenolics in 1908, later extending to area and melamine and reaching commodity status in the 1940s with glass fiber in unstructured polyesters. From guitars, tennis racquets, and cars to microlight aircrafts, electronic components, and artificial joints, composites are finding use in diverse fields. The fiber-reinforced composite market is a multibillion-dollar business. The applications of fiber reinforced composites in various sectors are represented in 1.4. Pi-Chart :Use of fiber reinforced composites in various fields



Glass fiber is one of the dominant fiber and in used to reinforce thermoplastic and thermoset composites current research finding show that in certain composite applications, natural fibers demonstrate competitive performance to glass fibers. After decades of development of high-performance artificial fibers like carbon and glass natural fibers have gained renewed interest, especially as a glass fiber substitute in automotive industries. Advantages of natural fiber composites are as follows:

- Low weight per unit volume (specific weight) results in higher specific strength and stiffness compared to glass fiber composites.
- Low cost production and readily available.
- Low CO_2 emission.
- Eco-Friendly processing, no wear and tear.
- High electrical resistance.
- Good thermal and acoustic insulation properties.
- Bio-degradable and Ryclable

Synthetic fibers are expensive compared to the natural fibers. The price of glass fiber is around 1200-1800 US$/ton where as the natural fiber costs around 200-500 US$/ton. The density of synthetic glass fibers are around 2500Kg/M3 while the density of natural fibers are only 1000Kg/M3.[14] The low density of natural fibers ensures weight reduction of composite materials synthetic fibers are non-renewable where as plant fibers are renewable. They have the ability to be recycled. The natural fibers leave very little resides if they are burned for disposal returning very less CO_2 to the environment. Thus composite materials encompassing natural fibers are environmentally viable material. The biodegradable and recycling ability of natural fiber composites is displayed in figure 1.5. Recycling of composites based on natural fibers



Recycling of composites based on natural fibers.

Along with advantages the natural fiber exhibit some disadvantages like.

- Quality influenced by weather due to hydrophilic nature.
- Restricted maximum processing temperature
- Poor fiber-matrix adhesion
- Lower durability.

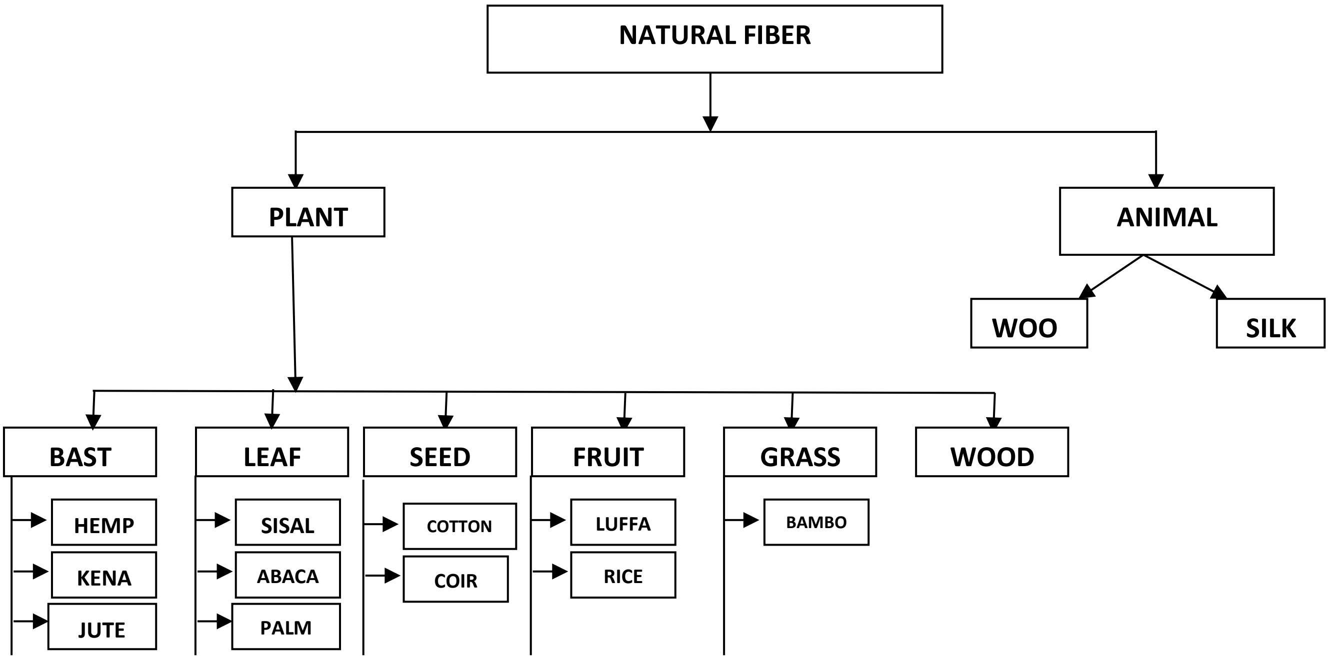
Therefore continuous research is going on to minimize the disadvantages of natural fiber composites. Natural fiber composites are now emerging as a realistic alternative to synthetic fiber-reinforced plastic Eco-friendly bio-composites have the potential to be the new material of the 21st century and be a partial solution to many global environmental problems.

NATURAL FIBERS:

Growing environmental awareness has triggered the researchers world-wide to develop and utilize materials that are compatible with the environment. In this process the natural fibers have become suitable with the environment. In this process the natural fibers have become suitable alternatives to traditional synthetic or manmade fibers and have the potential to be used in cheaper, more, sustainable and more environmentally friendly composite materials. [15]

A natural fiber may be further defined as a agglomeration of cell in which the diameter is negligible in comparison with the length. Although nature abounds in fibrous materials, especially cellulosic types such as cotton, wood, grains, and straw, only small number can be used for textile products or other industrial purposes. Apart from economic considerations, the usefulness of a fiber for commercial purposes is determined by such properties as length, strength, adaptability, elasticity, abrasion resistance, absorbency, and various surface properties. Most textile fibers are slender, flexible, and relatively strong. They are elastic in that they stretch when put under tension and then partially or completely return to their original length when the tension is removed.

A broad classification of natural fibers is represented schematically in figure 1.6.



BIOMASS:

Biomass is biological material derived from living, or recently living organisms. It most often refers to plants or plant-based materials which are specifically called lignocellulosic biomass. As an energy source, biomass can either be used directly via combustion to produce heat, or indirectly after converting it to various forms of biofuel. Conversion of biomass to biofuel can be achieved by different methods which are broadly classified into:*thermal*, *chemical*, and *biochemical* methods.[16]

Wood remains the largest biomass energy source today; examples include forest residues (such as dead trees, branches and tree stumps), yard clippings, wood chips and even municipal solid waste. In the second sense, biomass includes plant or animal matter that can be converted into fibers or other industrial chemicals, including biofuels. Industrial biomass can be grown from numerous types of plants,including miscanthus, switchgrass,hemp, corn, popla r, willow, sorghum, sugarcane, bamboo, and a variety of tree species, ranging from eucalyptus to oil palm (palm oil).

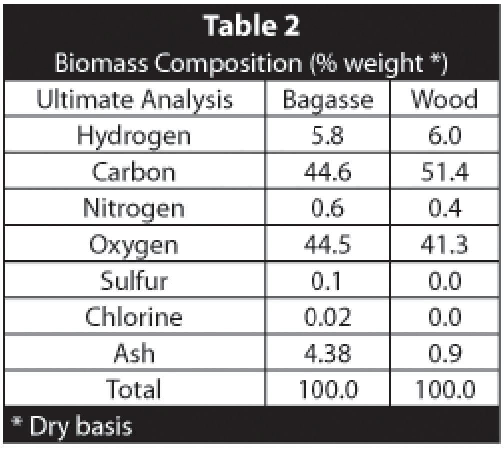
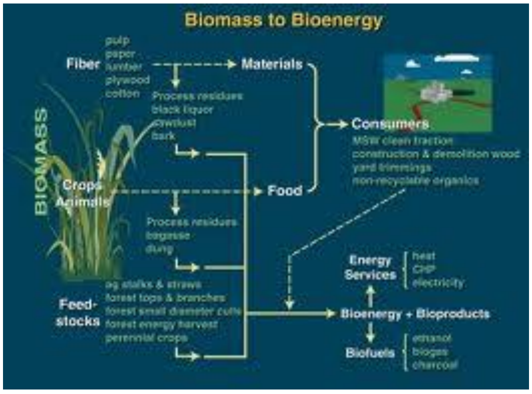


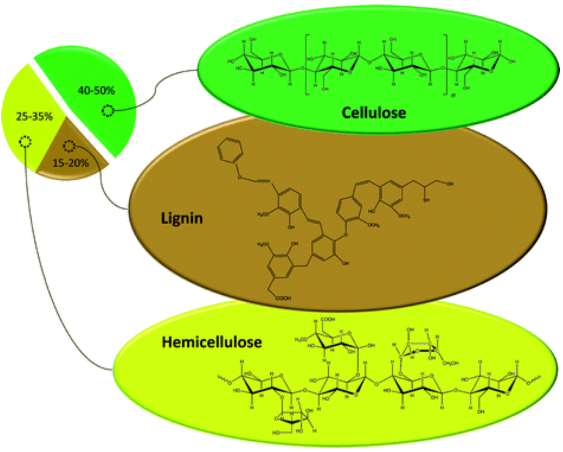
Table 2
Biomass Composition (% weight *)

Ultimate Analysis	Bagasse	Wood
Hydrogen	5.8	6.0
Carbon	44.6	51.4
Nitrogen	0.6	0.4
Oxygen	44.5	41.3
Sulfur	0.1	0.0
Chlorine	0.02	0.0
Ash	4.38	0.9
Total	100.0	100.0

* Dry basis



Plant energy is produced by crops specifically grown for use as fuel that offer high biomass output per hectare with low input energy. Some examples of these plants are wheat, which typically yield 7.5–8 tonnes of grain per hectare, and straw, which typically yield 3.5–5 tonnes per hectare in the UK. The grain can be used for liquid transportation fuels while the straw can be burned to produce heat or electricity. Plant biomass can also be degraded from cellulose to glucose through a series of chemical treatments, and the resulting sugar can then be used as a first generation biofuel.[17]



Biomass can be converted to other usable forms of energy like methane gas or transportation fuels like ethanol and biodiesel. Rotting garbage, and agricultural and human waste, all release methane gas—also called "landfill gas" or "biogas." Crops, such as corn and sugar cane, can be fermented to produce the transportation fuel, ethanol. Biodiesel, another transportation fuel, can be produced from left-over food products like vegetable oils and animal fats. Also, biomass to liquids (BTLs) and cellulosic ethanol are still under research.

There is a great deal of research involving algal, or algae-derived, biomass due to the fact that it’s a non-food resource and can be produced at rates 5 to 10 times faster than other types of land-based agriculture, such as corn and soy. Once harvested, it can be fermented to produce biofuels such as ethanol, butanol, and methane, as well as biodiesel and hydrogen.[18]

The biomass used for electricity generation varies by region. Forest by-products, such as wood residues, are common in the United States. Agricultural waste is common in Mauritius (sugar cane residue) and Southeast Asia (rice husks). Animal husbandry residues such as poultry litter are common in the UK.

ROLE OF MATRIX IN A COMPOSITE:

Many materials when they are in fibrous form can’t exhibit high mechanical strength alone. The fiber should be bonded by a suitable matrix so that the applied stress is distributed throughout the fibers. In this way the composites achieved the higher value of mechanical strength. The matrix isolates the fibers from one another in order to prevent abrasion and the fibers are protected from being damaged. A good matrix possesses ability to deform easily under applied load, transfer the load on the fibers and evenly distribute stress concentration.

CLASSIFICATION OF MATRIX

Polymer matrix composites can be sub-divided into two classes based on the type of polymer matrix i.e. thermo-set or thermoplastic. Thermoplastic: A thermoplastic is a plastic that melts to a liquid when heated and freezes to a brittle, very glassy state when cooled sufficiently. Most thermoplastics are high molecular weight polymers whose chains associate through weak Vander Waals forces as in polyethylene, stronger dipole-dipole interactions and hydrogen bonding as in nylon

Thermoset Matrix:Thermosets are materials that undergo a chemical reaction (cure) and transform from a liquid to a solid or brittle to ductile state. The addition of catalyst or heat or some other activating agents will initiate the chemical reaction. During this reaction the molecules cross-link and form significantly longer molecular chains, causing the material to solidify. This change is permanent and irreversible.

Polyester resin is the most widely used thermosetting system, particularly in marine industry. [19]

RESINS:

Typically, most common polymer-based composite materials, including fiber glass, carbon fiber and Kevlar include at least two parts, the substrate and the resin.

Polyester resin tends to have yellowish tint, and is suitable for most backyard projects. Its weaknesses are that it is UV sensitive and can tend to degrade over time and thus generally is also coated to help preserve it. It is often used in the making of surf boards and for marine applications. Its hardener is a peroxide, often MEKP (methyl ethyl ketone peroxide). When peroxide is mixed with the resin, it decomposes to generate free radicals, which initiate the curing reaction. Hardeners in these systems are commonly called catalysts, but since they don't reappear unchanged at the end of the reaction, they don't fit the strictest chemical definition of a catalyst.

NANOCOMPOSITE :

A nanocomposite is a multiphase solid material where one of the phases has one, two or three dimensions of less than 100 nanometers (nm), or structures having nano-scale repeat distances between the different phases that make up the material. In the broadest sense this definition can include porous media, colloids, gels and copolymers, but is more usually taken to mean the solid combination of a bulk matrix and nano-dimensional phase(s) differing in properties due to dissimilarities in structure and chemistry. The mechanical, electrical, thermal, optical, electrochemical, catalytic properties of the nanocomposite will differ markedly from that of the component materials. Size limits for these effects have been proposed, <5 nm for catalytic activity, <20 nm for making a hard magnetic material soft, <50 nm for refractive index changes, and <100 nm for achieving superparamagnetism, mechanical strengthening or restricting matrix dislocation movement.[20]Nanocomposites are found in nature, for example in the structure of the abalone shell and bone. The use of nanoparticle-rich materials long predates the understanding of the physical and chemical nature of these materials. Jose-Yacaman *et al.* investigated the origin of the depth of colour and the resistance to acids and bio-corrosion of Maya blue paint, attributing it to a nanoparticle mechanism. From the mid-1950s nanoscale organo-clays have been used to control flow of polymer solutions (e.g. as paint viscosifiers) or the constitution of gels (e.g. as a thickening substance in cosmetics, keeping the preparations in homogeneous form). By the 1970s polymer/clay composites were the topic of textbooks, although the term "nanocomposites" was not in common use.In mechanical terms, nanocomposites differ from conventional composite materials due to the exceptionally high surface to volume ratio of the reinforcing phase and/or its exceptionally high aspect ratio. The reinforcing material can be made up of particles (e.g. minerals), sheets (e.g. exfoliated clay stacks) or fibres (e.g. carbon nanotubes or electrospun fibres). The area of the interface between the matrix and reinforcement phase(s) is typically an order of magnitude greater than for conventional composite materials. The matrix material properties are significantly affected in the vicinity of the reinforcement. Ajayan *et al.* note that with polymer nanocomposites, properties related to local chemistry, degree of thermoset cure, polymer chain mobility, polymer chain conformation, degree of polymer chain ordering or crystallinity can all vary significantly and continuously from the interface with the reinforcement into the bulk of the matrix.

This large amount of reinforcement surface area means that a relatively small amount of nanoscale reinforcement can have an observable effect on the macroscale properties of the composite. For example, adding carbon nanotubes improves the electrical and thermal conductivity. Other kinds of nanoparticulates may result in enhanced optical properties, dielectric properties, heat resistance or mechanical properties such as stiffness, strength and resistance to wear and damage. In general, the nano reinforcement is dispersed into the matrix during processing. The percentage by weight (called *mass fraction*) of the nanoparticulates introduced can remain very low (on the order of 0.5% to 5%) due to the low filler percolation threshold, especially for the most commonly used non-spherical, high aspect ratio fillers (e.g. nanometer-thin platelets, such as clays, or nanometer-diameter cylinders, such as carbon nanotubes).

POLYMER NANOCOMPOSITES:

Polymer nanocomposites (PNC) consist of a polymer or copolymer having nanoparticles where nanoparticles are those with at least one dimension of less than 100 nm or nanofillers dispersed in the polymer matrix. These may be of different shape (e.g., platelets, fibers, spheroids), but at least one dimension must be in the range of 1–50 nm. These PNC's belong to the category of multi-phase systems (MPS, viz. blends, composites, and foams) that consume nearly 95% of plastics production. These systems require controlled mixing/compounding, stabilization of the achieved dispersion, orientation of the dispersed phase, and the compounding strategies for all MPS, including PNC, are similar.The transition from micro- to nano-particles lead to change in its physical as well as chemical properties. Two of the major factors in this are the increase in the ratio of the surface area to volume, and the size of the particle. The increase in surface area-to-volume ratio, which increases as the particles get smaller, leads to an increasing dominance of the behavior of atoms on the surface area of particle over that of those interior of the particle. This affects the properties of the particles when they are reacting with other particles. Because of the higher surface area of the nano-particles, the interaction with the other particles within the mixture is more and this increases the strength, heat resistance, etc. and many factors do change for the mixture.An example of a nanopolymer is silicon nanospheres which show quite different characteristics; their size is 40–100 nm and they are much harder than silicon, their hardness being between that of sapphire and diamond.

APPLICATIONS OF NATURAL FIBER REINFORCED POLYMER COMPOSITES:

Structural Application : A structural bio-composite can be used as load bearer in building industry load-bearing wall stairs, roof systems and subflooring.

Non Structural Application: Nonstructural bio-composites are used per products such as ceiling tiles furniture, windows and doors Bio-composites are utilized for construction of composite panels like fiber board, particle board and mineral-bonded panels.

Electronic Industry : Nanocellulose has been found to hear two essential properties like high sonic velocity and low dynamic loss. SONY had already explored this property of cellulose by using them in construction of diapharagm in headphone.

Pharmaceutical Industry: Cellulose composites have been used in drug-loaded tablets suitable for the oral administration of drugs. [21]

METHODLOGY

MATERIALS :

Rice husk (Biomass): Rice husk an agricultural waste product of rice grain, is obtained by dehusking of rice, is thoroughly washed with deionised water, filtered with ordinary filter paper and dried in sunlight for seven days. It is grounded to power like form and is purified with absolute ethanol. It is then dried in microwave oven at 80^0C for 24hrs.

Chemicals :P-nitro aniline, m-aminophnol, formaldehyde, sulphuric acid

METHODS;

Preparations of P-nitro aniline polymer (PNA):

0.01 mol of p-nitro aniline was taken in a clean and dry 100 mol flask with about 2-4mol of formaldehyde and 2 N sulphuric acid. The mixture was heated to 80^0C for about 8hrs. The polymer obtained was reportedly washed with deionised water and alcohol to remove unreacted monomer. The resulting polymer was dried and kept in dessicator.

Preparations of M-Aminophenol polymer (MAP):

0.01 mol of M-Aminophenol was taken in a clean and dry 100 mol flask with about 2-4mol of formaldehyde and 2 N sulphuric acid. The mixture was heated to 80^0C for about 8hrs. The polymer obtained was reportedly washed with deionised water and alcohol to remove unsaturated monomer. The resulting polymer was dried and kept in dessicator.

Preparations of rice husk resin composite

10,30 and 50wt% of rice husk with resin polymer were taken in a clean and dry 200ml flask with 2ml of 2N sulphuric acid as catalyst. The mixture was heated to 80^0C for 8hrs. Brownish coloured composite was filtered, washed repeatedly with deionised water and with alcohol. It was dried at 110^0C for 48hrs.

Preparation of nanocomposite :1-2gm of biocomposite was taken in a 50ml beaker with 2N sulphuric acid and subjected to sonication at room temperature for 20minutes.

CHARACTERIZATION

XRD Analysis:

RESULTS AND DISCUSSION

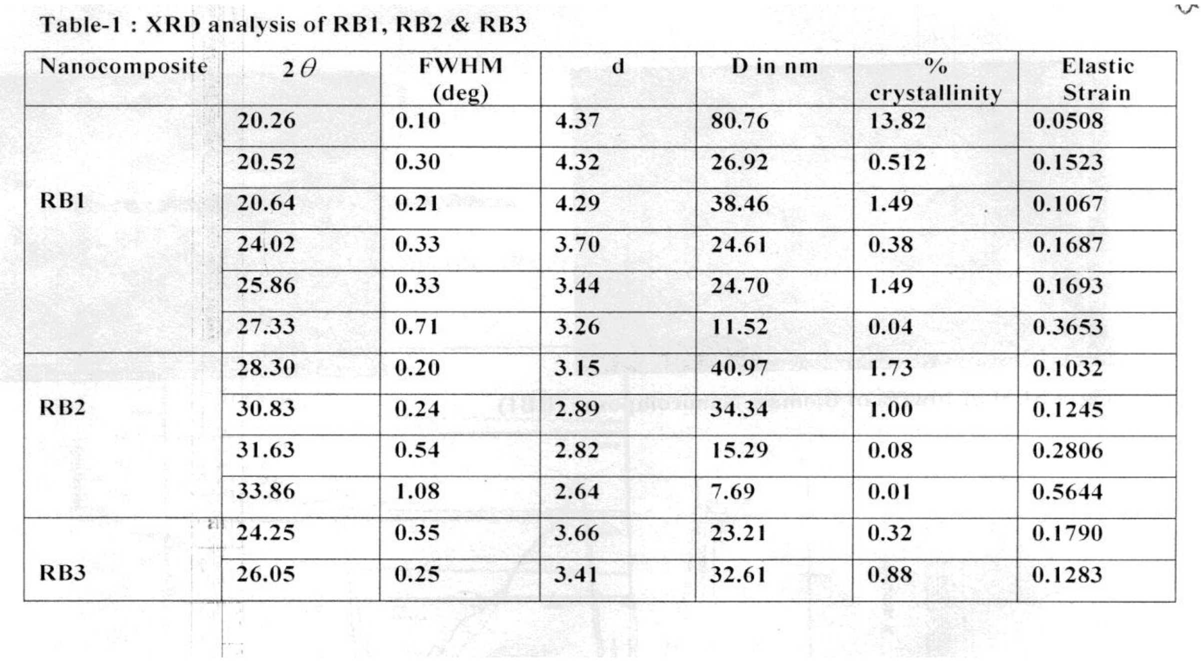


Table-1 : XRD analysis of RB1, RB2 & RB3

Nanocomposite	2θ	FWHM (deg)	d	D in nm	% crystallinity	Elastic Strain
RB1	20.26	0.10	4.37	80.76	13.82	0.0508
	20.52	0.30	4.32	26.92	0.512	0.1523
	20.64	0.21	4.29	38.46	1.49	0.1067
	24.02	0.33	3.70	24.61	0.38	0.1687
	25.86	0.33	3.44	24.70	1.49	0.1693
	27.33	0.71	3.26	11.52	0.04	0.3653
RB2	28.30	0.20	3.15	40.97	1.73	0.1032
	30.83	0.24	2.89	34.34	1.00	0.1245
	31.63	0.54	2.82	15.29	0.08	0.2806
	33.86	1.08	2.64	7.69	0.01	0.5644
RB3	24.25	0.35	3.66	23.21	0.32	0.1790
	26.05	0.25	3.41	32.61	0.88	0.1283

Table 1 gives the XRD data of the nanocomposite RB$_1$, RB$_2$, RB$_3$ (10,30&50 wt% of RH) of MAP resin. Amorphous nature and typical silica character stick is observed at temperature range of 25-30 degree Celsius.. This table also gives the crystallite size, percentage crystallinity and elastic strain of the nonocomposites. The cystallinity size is determined by Debye-Scherrer formula.

$$D = \frac{K\lambda}{\beta \ \mathrm{Cos}\,\theta}$$

Where D = crystallite size, K = shape factor = 0.9, λ = wavelength of Cu (Kα) = 1.54°A,

β = Full width at half maximum (FWHM) and θ = angle of diffraction.

The crystallite size varies from 7 – 80 nm. % Crystallinity was determined from the formula:

$$\text{Crystallinity} = \left[\frac{0.24}{\beta}\right]^{3}$$

From the table it is evident that crystallinity decreases with increase in wt% of RH. This may be due to formation of covalent bonds and hydrogen bonds between the –OH and -COOH groups of rice husk with the –NH2 and –OH groups of the polymer matrix. This results in change in the crystallinity. With 50wt% of RH with polymer in RB3, the formation of covalent bonds and hydrogen bonds is more and therefore the deviation from crystallinity. The elastic strain was calculated by the formula:

$$\text{Elastic strain} = \frac{\beta}{2\mathrm{Cos}\,\theta}$$

The elastic strain was found to be lower in RB3 than in other nanocomposites.

CONCLUSION:

From results and discussion it concluded that the crystallinity of nanocomposite decreases with increase in wt% of RH. The XRD data shows the successful formation of the nanocomposite. The elastic strain reveals that the nanocomposite RB$_2$ has compatibly greater elastic strain that other nanocomposite.

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