A Review of Composite Materials and its application

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Abstract:

Natural fiber bio-composites are gaining popularity as an environmentally friendly alternative and solution to the problems of non-degrading and energy consuming synthetic fiber composites. The primary advantage of composite is lightweight, relative stiffness and strength properties. The key parameters of composites are its physical properties, material properties, tooling, design, inspection and repair. In this paper a review is being carried out on Composite materials such as metal matrix composites, ceramic composites, natural fibro-reinforced composites, and polymer matrix composites and recent trend for manufacturing of composites is discussed.

Keywords : Hybrid Bio Composite, , Ceramic composites, , natural fibro-reinforced composites

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.

Composite materials are the advanced types of materials. Composite materials are the combination of different materials with significantly different physical or chemical properties to produce a new material with different characteristics from the individual materials. The individual materials remain distinct within the new material.

Composite materials are preferred as these are stronger, lighter or less expensive when compared with individual materials. Due to these reasons, composite materials are replacing individual materials in the engineering and construction applications.

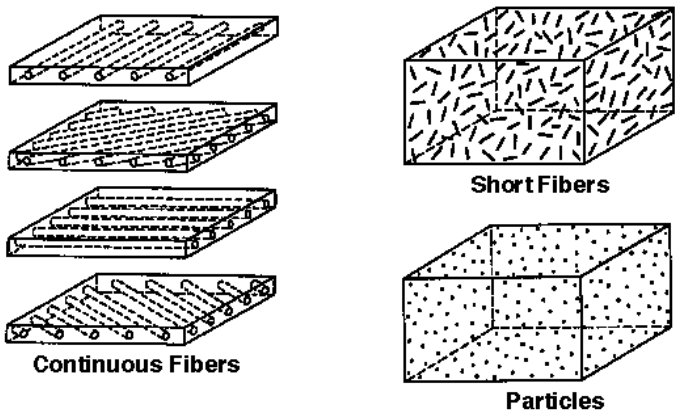

Figure 1: Fiber reinforced composites [1]

Composite materials are mainly classified depending 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 of completely degradable. Sometimes classification is also done on the basis of the geometry of the reinforcement. It explains the size of the fibers, orientation and the directions in which fibers are placed. The detailed classification is explained in the chapter of review of literature.

Manufacturing processes of composite materials:

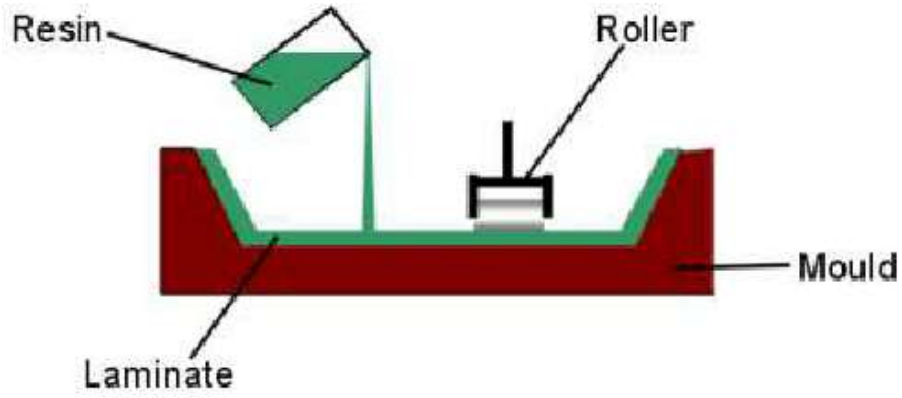

Figure 2: hand lay-up technique [2]

Fibers in the form of woven, knitted, stitched or bonded fabrics are placed in the in the mould and then the resin is impregnated using rollers, brushes or a nip-roller type impregnator. The impregnation 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.

Vacuum-assisted resin transfer molding:

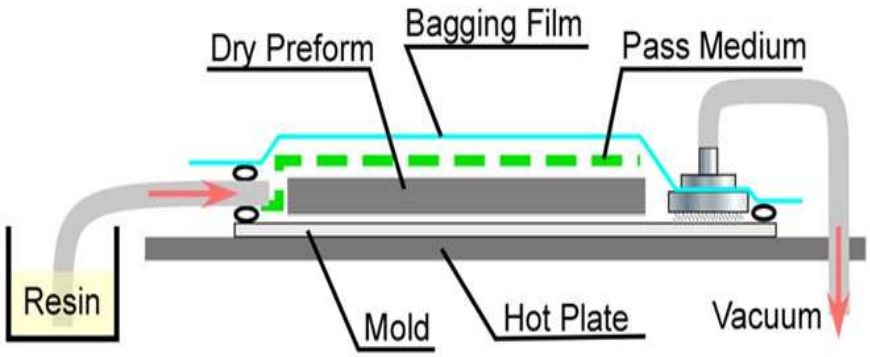

Figure 3: Vacuum-assisted resin transfer molding technique [3].

Vacuum Assisted Resin Transfer Molding (VARTM) is a shut mold composite producing process. VARTM is a variety of Resin Transfer Molding (RTM) with its recognizing trademark being the substitution of the top section of the mould instrument with a vacuum pack and the utilization of a vacuum to help in resin flow. The procedure includes the utilization of a vacuum to encourage flow of resin into a fiber layup contained inside a mould instrument secured by a vacuum pack. After the impregnation happens the composite part is permitted to cure at room temperature with a discretionary post cure some of the time carried out.

Compression molding:

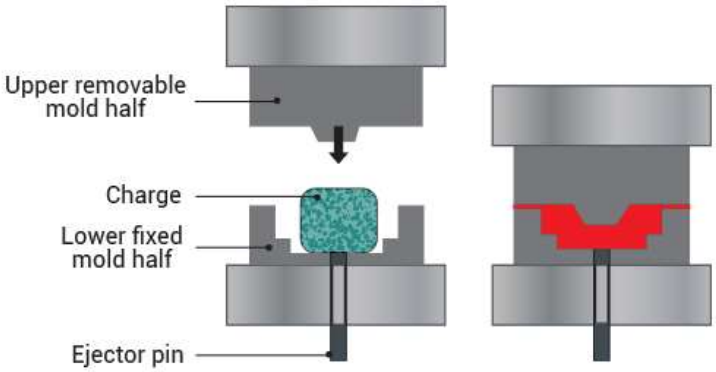

Figure 4: Compression Molding technique [4].

Compression molding is a shut mold composite producing process that utilizes coordinated metal molds with the use of external force. In this technique, a built composite layup is put in the open form hole, the form is shut, and merging force is applied. The force stays on the mold all through the cure cycle, which for the most part happens in oven. The blend of pressure and heat creates a composite part with minimum void content and high fiber volume fraction about net shape complete component. Compression molding frequently yields composite parts that have the ideal mechanical properties conceivable from the specific blend of constituent materials.

Classification of composite materials:

Composite materials are broadly classified as synthetic fiber-reinforced polymer composites and bio-composites or natural fiber reinforced polymer composites. Fiber-reinforced composites 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].

Furthermost, 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]

Bio-composites or natural fibers composites:

The bio-composites incorporate natural fibers reinforced polymer matrices both from non renewable) and renewable resources. Bio-composites are either partially bio-degradable or completely bio-degradable.[7]

Natural fibers when blended with non-bio-degradable synthetic polymers produce partially bio-degradable composites. In case of completely bio-degradable composites, natural fibers or bio-fibers are blended with bio-degradable polymers like poly lactic acid (PLA), poly vinyl alcohol, plant based oil resins, etc. Bio-fibers reinforced with bio-polymers are called as 'Green Composites'. Natural fibers for reinforcing include wood fibers and non-wood fibers such as jute, flax, hemp, banana, sisal, pineapple, sugarcane, oil palm, etc

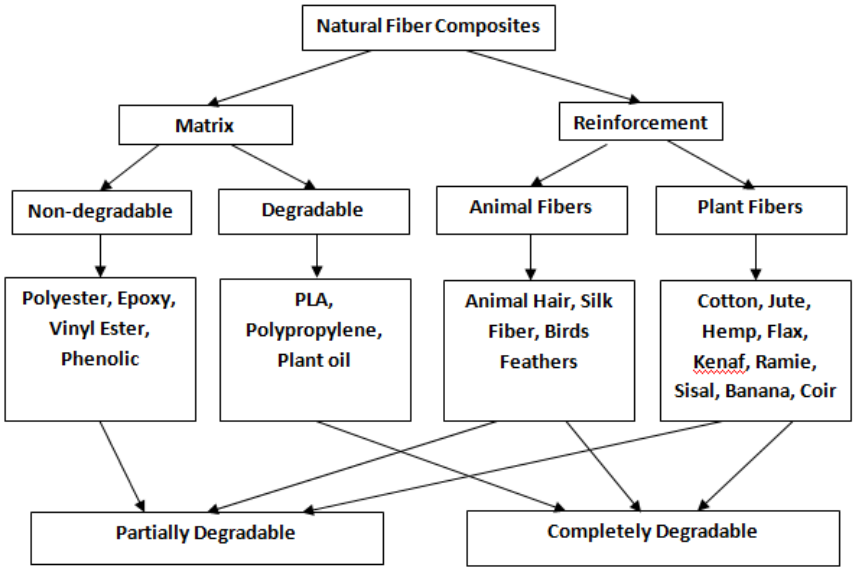

Figure 9: Constituents used in natural fibers composites.

A composite material that is "Composition of Materials" consists of reinforcing phase like fibers, particles or sheets ingrained in the matrix phase. The reinforcing material is the main load-carrying member. The matrix phase holds the reinforcing material in the defined position and transfer the load between them. It also protects the reinforcing materials from damage throughout the composite processing. Compared to the reinforcing phase, the matrix phase is ductile and hence is the source of composite toughness. Combination of these phases evolves a new material with advanced properties than the individual ones. Composite materials are reliable, have improved mechanical properties per unit weight and their modern manufacturing techniques allows manufacturer to fabricate large and complex shapes components [8]. Composite materials are of the type synthetic fiber-reinforced polymer composites and natural fiber-reinforced or biocomposites. Fiber-reinforced composites have practiced in engineering and other industrial applications owing to their either comparable to or better properties

in contrast with conventional materials[9] Furthermost, fiber-reinforced resin-matrix composite materials with high strength and high stiffness are gaining popularity in weight delicate applications like aircrafts and other space vehicles, automotive, marine and construction industries [10, 11]. Biocomposites have extensively used in making body parts of the automobile [12].Synthetic fibers used for reinforcing includes carbon, glass, aramid, Kevlar, boron, etc.

Conclusion: Composites have attractive mechanical and physical properties that are now being utilized in automotive industry and aerospace on a grand scale world-wide. New fibres, polymers, and processing techniques for all classes of composites are constantly being developed. Research is also ongoing to improve repair techniques, recyclability, and the bonding between fibres and matrix materials. Due to Development of new fire retarding constituents, the polymers are also available with higher temperature range

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