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STUDY OF APPLICATION AND ADVANCES OF COMPOSIT MATERIALS

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Abstract

Two or more chemically different constituents combined macroscopically to yield a useful material which is called composite material. One constituent is called reinforcing phase and the one in which the reinforcing phase is embedded is called matrix.

Composite materials have changed all the material engineering. The development of composite materials has given a new direction to engineers to use better materials resulting in cost reduction, increase efficiency and better utilization of available resources.Composite materials have endless engineering application where strength to weight ratio, low cost and easy fabrication are required. For many critical applications, the use of composite materials in comparison to metals has resulted in savings of both weight and cost. Some examples are aerospace applications, cascades for engines, leaf spring, curved fairing and fillets, replacements for welded metallic parts, ducts, tubes, cylinders, blade containment bands, biomedical devices, electronic devices, sports goods etc. In aerospace approximately 50% of the parts are made from composites due to their high specific strength, light weight and stiffness. Many composites used today are

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the leaders of materials technology, with performance and costs appropriate to ultra demanding applications.This paper presents the current study of application of composites in industries and finds the approach of composite material in future direction with its advantages-disadvantages and applications in industries. This paper also presents the Properties, Characteristics, Challenges, Opportunities and Future demand of Composite material for advance industrial application.

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1. Introduction

Composite material offers to engineers many advantages that are especially appealing for engineering applications. They are made up of combining two or more materials in such a way that the resulting materials have improved properties. The different composite materials consist of high specific strength, high specific stiffness, more thermal stability, more corrosion and wear resistance, high fatigue life. When designed properly, the new combined material exhibits better properties than would each individual material. The requirement of composite material has gaining momentum in these days due to these properties. Apart from defense and automotive industries, aircraft industries also using composites largely in the present days for reducing the weight of the aircraft and improved strength. The addition of high strength, high modulus refractory particles to a ductile metal matrix produce a material whose mechanical properties are intermediate between the matrix alloy and the ceramic reinforcement.

Aluminium based composite materials are leading ones in this area, they are fabricated using many methods, including powder metallurgy processes, and then formed The metal matrix composite can be reinforced with particles, dispersoids or fibres. However, the biggest interest in composite materials is observed for those reinforced with hard ceramic particles due to the possibility of controlling their tribological, heat- or mechanical properties by selection of the volume fractions, size, and distribution of the reinforcing particles in the matrix. The ceramic preforms, being a framework, are the base of the composite materials manufactured by infiltration method. These preforms mainly determine the structure and the properties of the final

product. The properly manufactured semi-finished product should be characterized by open porosity allowing the liquid metal to flow as easily as possible.

1.1Types of composite

(i)Organic Matrix Composites (OMCs)

(ii)Polymer Matrix Composites (PMCs)

- Thermoset
- Thermoplastic

(iii)Carbon Matrix Composites (CCCs)

(iv)Metal Matrix Composites (MMCs)

(v)Ceramic Matrix Composites (CMCs)

1.2 Reinforcement

Function is to reinforce the primary phase.Imbedded phase is most commonly one of the following shapes:

- Fibers
- Particles
- Flakes

In addition, the secondary phase can take the form of an infiltrated phase in a skeletal or porous matrix Example: a powder metallurgy part infiltrated with polymer.

The reinforcement of metals can have many different objectives;

- Increase in yield strength and tensile strength at room temperature and above while maintaining the minimum ductility or rather toughness,
- Increase in creep resistance at higher temperatures compared to that of conventional alloys,
- Increase in fatigue strength, especially at higher temperatures,
- Improvement of thermal shock resistance,
- Improvement of corrosion resistance,
- Increase in Young's modulus,

--Reduction of thermal elongation

2. Application and Advances Of Composite Material.

Aerospace Industries: More than 50% components are made from composite material. The main benefits that composite components are reduced weight and better mechanical properties. Composites are used widely in in development of helicopters, fighter aircraft, small and big transport aircraft, satellites launch vehicles and missiles. Various components of aircraft are fabricated with composites like ruddar, spoilers, airbrakes, elevators, doors, engine cowlings, rear bulkhead, wing ribs, main wings, turbine engine blades, propellers and Interior components.

Bio Medical fields: A composite is one of the most widely material used in a medical device and used with biological system. In this modern technology in synthetic materials, surgical technique have permitted the use of composite material in many ways. Medical practice today utilizes a large number of devices. Composite materials are used for sutures, bone and joint replacements, vascular grafts, heart valves, intraocular lenses, dental parts, pacemakers, biosensors, artificial heart valves etc. They are widely used to replace or restore the function of disturbed or degenerated tissues of organs, to improve function, to assist in healing, to correct abnormalities and improves the quality of life of the patients.

Heavy transport vehicles : The composite materials are used in production of component parts with cost-effectiveness. Good reproductively and better mechanical properties are the basic requirements of composites. While the costs of achieving advanced composites may not justify the savings obtained in terms of weight for vehicles production, carbon fibers reinforced epoxies have been used in racing cars and now a days for the safety of cars.

Polyester resin: With suitable fillers and reinforcements these were the first applications of composites for road transportation. The choice was dictated by properties like low cost, ease in production and designing of important parts etc. Using variety of reinforcements, polyester is used for improving the system and other applications.

Railway carriages: Here it is desirable to reduce the weight of rail bodies and heavy transport vehicles, which can reduce power and braking requirements. It also reduces maintenance costs. Vehicle type, colour selection are major aspects for building rail cars. Structural concepts of certain aluminium and steel vehicles which are designed from sheets and stiffened by extrusion are not always the most efficient in case of collision. This can be achieved by using composites.

Electronics field: Composite materials have excellent properties related to parts of electronic fields. Electronic composites requires high thermal conductivity, low thermal expansion, low dielectric constant and high electrical conductivity required for particular electronic applications. Electronics composites can use fillers like silver particles, which provides high electrical conductivity. The application of composites for electronics are interconnections, printed circuit boards, interlayer dielectrics,lids, die attach, thermal interface materials, contacts, connectors, heat source and sinks, housings etc.

Chemical Industry: Required properties like fire resistance properties, lightweight, mold ability, and resistance against chemicals has made the material used in the chemical industry. Composites are extensively used in industrial gratings, scrubbers, ducting, storage tanks, columns, exhaust stacks, piping, pumps & blowers, structural supports, reactors etc. For alkaline and acidic environments. Some other applications are in shaft, fan blades, ducts, underground storage tanks, stacks, composite vessels etc.

Sports: Composite materials are used widely for sports equipment as they offer properties like ease of transport, low weight, low maintenance and durability. The anisotropic nature resulted in low resistance and the variation in properties and high moisture absorption allocate various deformations. The composite material has characteristics of fatigue resistance, superior thermal stability, break resistance, friction resistance, abrasion resistance and vibration resistance. It has also light weight, high strength and good design freedom and they can be processed and shaped easily, so they are widely used in sports equipment. The planning boats, sailing boats, sailboards tennis rackets, badminton rackets, softball bats, ice hockey sticks, bows and arrows etc are made of composite materials.

Automobile parts: Glass and sisal fibers usually find the maximum use here. Sisal costs very less and it has prompted extensive research to come up with applications in which sisal is the main reinforcing material in filled polyester resin, in parts for which specific mechanical properties are required and appearance is not important. Heater housings, which find uses of sisal, are produced by compression moulding. This choice is also dictated by the demands of the competitive market for new and alternate materials.

Commercial aircraft applications: This is one of the most important uses of composites. Aircraft, unlike other vehicles, need to carry greater stress on safety and weight. They can be achieved by using materials with very good specific properties. A modern civil aircraft must be designed to meet the numerous criteria of power and safety. Fiber epoxy composites are used in aircraft engine to enhance performance of system. The pilot's cabin door of aircrafts is made with fiber glass resin composites and these are also used in other transport systems.

Turbojet engine : Dynamic and static conditions are combined here.These applications requires light weight materials and this combination offers advantages. The weight of rotors, compressors and bearings are decreased. Initially, turbojet engines were used in fighter aircraft and today in commercial planes. The need of a commercial plane is long service life and durability which is possible because of composites.

Space vehicles: Glass filaments were used in space vehicles for several years now as laminations in secondary structures. As its importance as an engineering material is required, glass is attractive because of high specific strength, low cost, excellent forming characteristics, high impact resistance and thermal stability. A major concern for management of space vehicle is the delivery of hardware which meets the important requirements of schedule, performance and the cost. Increased reliability and performance may be achieved by changing the material among other options. Composites have great potential for this respect and performance can be achieved by extracting weight reduction of structure.

Railway carriages: It is desirable to reduce the weight of rail car bodies as well as heavy transport vehicles, which reduces the power and braking requirements. This also reduces maintenance costs. Vehicle type, colour selection are the major aspects of building rail cars. Structural concepts on certain aluminium and steel vehicles which are designed from sheets and stiffened by extrusion are not always the most efficient in case of collision. Fire retarding properties, noise and heat insulation and crack resistance are the additional benefits.

Power Distribution and Lighting : Composite material power and lighting poles are finding increased application for both performance and environmental reasons. Traditional wooden poles

used in forest depletion. For protect them against rot and termite attack, they require treatment with highly toxic chemicals, which have been found to leach out in the surrounding environment. Lightweight composite poles are easily transported and erected; they resist corrosion, rot and insect attack and provide superior insulation properties. They can be designed to reduce the possibility of collision fatalities when close placement to roads is required.

Repair, Retrofit and Rebars : Composite plates are successfully used for repair masonry beams, columns, building and other structures damaged or weakened by impact, earthquake or subsidence and can be usually adhered in place by hand without the need for heavy lifting equipment. Such repairs can be possible much more rapidly than by traditional techniques. Composite reinforcing bars may be used to replace steel in conventional reinforced concrete to prevent "concrete cancer" problems resulting from internal corrosion of the reinforcement.

3. Conclusion

Because of the challenges of development of material with better properties in advance engineering fields, different composite materials have shown cost and energy advantages over traditional materials. The combination of different particles as rainforcement found to give better mechanical and physical properties.

Several limitations must be overcome in order to exploit the full potential of composite materials . First the proper manufacturing process should be developed and implemented. Secondly properties of composites are greatly depended on the volume percentages of rainforcement particles . The current challenge is to make them cost effective. The efforts to produce economically attractive composite components have resulted in several innovative manufacturing techniques currently being used in the composites industry.From this review, we conclude that composite materials have many advantages andapplication in various industries and they are becoming necessary part of the advance engineering applications. We can make better life style with the help of composite material.

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