



Composite Materials from Origins to Innovation: Historical Perspective and Modern Applications

Nishi Gupta¹, Harpreet Kaur¹, Shalini Sharma¹, Gargee Chakraborty¹

¹ Department of Mathematics, University Institute of Sciences, Chandigarh University, Mohali, Punjab, India

Abstract: The primary objective of this work is to find out which material is best for composite structure. The biggest problem facing is to choose the material. Several parameters are kept in mind while choosing the material, including lower cost, weight, strength, stiffness, attractiveness, fatigue and tired life, temperature dependent on behavior, thermal insulation, oxidation, wear resistance, and affordability. Materials commonly used in airplane break discs, turbines, rotators etc., were studied and analyzed to determine the best material. The study is based on the analysis from 1950-2018. The paper concludes with a comparative analysis between various composite and monolithic materials based on a broad range of characteristic attributes, including strength, stiffness, weight, fatigue resistance, temperature tolerance, structural behavior, thermal insulation, conductivity, toughness joint ability, oxidation resistance, wear resistance, cost-effectiveness, melting point, compressive strength, and thermal stability. It is concluded that aluminum silicon carbide (Al-SiC) is the most appropriate material among copper, steel, pure aluminum, P92 steel, titanium, magnesium, and the aluminum alloy Al6061-T6511.

Keywords: Composite materials, stress, strain, creep, thermal conductivity.

1 Introduction

Materials have played a critical precarious role in intensifying the quality of human life since the dawn of civilization. With the growing diversity of societal needs and the procession of science and technology, industrial development now demands increasingly sophisticated and high-performance material properties [1-6]. The furtherance of modern technologies, modern high-tech devices, machines, automobiles, aircrafts and structural products has been made possible the development of new materials. Many emergent applications, especially in aerospace, underwater exploration, and transportation demand materials with incomparable combinations of properties that traditional metals, alloys, ceramics, and polymers cannot give. For instance, aerospace engineers look for structural materials that are lightweight yet strong, stiff, resistant to abrasion, and corrosion-resistant. Achieving this combination is hard, as materials that are strong often tend to be dense, and enhancing strength or stiffness can reduce impact resistance. These complex and often contradictory requirements have driven materials engineers to initiate and develop advanced materials

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that supply both cost-effective and are capable of meeting these stringent demands something conventional monolithic materials struggle to achieve. Emergent from mid-20th century, composite materials are quickly gaining recognition as a capable class of engineering materials, offering innovative possibilities for advancing modernized technologies. Since then, they have found applications across nearly every industry [7].

Although numerous ingredients have been engineered with superior high-temperature properties, the ever-growing demands of modern technology continue to push the need for materials with superior strength and oxidation confrontation at high temperatures. Yesteryears, high-temperature applications were primarily found in steam power plants, oil refineries, and chemical processing facilities, where operating temperatures rarely exceeded 500°C. At high temperatures, material strength becomes highly reliant on both the strain rate and the duration of its exposure. In many engineering applications, especially those involving composite materials, components are subjected to severe thermo-mechanical loading where creep plays a vital role. Evaluating the performance of such mechanisms under complex, multi-axial stress conditions is both challenging and time-intensive. Therefore, the prediction and analysis of creep behavior in composite engineering mechanisms is crucial for estimating their enduring reliability and service life. Progressive theoretical hypothesis have been efficaciously employed to characterize inclusive range of damage phenomena, including creep damage, which had low- as well as high-cycle fatigue, creep-fatigue interaction, also has brittle and elastic damage, ductile and plastic damage, with strain softening, along with the sensitivity in strain-rate, and it has impact-induced impairment damage.

These advancements span a diverse array of constituents such as rubbers, concrete, rocks, polymers, composites, ceramics, and metals, reflecting the interdisciplinary nature of the field. Due to these results, creep and damage mechanics have entreated substantial interest from researchers across micromechanics, continuum mechanics, materials science, physics, chemistry, mathematics, and numerical analysis. Despite this progress, the continued evolution of damage mechanics depends on the timely propagation of original research findings.

2 Composite materials

Composites are the kind of materials which have two or more than two phases, mainly with the minimum of two phases such as matrix and reinforcement. The other phases are fillers, particles, flakes, etc., thus obtained materials are called as composites [8-11]. Composite and fused materials are extensively utilized in both industry and biomedical applications, primarily as load-bearing structural components i.e., due to their unique amalgamation of high strength, exceptional robustness, and low flexural rigid stiffness. [10, 12-14].

Deepak V. defined composite fused material is made through the combination of two or more materials to provide an exceptional combination of properties, considered one of that's made up of stiff, lengthy fibers and with a binder or 'matrix' which holds the fibers in right place. Kelly demarcated that "The composites should not be regarded simple as a combination of two materials. In the broader significance; the combination has its own distinctive properties. In terms of strength to resistance to heat or some other desirable quality, it is better than either of the components alone or radically different from either of them". Beghezan explains that "The composites are compound materials which differ from alloys by the fact that the individual components retain their characteristics but are so incorporated into the composite as to take advantage only of their attributes and not of their short comings, in order to obtain improved materials". Van Suchetclan explains "Composite materials as heterogeneous materials consisting of two or more solid phases, which are in intimate contact with each other on a microscopic scale. They can be also considered as homogeneous materials on a microscopic scale in the sense that any portion of it will have the same physical property."

Composites are multifunctional materials that provide properties that no discrete material can achieve. Concrete for example, composed of cement, water, stones and sand. A composite fused material, in general is made up of reinforcement (fibers, particles and flakes) contained in a matrix (polymers, ceramics, metal). Today's scenario where highly embedded techno- machineries, aircraft and race cars are improving all the time as it will be able to manufacture materials that are lighter, stronger and capable of handling huge loads therefore composite materials are a vital element of human life. In the automotive industry, CMs are used mostly for cylinder liners, for combustion chambers, also for CNG storage cylinders, braking rotors, pistons and for diesel engines, drive shafts, flywheels, motorcycle pulleys and drive sprockets. Propulsion shafts, cylindrical pressure hulls, composite piping systems, and boat hulls are all found in submarines. Hard disc drives of computers, machine needles used for carpet-weaving, thermal management, vessels used for pressure build up, blades for wind turbine, electronic packaging, laptop cases, MRI scanner cryogenic tubes, electric motors, wheel chairs, frames used for eyeglasses, artificial ligaments, camera tripods, hip joint implant, drilling tubes, musical instruments, and MRI scanner cryogenic tubes are all examples of industrial and commercial products. In the field of aerospace, rocket nozzles, engines parts, wind tunnel blades, spacecraft truss structure, turbine rotor, turbine wheels, solar panels, space shuttle and reflectors are all examples of aerospace tools. Engine casing, wings, rotary launchers, drive shaft are examples of missile structures in aircraft. Golf shafts, racing bicycles, fishing rods and tennis rackets as well as space structures, are used in sports. The Chinese wall is an excellent example of an old composite structure that is both strong and long-lasting. Some issues, such as corrosion and high temperatures can shorten the material's life, reduce its strength and raise its creep rate. The following parameters are kept in mind while choosing a composite material for a particular application:

• Mechanical Strength	• Rigidity (Stiffness)
• Aesthetic Appeal	• Aesthetic Appeal
• Lightweight Nature	• Fatigue Resistance
• Thermal Stability	• Thermal Insulation Capability
• Thermal Conductivity	• Toughness
• Formability	• Joinability
• Oxidation Resistance	• Wear Resistance
• Cost-Effectiveness	

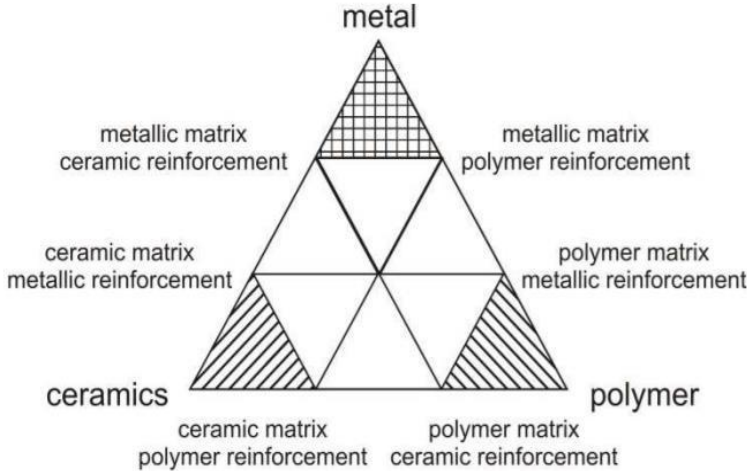


Fig. 1. Composite as a combination with the blend of materials

Properties of composite fused materials exhibit a unique combination — to illustrate as in high rigid stiffness, high strength, low weight, excellent high-temperature performance concert, superior corrosion resistance, high hardness, and enhanced conductivity—that are unattainable by any of their individual constituents. These extraordinary characteristics arise from several key factors:

- Intrinsic properties of the individual ingredients
- Relative virtual proportions of each constituent
- Size, shape, and morphology of the constituents
- Quality of interfacial bonding between constituents
- Alignment and orientation of the reinforcing phases

Most noteworthy advantages of composite materials have high explicit modulus and high specific strength in comparison to conventional materials.

- Specific Modulus are defined as the ratio of Young’s Modulus to density.
- Specific Strength is the ratio of material strength over density.

For instance, a graphite/epoxy unidirectional composite can attain strength comparable to that of steel, yet its peculiar strength is approximately three times higher. This results in significant material and energy savings, making composites highly attractive for weight-sensitive and performance-critical applications.

2.1 Research Background

The concept of mixing some components to create an innovative substantial with new innovative properties is not possible with character components and is not of latest foundation. Human have been developing composite materials to construct robust, robust and light featured objects from last thousands of years. The first and initial use of composite in “1500 B.C”. While early “Egyptian” and “Mesopotamian” settler used a mixture blend of “mud” and “straw” to generate strong and long-lasting homes. Straw continue to be persistent to offer support to ancient composite products which includes ceramic and boats. Far ahead, in “1200 A.D”. The “Mongols” devised the primary composite bow. Using a mixture of “wooden”, “bone”, and “animal glue,” bows have been pressed and wrapped with birch bark. These mentioned bows were extraordinarily effective and very correct. Composite “Mongolian” longbows supplied “Genghis Khan” with army supremacy and domination, with for the reason that of the composite era, this armament becomes the maximum powerful and influential weapons on the earth till the invention of “gunpowder”. Even though composite fused materials have been identified in vivid paperwork all through the antiquity of mankind, the records of current composite possibly commenced in “1937” while salesmen from the “Owens Corning fibre glass” organization commenced to promote fibre glass to interested events around the “United States”. Fiber glasses have remained approximately through coincidence in “1930”, whilst an engineer has become intrigue through a fiber that became shaped all through the manner of making use of lettering to a tumbler milk bottle. The composite material has many engineering applications for example composite material used for making turbine engines, airplanes jet and also in industries, particularly in structural applications.



Figure 2(a): The mud and straw mixture for making homes in 1500 B.C

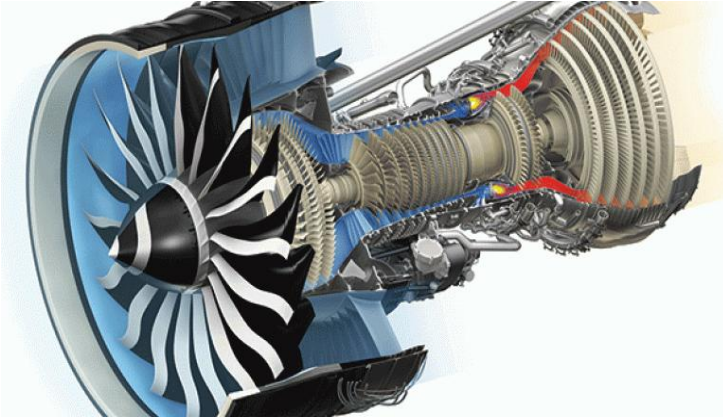


Figure 2(b) Turbine engine

2.2 Practice Background

A composite fused material is a material prepared from two or more substantial materials with different physical and chemical properties. “Wattle and daub is one of the oldest man-made composite materials, at over 6000-year-old”. From B.C to present time verities of composite material are used.

2.3 Ancient Times

People have been making composites for many thousands of years [9, 15-16]. The instances B.C. manifested as the beginning of types of composites substances utilized in every day application. The initial recognized make usage of composite is accredited to the “Mesopotamians”. These historic human beings glued wooden strips at one of kind angles to form plywood in 3400 B.C. In the middle of 2181 and 2055 B.C., “Egyptians” used material Cartonnage also layer of linen or papyrus which soaks plaster to style the design of dying mask. All over the place 1500 B.C., “Egyptians and Mesopotamians” developers and skilled artisans use straw to boost usage of bricks made out of mud, for pottery and for boats as well. In 25 B.C., “The Ten Books on Architecture” describe material and prominent diverse varieties of lime and mortars. Captivatingly, the further studies demonstrate to the cement defined is comparable, and inside some approach, greater to the “Portland” cement used these days. Since the prehistoric times, builders, artisans, engineers and manufacturer persevered to create composite of a much broader collection of substances for extra state-of-the-art application.

In approximately 1200 AD, “Mongols” innovation designed the first composite bows through from a mixture of “timber”, “bamboo”, “bone”, “cattle tendons”, “horns”, “bamboo” and “silk bonded” with herbal pine resin. These slight, small powerful,

extraordinarily perfect bows had been the most fear armaments on the earth till the “14th century” discovery of effective and nominal firearm. Starting from the 1870’s via the 1890’s, a chemical revolution then modified composite development. New form of artificial resins had been converted from a liquid to strong kingdom inside a pass-related molecular edifice the use of a method referred to as “polymerization”. Early synthetic type of man- made resins blanketed “celluloid”, “melamine” and “Bakelite”.

In 1900’s, chemical improvements through the expansion of plastics. Material consisting of “vinyl”, “polystyrene”, “phenolic” and “polyester” has been produced and underpinning became needed to offer strength and stress. “Polyoxybenzylmethylenglycolanhydride” or “Bakelite” because it is usually regarded to be advanced with “Belgian-born New York chemist Leo Baekeland in 1907”. A thermosetting phenol formaldehyde based resin material created from removal response of phenol with formaldehyde, Bakelite stand as single of the first plastics crafted from artificial components. It’s non-conductivity and heat-resistant residences made the composite material extensively utilized in industrial and purchaser items packages along with electric insulators, radio and cell phone casing, kitchenware, earrings, tube stem, and kids’ toys. In 1993, in reputation of Bakelite’s importance because the first initial and prime artificial plastic, the “American Chemical Society special Bakelite a National Historic Chemical Landmark”. Though predictable to be documented as the maximum essential epoch inside the composite industry, the 1930s noticed the enlargement of resins types are still used today. In 1935, “Owens Corning” introduces the first glass- fiber and released the fiber strengthened polymer (FRP) enterprise. In 1936, unsaturated polyester based resins have been patented. Due to their curative homes, unsaturated polyester based resins are dominated with leading preference for resins to be used for production these days. In 1938, other better performance based resin structures similar to epoxies have been discovered.

The supplies of “World War II” grabbed the FRP industry market from studies to manufacture. In addition to high-energy and to the weight houses, chemists have discovered that fiber glasses composite are transparent by nature in comparison to radio frequencies. This further leads to the composite material variation for radar domes with a different digital system. Although they are not commercialized until “WWII”, then further to this the first industrial grade boat hulls have been industrialized in the present decade. By the year 1947, a completely composite material body vehicle was designed as a prototype and later examined mainly to the advancement of the 1953 Corvette. Fiber glass infuses with resin material then molded in matched metallic die which is used to construct classic car. Two methods of as applied for compression molding i.e., “sheet molding compound (SMC)” and “bulk molding compound (BMC)”, both emerged as the foremost dominant styles of molding for the automobile or the other similar type of industries. In early 1950’s, production innovation continues through the traits of “Pultrusion”, “vacuum bag molding”, and “huge-scale filament winding”. These composite materials endure to locate applications. “Pultrusion” is used to construct linear components which include “ladders” and “moldings”.

Winding up of Filament is one instance of aerospace composite material substances. It has become the root- basis for massive-scale of rocket automobiles that propel investigation of area within the period of 1960's.

In 1961, the primary carbon fiber was registered as patent and after a number of years it gets commercially available in the market. Carbon fibers have stepped forward as thermoset component stiffness of its material to weight ratios, which are used even in more application inclusive of "aerospace", "automotive", "sporting goods", and "client goods". In the 1960's, the marine- market got changed into the major patron of composite based materials. Subsequently in coming 20 years, the composite substances marketplace itself to be superior. Ultra-high molecular mass polyethylene the upcoming new material as a different superior fibers were utilized in breakthroughs as for aerospace additives, which is structural and has personal Armor, with wearing equipment, clinical gadgets and other applications. In 1970's, the automotive marketplace surpasses marine market as the number one marketplace – a role it keeps nowadays. It witnessed, Mar-Bal in full swing started to make custom-molded breakers for numerous programs which include- Electrical breakers; Motor assemblies; Small appliances. With this humble start, Mar-Bal grow as incorporated thermoset composites solution and is commonly used these days.

By the mid 1990's, composite materials turn out to be greater not unusual in production and construction within mainstream. It is effective in price and used as an alternative to conventional substances similar to metallic and engineered thermoplastics, thermoset designed composites are commonplace components in the equipment, which has creation, electric and transport industries. Common applications include: Weather-resistant coatings and stains, Electrical infrastructure components, Pole- line hardware, Electrical cross-arms, Insulators, Handles and knobs. The year 2000 witnessed the improvement of the 787 Dream liner verified composites for high-energy also stiff packaging. It has also seen the ongoing growth of end technology, like "PVD" and "THERMTIAL", accelerated the range of packages within the automotive appliance and in the patron merchandise industries. The "Beech Starship" 2000, which is approximately entirely made from carbon epoxy faced "honeycomb" sandwich. In 2006, advanced carbon logy and fiber optic strain sensor were used at the unfastened status carbon spars for the Maltese Falcon, the latest sailing yacht.

In 2013 "polymer resin matrix" materials and high fibers glass, carbon have been introducing resulting in steady expansion and reduce inside cost. FRP (Fiber-reinforced plastic) material also used in "wind mill blades", "industrial, shafts" and "fuel cylinders" for natural gas vehicles also bridges support beams. Two packages that practice the experience with the modern growth of advanced materials are airplane composite substances and composite sheets as used for marine use. Other materials fused together as "environment-friendly" resins- integrate plastics that are recycled and "bio-based" polymers that meet up the call for more potent, more- lighter environment friendly products. By comparing exclusive properties of said composite material, it's been resolute that Al-SiC have extreme tensile, correct level of fatigue, fracture residences, high point of melting factor, immoderate ductility, had excessive

thermal and electric conductivity and good erosion resistance. Steel has tensile, excessive power to weight ratio which has excessive energy in preserving the unit mass. In high temperature steel loses its properties. Plastic is long lasting, low cost, lesser power and heavy chemical compounds requirement in manufacture and light weight. But Plastic is made of a non-renewable beneficial aid, which offers extra reasons to apply recyclable buying baggage. Copper has high electric conductivity likewise way high thermal conductivity so copper must to a chief advantage for the producing of virtual and electric powered components. The maximum critical dangers of copper cord are its weakness to corrosion that is oxidation. Titanium is exceedingly resistant for chemical attack and maximum power to weight ratio of any metallic. Titanium stiffness to weight ratio as metal is much like steel. But Titanium from a production and engineering mind-set is its excessive reactivity, technique it need to be managed in another manner at some point of all tiers of its manufacturing. Magnesium has control load may be larger than the aluminum alloy. It has poor corrosion resistance and precise protecting solvent need to be delivered at the same time as melting, low elastic coefficient additionally lower using magnesium alloy as a structural material. Aluminum is light and very strong. Aluminum is completely recyclable, electrically conductive. Aluminum is proof against UV radiation, hygienic, magnetically neutral, and electrically conductive. Aluminum oxidizes quick, and the ensuing surface coat of aluminum oxide resists further corrosion, by way of air, water, and chemicals. This defensive coating is clear, colorless, and non-staining. Aluminum may be effortlessly colored with the aid of anodization, and holds paint extraordinarily well [17].

Silicon Carbide (SiC) has high typical standard of hardness, has low thermal increase, high thermal consistency, excellent resistance at excessive temperatures, electric conductivity, nonlinear electric resistance. SiC has benefits and is used for high voltage, to build excessive strength and has high temperature utility. But Silicon carbide is not available as herbal mineral. There is issue in doping in SiC fabrication due to its chemical inertness, bodily power and occasional diffusion coefficient of different impurities. Interconnects and passive components (e.g. Inductors) have to deal with intense situations with reliability and sturdiness with a view to hold SiC functionally energetic in such situation. When compared different composite materials and monolithic materials, Al-SiC is rated the best and are economically less costly materials for usage.

3 CLASSIFICATION OF COMPOSITE MATERIAL

Composites are characterized by matrix type (polymer, metals, ceramics and carbon) and reinforcement geometry (particulate, flake and fiber), shown in Fig. 3.

Classification as based on Reinforcement of Geometry:

1. Particulate Composite
2. Flake Composite
3. Fiber Composite

Particulate Composite: Particulate composites, as shown in Fig. 4, consist of particles that are reinforced in matrix metal, ceramics otherwise alloys. Because particulates are dispersed at random, they are generally isotropic. Particulates, in comparison to fibers have very short dimensions. Particle composites have a variety of benefits, including higher strength, oxidation resistance and operating temperature for example, using aluminum particulates in a rubber matrix or silicon particulates in an aluminum matrix.

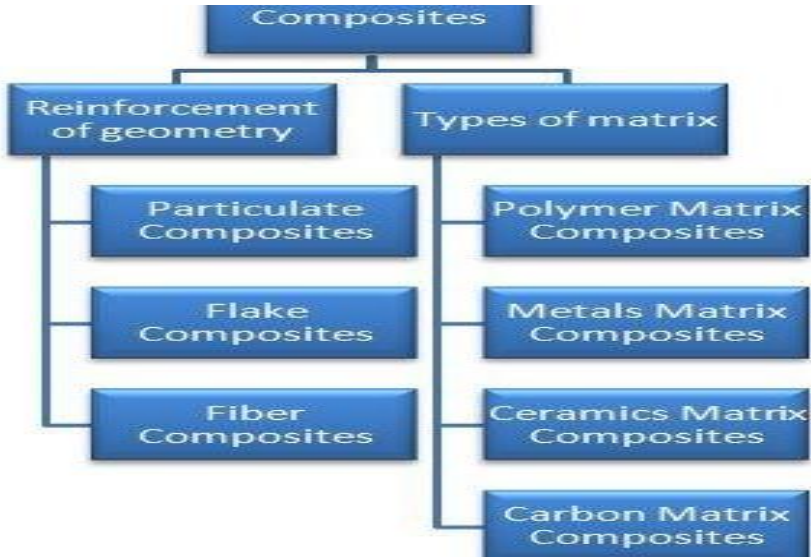


Figure 3: Classification of composite material

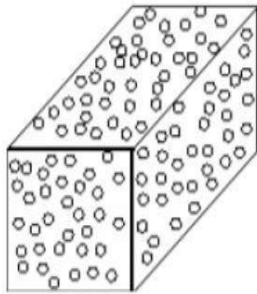


Figure 4: Particulate composite

Flake composite: As shown in Fig. 5, flake composites are created when a matrix is reinforced with flake such as glass, silver, mica, or other minerals. High strength in minimum low cost is the two basic advantages of flake composites. The most significant disadvantage of flake composite is that it is difficult to orient, limiting the number of materials that may be used.

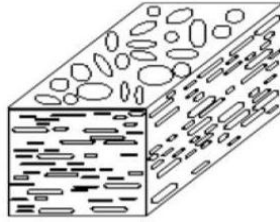


Figure 5: Flake composite

Fiber composites: Figs. 6 and 7 illustrate fiber composites constructed of a matrix reinforced by short or long fibers. The fibers that make up a matrix can be either continuous or discontinuous for example aluminum metal.

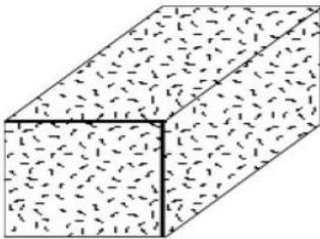


Figure 6: Short fiber composite

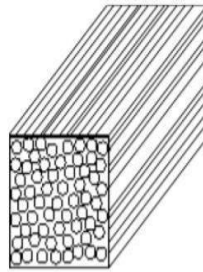


Figure 7: Long fiber composite

Classification as based on Matrix:

As per the matrix, Composites materials may be categorized as:

1. Polymer Matrix Composite - PMC
2. Metal Matrix Composite - MMC
3. Ceramic Matrix Composite - CMC
4. Carbon–Carbon Composite - CCC
5. Hybrid Composites – HC

3.1 Polymer Matrix Composite (PMC)

The most widely and advanced radical used composites are those composed of a polymer matrix e.g. epoxy or polyester—reinforced with fine-diameter fibers like graphite or boron. Among these, graphite/epoxy composites are particularly far-famed, offering strength roughly 05 times greater than steel on weight-for-weight basis. Their popularity stems from a combination of its less cost, high strong point strength, and ease of manufacturing. However, polymer matrix composites (PMCs) also have certain limitations. These include low operating temperature limits, high coefficients of thermal and had moisture expansion, & Anisotropic elastic properties, meaning reduced stiffness in certain particular directions; Despite these draw-

backs, PMCs offer significant advantages such as- High strength-to-weight ratio, Excellent in chemical resistance, Good insulating properties & Cost-effectiveness.

3.2 Metal Matrix Composite (MMC)

Metal Matrix Composites (MMCs) entail of a metallic matrix—such as aluminum, magnesium, or titanium—reinforced with fibers or particles like carbon or silicon carbide. These composites are proficient of operating at higher temperatures than their unreinforced metal counterparts, as suitable for demanding structural and thermal applications. The incorporation of reinforcements significantly enhances various material properties, including: Specific stiffness and strength, Abrasion and wear resistance, Creep resistance, Thermal conductivity & Dimensional stability. For instance, stiffness and strength of elastic in the base metal can be substantially improved, while also addressing challenges such as high thermal expansion coefficients and enhancing thermal and electrical performance.

- a) “Connecting the rods made of Al- Al₂O₃” ([“http://petroiran.blogfa.com.”](http://petroiran.blogfa.com)).
- b) “Roller cone bit with rock cutting inserts made of the WC-Co (<http://www.ret-monitor.com>).

Conductivities of metal can be reduced by addition of fibers such as silicon carbide. Reinforcements, characterized as either continuous or discontinuous, may constitute from 10 to 70 vol% of the composite. Recently, automobile industries have begun to use MMCs in their products, e.g. some engine components have been introduced consisting of an aluminum-alloy matrix that is reinforced with alumina and carbon fibers. MMCs are also used in driveshaft’s (that have higher rotational speeds and reduced vibrational noise levels), forged suspension and transmission components, and extruded stabilizer. MMCs are widely employed in a variety of industries, including defense, aerospace, shipbuilding, and automobile manufacturing. It’s used to manufacture engine or rocket bodies, as well as blades and stabilizers in military applications.

3.3 Ceramic Matrix Composite (CMC) & Carbon Composite

A CMC is a material composed of carbon or silicon carbide fibres reinforced by an alumina silicate ceramic matrix. We only use fibres that can withstand temperatures of over 1000 degrees Celsius. Catalytic converters, fuel injection parts, diesel engines, turbines, turbo rotors and valves are all used in the automotive sector. Artificial teeth, skeletal system elements and a heart valve are all examples of biomedicine. Bearings, gas turbines, auxiliary generators, fuel system components, fusion reactor walls, gas purification filters, heat exchangers and gas turbines are all examples of power engineering. Burners, crucibles, insulators, cutting systems, press molds, heat exchangers, underwater equipment, high-temperature equipment, and heat treatment furnaces are all examples of metallurgy and machining. Environmental engineering includes devices and systems designed for use in harsh environments, as well as water treatment

boilers equipment with a 2800°C and fluctuations of 1500°C temperature (outstanding thermal shock), component tooling and lining for nuclear and fusion reactors [18-23].

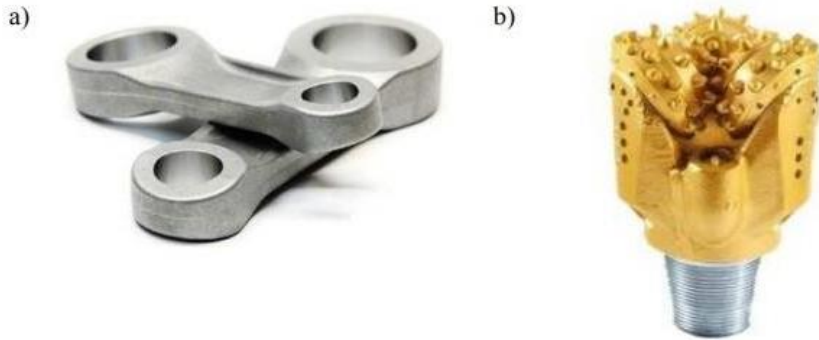


Figure 8: MMC materials have been used in a various application

3.4 Hybrid Composites

The composites obtained by using two or more different kinds of fibers in a single matrix are termed as hybrid. Although a variety of fiber combinations and matrix materials are used, but in the most common system, both carbon and glass fibers are incorporated into a polymeric resin. The carbon fibers are expensive, but they are strong and relatively stiff and provide low density reinforcement. Glass fibers lack the stiffness of carbon, but they are inexpensive. The carbon fibers are the first to fail, at which time the load is transferred to the glass fibers. Upon failures of the glass fibers, the matrix phase will have to sustain the applied load. Hybrid composites find applications in lightweight land, water and air transport structural components, lightweight orthopedic components and sporting goods.

3.5 Factors Effecting Mechanical performance

The variety of factors determines the mechanical performance of composite materials, including:

1. Fiber Factor
2. Matrix Factor
3. Other Factors

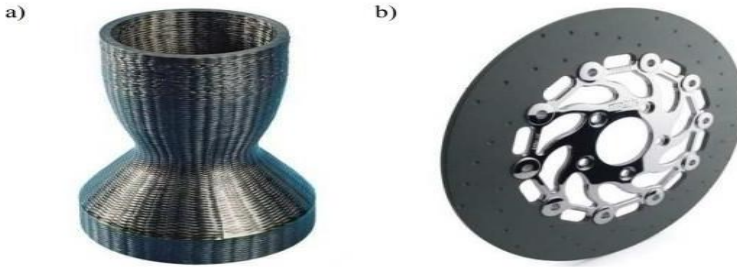


Figure 9: CMC materials have been used in a various application, (a) combustion chamber element (“<http://cs.astrium.eads.net>.”),(b) brake disc (“<http://www.sae.org>.”)

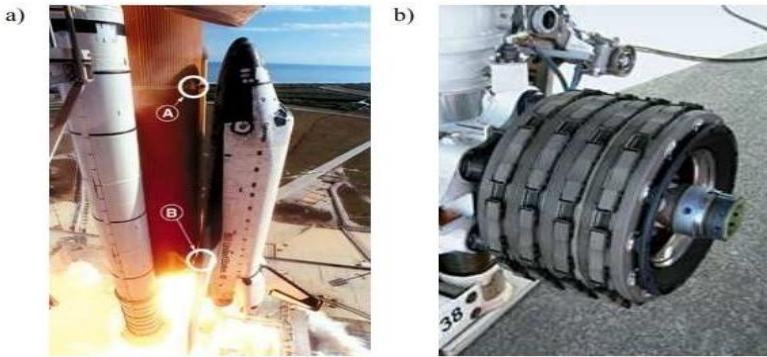


Figure 10: Examples of C- CC materials

(a) “Thermal protection system in the space shuttle” (“Walker J.D., Grosch D.J., SwRI ballistics tests help investigators determine the cause of Columbia loss, Southwest; Research Institute, the Fall 2003 issue of Technology Today.”).

(b) Carbon brakes of airplane (<http://www.boeing.com>”).

4 Advantages of using composite material

Composite material has numerous advantages in diverse fields as listed ahead:

Strength in relation with Weight	High Impact Strength
Corrosion Resistance	Nonconductive
Design Flexibility	Radars Transparent
Nonmagnetic	Low thermal Conductivity
Durable	

5 Applications of composite material

Composite Materials are many applications solicited in different fields of study that are shown in Fig. 11.

Some of applications of composite material in automobiles include combustion chambers, CNG storage cylinders, engine cylinder liners, drive, leaf spring, CNG storage cylinders, racing car brakes, flywheels, pulleys, radiator end caps, shock absorbers. Some of the sub-marine applications of composite materials include propulsion shafts, cylindrical pressure hulls, composite piping systems, sonar domes, scuba diving cylinders, boat hulls and floats. Fig. 11 shows computer hard disc drives, carpet weaving machine needles, wind turbine blades, fuel tanks, motors, artificial ligaments, and pressure vessels, cutting tool inserts, eyeglass frames, laptop cases, drilling tubes, drilling motors shafts. Some of the applications of composite materials in aerospace equipment and structures include rocket nozzles, heat exchanger panels, engine parts; spacecraft truss structure, reflectors, turbine rotors, turbine wheels, leading edge of missiles, nose caps and space shuttle. Fig. 12 shows examples of composite materials used in aircraft and missile systems, such as wings, engine casings, rings, rotary launchers, drive shafts, propeller blades, landing gear doors, helicopter components, thrust reverser, rotor drive shaft and main rotor blades. Storage casks for spent nuclear fuel rods are one of the applications of composite materials in nuclear reactors.

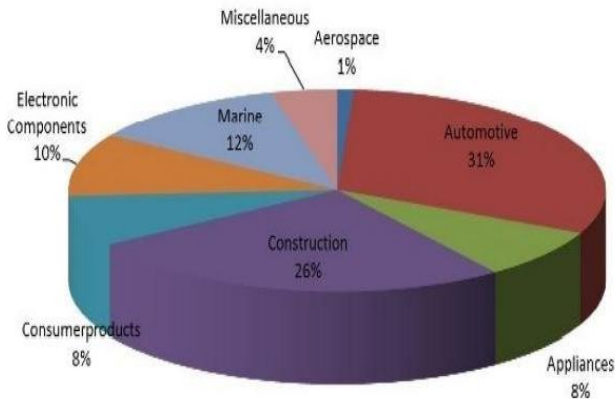


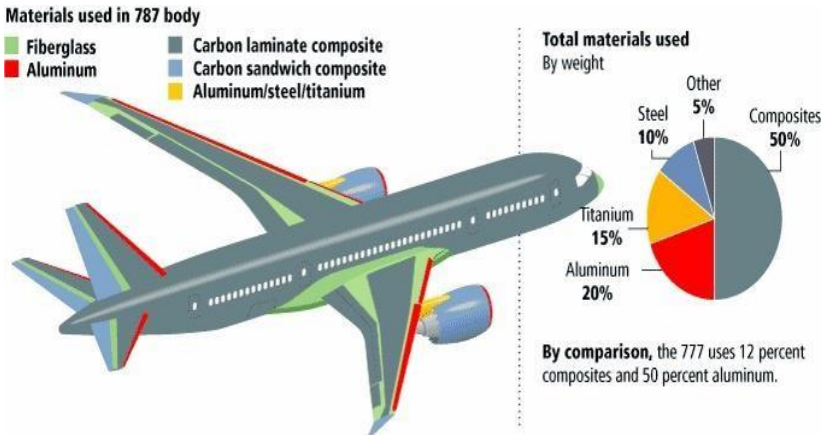
Figure 11: Composite application in different fields

Sports: Tennis rackets, racing bicycle frames, golf shafts, fishing rods, and pool cues are among the sporting equipment that uses composite materials.

Appliance: Cooking, refrigerator, small appliances, dishwasher, ice machines and laundry are applications of composite materials in appliances.



Figure 12: Computer hard disc drives
 (“https://en.wikipedia.org/wiki/Hard_disk_drive”)



6 Disadvantage of composite material

The following are some of the drawbacks of composites:

1. The cost of raw materials and composite material production is extremely high.
2. In comparison to wrought metals, composites are more brittle. As a result, they are easily damaged.
3. Repairing composites is more difficult than repairing metals.
4. A composite structure's mechanical characterization is more difficult than metal structures.
5. Composites do not always provide better performance, especially when the matrix is weak and the composites are not strong.

6. Many of the above drawbacks can be mitigated with careful design and material choices.

7 Conclusion

By comparing different properties of material, it has been found that Al-SiC have excessive tensile, with correct level of fatigue, fracture properties, has high melting factor, excessive ductility, excessive thermal and with electric conductivity and desirable erosion resistance. Steel has tensile, high electricity to weight ratio which means that it has high power in keeping by unit mass. Metallic units might be small and light-weight, not like other constructing material in substances, metal can be effortlessly fabricated and manufacturing hugely, flexible, reasonably-priced but Steel is an alloy of iron. These make it responsible to corrosion. This trouble may be solved to a degree the usage of anti-corrosion applications. It has high renovation price. In excessive temperature steel loses its properties. Plastic long lasting, low price, lesser power and heavy chemical compounds requirement in manufacture and light weight. But Plastic is fabricated from a non-renewable useful resource, which gives greater reasons to apply recyclable shopping bags. Copper has excessive electrical conductivity likewise means high thermal conductivity so copper have to a chief benefit for the manufacturing of digital and electric components. Copper is a totally ductile and tender metallic. But cost is very pricey and heavier, leading to better delivery costs. The maximum serious risks of copper cord are its weakness to corrosion that is oxidation. Titanium is enormously resistant for chemical attack and maximum electricity to weight ratio of any metal these particular houses make Titanium suitable for wide range of applications. Titanium stiffness to weight ratio as metallic is just like metallic meaning it can be used alternatively in which weight is a crucial attention. But Titanium from a production and engineering attitude is its excessive reactivity, approach it must be managed in another way at some stage in all levels of its manufacturing. It isn't desirable at excessive temperature degrees, above four hundred tiers. Titanium has excessive production fee. Magnesium has small density, much less than. Magnesium have managed load can be larger than the aluminum alloy. Good thermal conductivity, proper casting fine, exact dimensional balance, smooth to recycle. But Magnesium alloy has terrible corrosion resistance and unique protecting solvent need to be delivered while melting; low elastic coefficient additionally lowers the use of magnesium alloy as a structural material. By comparisons all the properties of material result are obtained Al-SiC is the material for used.

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