Method to Manufacture Composite Material and Recent Research on Composite Material: A review

Sumit Shoor, Rahul Kshirsagar

Department of Mechanical Engineering, Lovely Professional University, Phagwara, India.

Abstract: Composite research is captivating contribution from governments, manufacturers and research institutes. Composites material has good structural properties, physical, chemical properties as compared to another material. The foremost disadvantage in using these composites is that these are non bio-degradable in nature and causes environmental and global catastrophe. Furthermore, environmentally friendly composites are on the way being develop. These composites are made from matrix and a reinforcement of natural fibers and are partially or completely bio-degradable. In this paper literature review has been carried out and different methods to manufacture composites and recent work done.

Keywords: Composite Material, bio-degradable, natural fibers.

INTRODUCTION

Materials are the substance or substances from which the things are prepared or composed synthetically or naturally e.g. ceramics, glass, metals, Meta materials, plastics, etc. Materials having different physical, chemical and mechanical properties are joined together to form new material known a composites. The individual materials remain distinct within the new material. Composite materials are preferred as these are more durable, lighter or less costly when compared with individual materials. Due to these reasons, composite materials are replacing materials in the engineering and construction applications.

Classification of composites mainly depends upon the type of the reinforcement and the type of the matrix used. The reinforcement used can be either synthetic fibers or natural fibers and the matrix used can be either synthetic resin or resin based on plant oil. Depending on the combinations of the fiber-resin used, it can be concluded whether the composite is non-degradable, partially degradable or completely degradable.

Composite Material classification is also done on the basis of the 1) geometry of the reinforcement 2) Manufacturing processes of composite materials:
Literature Review: Fibers in the form of woven, knitted, stitched or bonded fabrics are placed in the mould and then the resin is impregnated using rollers, brushes or a nip-roller type impregnator. Which further helps in pushing resin inside the fabric. The process is followed by curing the fabricated laminates under standard atmosphere. Combination of resins such as polyester, epoxy, vinylester, phenolic and any fiber material can be used without any restrictions.

In Another study green composites was developed using bio-degradable natural fibers blended with bio-degradable matrix. Plant fibers like jute and banana fibers are blended with cashew nut shell liquid (CNSL) resin which is secondary product of cashew nut industry and is the main source of naturally appearing phenol was used to develop the composites. Which Further helps in in replacing non bio-degradable composites with green composites there by eliminating the disadvantage of the composites.[4]

Composite materials are reliable, have good mechanical properties per unit weight and their modern manufacturing techniques allows manufacturer to fabricate large and complex shapes components [4]
4.1. Classification of composite materials:

Composite materials are broadly classified as synthetic fiber-reinforced polymer composites and bio-composites or natural fiber reinforced polymer composites. Reinforcement with fiber have been practiced in engineering and other industrial applications since they could provide either comparable to or better properties than conventional pure polymer materials [5].

Furthermore, fiber-reinforced resin-matrix composite materials with high strength-to-weight and high stiffness-to-weight ratios are gaining popularity in weight delicate applications like aircrafts and other space vehicles, automotive, marine and construction industries[6].

Bio-composites are extensively used in the interior and exterior body parts of the automobile . Synthetic fibers used for reinforcing includes carbon, glass, aramide, Kevlar, boron, etc. [7]

Synthetic fiber based composites are blended with synthetic fibers as reinforcement with the synthetic resin polymer matrix. These composites hold high structural properties and presently catching broad application area. The foremost disadvantage in using these composites is that these are not environmental friendly and causes environmental and global catastrophe. This has given an idea for the development of eco-friendly bio-composites. In today’s era main focus is on replacing synthetic fibers with complete biodegradable eco- friendly natural fibers.

The bio-composites incorporate natural fibers reinforced polymer matrices both from non renewable [7] and renewable resources. Natural-fibers are having few advantage over carbon and glass fibers as reinforcement in polymers since they have comparable high specific strength, renewability, eco-efficiency, non-abrasive nature,
low energy consumption, low density, reduced tool wear, reduced cost, good thermal properties, light weight and environmentally friendly[8,9]. The only major drawback associated with the use of natural fibers is their relatively poor interface with the matrix and very less moisture resistance which greatly affects the properties of the final composite [10]

The widely used natural fibers as reinforcements for green composites or bio-composites are the bast fibers such as flax, hemp, jute, kenaf, sisal and banana fibers.

![Classification of Natural Fibers](image)

**Figure 5: Classification of Natural Fibers [11]**

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Natural Fibers</th>
<th>Density (g/cm³)</th>
<th>Elongation (%)</th>
<th>Tensile Strength (Mpa)</th>
<th>Young's Modulus (Gpa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>cotton</td>
<td>1.5-1.6</td>
<td>7.0-8.0</td>
<td>400</td>
<td>5.5-12.6</td>
</tr>
<tr>
<td>2</td>
<td>jute</td>
<td>1.3</td>
<td>1.3-1.8</td>
<td>393-773</td>
<td>26.5</td>
</tr>
<tr>
<td>3</td>
<td>hemp</td>
<td>1.47</td>
<td>1.8-4.0</td>
<td>690</td>
<td>70</td>
</tr>
<tr>
<td>4</td>
<td>flax</td>
<td>1.5</td>
<td>1.9-3.2</td>
<td>500-1500</td>
<td>27.6</td>
</tr>
<tr>
<td>5</td>
<td>kenaf</td>
<td>1.45</td>
<td>1.5-1.6</td>
<td>930</td>
<td>53</td>
</tr>
<tr>
<td>6</td>
<td>ramie</td>
<td>1.5</td>
<td>3.6-3.8</td>
<td>400-938</td>
<td>61.4-128</td>
</tr>
<tr>
<td>7</td>
<td>sisal</td>
<td>1.5</td>
<td>1.5-2.5</td>
<td>511-635</td>
<td>9.4-22</td>
</tr>
<tr>
<td>8</td>
<td>banana</td>
<td>0.75-0.9</td>
<td>4.1</td>
<td>180-430</td>
<td>23</td>
</tr>
<tr>
<td>9</td>
<td>coir</td>
<td>1.2</td>
<td>3</td>
<td>593</td>
<td>4.0-6.0</td>
</tr>
<tr>
<td>10</td>
<td>E-glass</td>
<td>2.5</td>
<td>0.5</td>
<td>2000-3500</td>
<td>70</td>
</tr>
<tr>
<td>11</td>
<td>S-glass</td>
<td>2.5</td>
<td>2.8</td>
<td>4600</td>
<td>86</td>
</tr>
</tbody>
</table>
Cashew nut shell liquid (CNSL main and commercial resources of naturally appearing phenols CNSL is dark brown or reddish brown viscous liquid. It posses honeycomb like structure. It is used in the synthesis of cheaper liquid crystalline polyester that can replace chemically synthetic polymers in certain applications. Research has been focused on liquid crystalline polymer because of its effective use as high efficient material.

CNSL mainly consists of cardanol, cardol and anacardic acid. The reddish brown viscous CNSL when reacted with formaldehyde in proper proportions forms rubbery gel to hardening agent which has good resistance to acids and alkalies attacks and can be used for variety of applications.

Conclusion:

It has been found out that Bio-composites and green composites had advantages such as cost effective, nature friendly and low density in contrast with traditional fibers. Alkaline treatment eliminates the hydrophilic nature of the natural fibers and improves the bonding between fibers and the matrix and results in the overall strengthening of the mechanical properties of the composites. Bio-composites are again partially degradable since one of the component either fibers or matrix is not degradable and leads to environmental issues. In future work focused can be on green composites where both the fibers and the matrix are bio-degradable.

References


