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Properties and usage areas of composite materials

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Abstract

Composite materials are obtained by physically combining materials to provide properties that cannot be obtained by individual components on a macro scale. They are materials with different mechanical and physical properties that can be prepared according to the desired application properties. The types of composite materials are increasing day by day to meet the increasing needs of the developing industry. Today, composite materials are frequently used in every field of industry.

Keywords: Composite materials; Aerospace industry; Automotive industry; Construction sector; Mechanical properties;

1. Introduction

The oldest and most widely known area of use of composite materials is the construction sector. Walls made of straw and fiberized mud are among the first examples of composite materials. Today, composite materials made of stone, sand, lime, iron and cement form our homes.

One of the most recent examples of composite materials is paper. Paper, which consists of cellulose and resin, has been offered to humanity as a unique tool of use in every area of our lives [1].

Today, the area of use of composite materials has reached very wide dimensions. The main areas of use of composite materials and the advantages provided in these areas can be listed as follows:

- ***Urbanism:*** In this field, composites are used in mass housing construction, environmental beautification works (statues, benches, electricity poles, etc.). The ability of the manufacturer to produce a large number of standard products in a short time provides savings in assembly and low cost opportunities, and the user with high insulation capacity, lightness and high mechanical strength.
- ***Home Appliances***: Composite materials are used in frequently used household appliances such as tables, chairs, television cabinets, sewing machine parts, hair dryers and decorative household items. In this way, it provides advantages such as complete and mixed part production, ease of assembly, protection from electrical effects and lightness.
- ***Electrical and Electronic Industry:*** Composites are used in the production of all types of electrical and electronic materials, especially electrical insulation.
- ***Aerospace Industry:*** Composites are increasingly gaining wider application in the aviation industry (Figure 1). They are successfully used in glider bodies, aircraft models, aircraft bodies and interior decoration, helicopter parts and space vehicles. Lighter material provides resistance to atmospheric conditions and high strength. [2]

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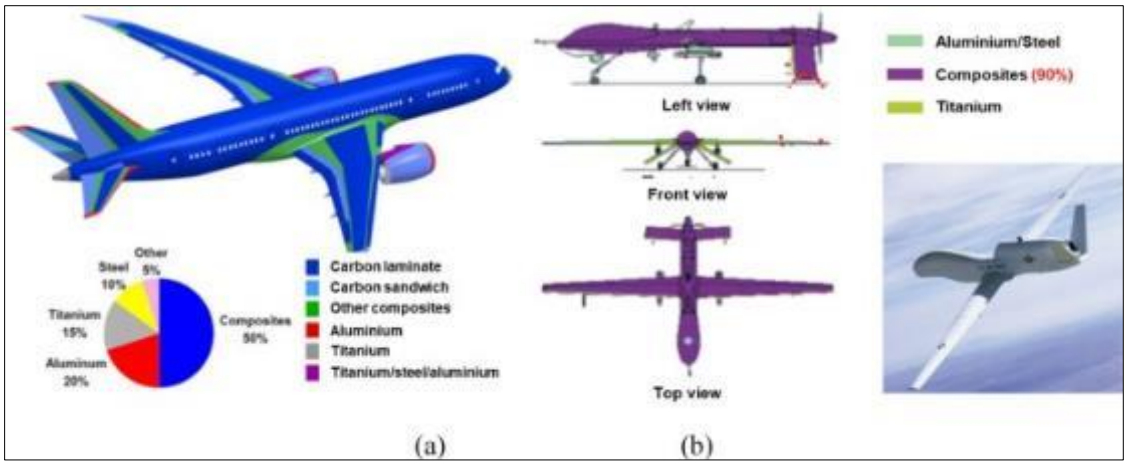

Figure 1 Use of composites in the aerospace industry

- ***Automotive Industry:*** The main products made of composites in this field are automobile body parts, interior equipment, some engine parts, bumpers and tires (Figure 2).

Figure 2 Use of composites in the automotive industry

- ***Construction Machinery:*** Composite materials are also used in the production of construction machinery covers and work cabins. In this way, the number of parts used in production can be reduced, single-piece production is possible. In addition, savings are made on electrical insulation materials [2-5].
- ***Construction Sector:*** Facade protections, holiday homes, buffets, bus stops, cold storage, construction molds are applications of composite materials (Figure 3). The design is flexible and easy, and provides great advantages in transportation and assembly. The insulation problem is solved and maintenance costs are reduced.

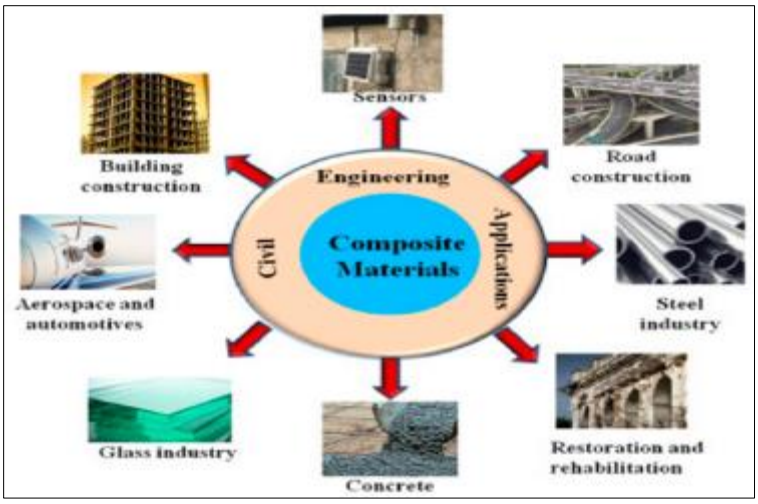

Figure 3 Use of composites in the construction sector

- ***Agricultural Sector:*** Composites have a special importance in the construction of greenhouses, grain collection silos, water pipes and irrigation channels. These examples made of composite materials provide advantages such as light transmittance, resistance to natural conditions and corrosion, low investment and easy assembly if desired [6,7].
- ***Space and Rocket Industry:*** The first area of use of composites in the rocket industry is the rocket casing application (Figure 4). Thus, the carrying capacity and range of rockets have been increased. Space shuttles are one of the first applications where metal matrix composites (MMC) are widely used. The main frame of space mechanics is made up of unidirectional boron fiber aluminum main structure tubes. These tubes provide more weight savings compared to aluminum types [8].

Figure 4 Use of composites in the space and rocket industry

Since many properties of composite materials differ greatly from those of metals, they have gained importance compared to metal materials. The low specific gravity of composites provides a great advantage in light constructions. In addition, the corrosion resistance of fiber-reinforced composite materials and their heat, sound and electrical insulation provide an advantage for the relevant areas of use.

The advantages and disadvantages of these materials are briefly discussed below. Theoretical studies are being conducted to eliminate the disadvantages of composite materials, and if these studies yield positive results, composite materials can replace metallic materials [9].

- ***High strength:*** The tensile and bending strength of composites is much higher than many metallic materials. In addition, due to their molding properties, composites can be given the necessary strength in the desired direction and region. Thus, material savings are made and lighter and cheaper products are obtained.

- ***Easy Shaping:*** Large and complex parts can be molded as one piece in a single operation. This also provides savings in material and labor.
- ***Electrical Properties:*** Composite products with very superior electrical properties are obtained by selecting appropriate materials. Today, composites can be used as a good conductor in large energy transmission lines and, when necessary, as a good insulator material in another structure.
- ***Resistance to Corrosion and Chemical Effects:*** Composites are not damaged by weather effects, corrosion and most chemical effects. Due to these properties, composite materials are safely used in the construction of chemical tankers, pipes and aspirators, boats and other marine vehicles. Especially being resistant to corrosion provides advantages in many areas in the industry.
- ***Heat and Fire Resistance:*** The heat resistance feature of composites, which can be made of materials with low heat conduction coefficients, allows them to be used under high temperatures. The heat resistance of composites can be increased with some special additives.
- ***Permanent Coloring:*** The desired color can be given to the composite material by adding pigments to the resin during molding. This process does not require additional expense or labor.
- ***Vibration Damping:*** Due to ductility, composite materials have a natural vibration damping and shock absorption feature. Crack propagation is thus minimized.

Apart from all these positive aspects, we can list the unsuitable aspects of composite materials as follows:

- Air particles in composite materials negatively affect the fatigue properties of the material.
- Composite materials show different mechanical properties in different directions.
- Tensile, compression, shear and bending strength values vary for the same composite material.
- Since the drilling and cutting type operations of composite materials cause opening in the fibers, precision manufacturing cannot be mentioned in such materials.

As can be seen, composite materials have many advantages over steel and aluminum despite some disadvantages. With these features, composites are a material that can solve problems in many industrial branches, from automobile bodies and bumpers to sea boats, from building facades and panels to complete bathroom units, from household goods to agricultural vehicles. [10].

2. Conclusion

Composite materials can be tailored to various properties by appropriately selecting their components, proportions, distributions, morphologies, crystallinity degrees, crystallographic textures, as well as the structure and composition of the interface between the components. With this strong adaptability, composite materials can be designed to meet the needs of technologies related to aerospace, automobile, electronics, construction, energy and other industries. As a result, composite materials account for the majority of commercial engineering materials

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