ASPECTS OF COMPOSITE MATERIALS EVOLUTION

Assoc. Prof. PhD. Minodora Maria PASĂRE, „Constantin Brâncuşi" University of Târgu-Jiu, Romania
Prof. PhD. Liliana LUCA, „Constantin Brâncuşi" University of Târgu-Jiu, Romania
Assoc.Prof. PhD. Radostin DIMITROV, Technical University of Varna, Bulgaria

ABSTRACT: *The composite material results from a combination of two or more constituent materials that may be of the same type or they may be of different types, from physical and chemical point of view of the properties. The constituent materials maintain their separate identity in the composite material but a new material with improved properties and characteristics results. The two constituent materials are called matrix and reinforcement. Composite materials have special advantages compared to traditional materials therefore they can be used and applied in different areas such as: aeronautical and military industry, marine, medicine, sports, leisure, motor vehicles, construction, etc.*

KEY WORDS: composite materials, properties, areas of use, characteristics

1. INTRODUCTION

Composite materials are also called "new materials" and their primary interest in being used in various fields comes from their remarkable characteristics. Composite materials have special advantages compared to traditional materials. These include: use of more materials as a matrix or reinforcement, low weight, increased durability, fatigue resistance, longer service life, high strength and rigidity, impact resistance, amplifies or absorbs vibrations, corrosion resistance, fire resistant, low thermal conductivity, strength in extreme outdoor environment, low thermal conductivity, increased dimensional stability, anisotropic properties, dimensional stability, low weight, relatively low cost of installations where it is manufactured, relatively low cost for obtaining, etc.

2. Composite materials evolution

Composite materials have been around since ancient times. In fact, composite materials are always found in nature. Thus, wood can be considered the first composite material existing in nature [1, 2].

A storage vessel dating from 900 AD during the Merovingian from Scotland was discovered and is on display at the British Museum in London. This vessel is made of fiberglass reinforced with a resin. Currently, this material could be considered a composite material with epoxy resin matrix and glass fiber reinforced [3].

We also mention the Mongolian arches, made of bamboo core on which was added tendon on the inside and horn on the outside. Some of these existing bows, which are over 900 years old, have been tested and found to be almost as powerful as modern springs. They could reach targets up to about 490 meters [4]. Also from the composite material were made the traditional Japanese swords. Among the composites that appeared over time, we can mention the raincoat created by Charles Macintosh in 1823, made of cotton over which he attached a rubber layer. In 1892, François Hennebique filed the patent for reinforced concrete (the composite used in construction, the concrete has the role of matrix and steel forms the

reinforcement) [5].

In 1870-1890 the first synthetic resins that man made through a chemical process of polymerization appear and were called polymeric resins; they can be transformed from the liquid state to the solid state by crosslinking the molecules. In 1907, chemist Leo Hendrik Baekeland, creates a new synthetic resin called bachelite, which was, however, extremely fragile. Baekeland has managed to remedy this impediment and obtain a product with good characteristics by softening and strengthening it with cellulose. In 1917 the bachelorette was used at the gearshift knobs for Rolls Royce cars. In the 1930s, with the spectacular evolution of the resins, the composite materials as a whole evolved. Thus, new types of resins appear that have special properties, including epoxy resins [4].

In 1936 Carleton Ellis manufactures and patents the unsaturated polyester resins that are the basis for obtaining composite materials.

Composite materials developed rapidly during World War II due to the need to find and use lighter materials for the manufacture of airplanes and boats participating in fights and to withstand weather conditions, air and water corrosion. In 1942, the first boat made of fiberglass was manufactured; this fiber was also used in fields such as aeronautics or the manufacture of electrical components. Thus, over seven million kilos of fiberglass were used for military applications. FRP composites they have been used in corrosive environments, due to their high corrosion resistance. The fiberglass pipe, used for the first time in 1948, being highly resistant to corrosion is used in the oil industry. Since the 1970s, the evolution of composite materials has been rapid. Composite materials with metallic matrix appear on the market. Stephanie Kwolek, a DuPont chemist, invented Kevlar (aramid) which is a para-aramid fiber and is used in advanced composites. Kevlar its use in ballistic and stab-resistant body armor [4].

At the beginning of the 80's composites materials occupy an important position in the material hierarchy. Their area of use expands and begins to be used in new field, such as infrastructure. Bridges are constructed partially or totally from composite materials; appears the first bridge constructed of reinforced concrete with FRP. Currently, FRP composites are used for seismic consolidation of brick or reinforced concrete structures.

Today, composite materials are widely used in almost all sectors of activity such as the automotive industry, the aerospace industry, the military industry, infrastructure, medicine, sports and recreation etc.

In aeronautics, composite materials are used because of their excellent characteristics: low weight, high corrosion resistance, high fatigue resistance and rigidity. Being easy to work with, they allow for great flexibility and can be modeled to your desired design. It was possible to obtain a light aircraft, with a single engine made almost entirely of carbon fiber reinforced polymer (CFRP). At this type of aircraft the engine is lighter and has a higher payload. In the work [6] it is specified that for this type of aircraft at “least one of plane's safety features relies on CFRP's excellent crash absorption properties. The plane's safety cell can take a frontal crash with minimal transfer of impact energy to the pilot or the passenger. The second safety element is an integrated aircraft ballistic parachute recovery system — essentially a parachute for the entire plane — embedded in the fuselage”.

In figure 1 it is shown the component parts made of carbon fiber reinforced composite materials used in Airbus 350 aircraft [7].

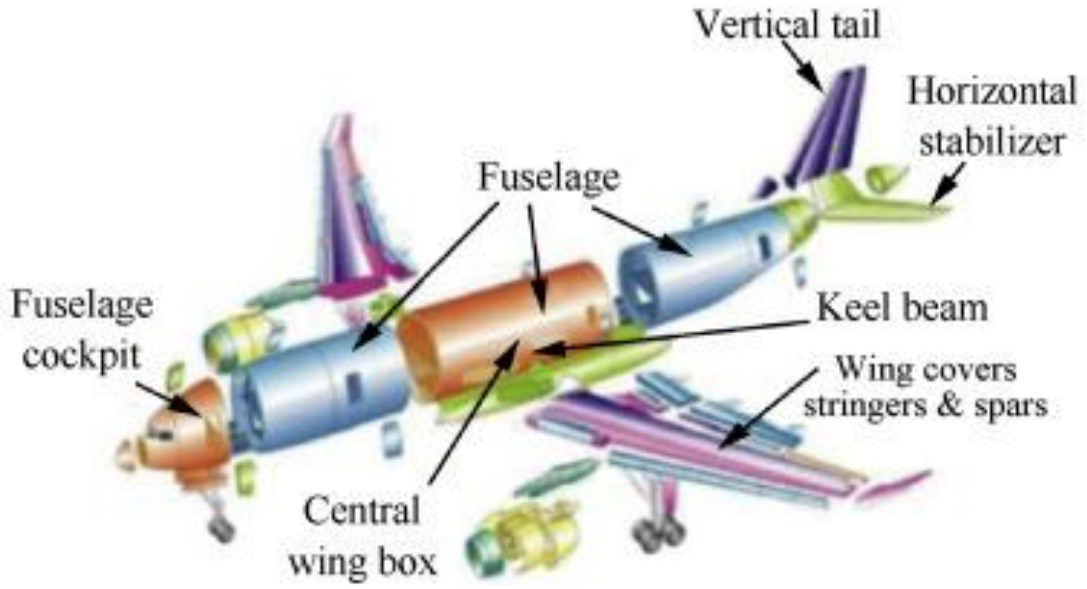

Fig. 1. CFRP composite components used at Airbus 350 [7]

Composites have also successfully entered the shipbuilding industry, delivering outstanding performance related to low weight, high strength, safety, corrosion resistance, durability, reliability and low maintenance costs. Numerous components are built from composite materials: ships, boats, decks and bridge superstructures, shafts, etc.

Composites such as polyester resins, which are either glass fiber or carbon fiber or aramid fiber, are used in ship transport due to their low weight and high rigidity. These characteristics have resulted in increased speed and reduced fuel consumption of ships.

In the automotive industry, composite materials have been successfully introduced and offer a good alternative for replacing many metallic materials, which has resulted in increased structural performance, safety, durability, light weight, lower costs and not least the reduction of pollution and compliance with environmental and safety regulations etc. They are used in bodywork, structural elements, etc.

An eloquent example for the use of composite materials is the Formula 1 cars, which are built almost exclusively from composite materials.

For the heavy vehicle industry, composite materials are used in the construction of buses, trains, heavy trucks, trailers, etc. Their introduction in the composition of these vehicles has resulted in a more efficient fuel consumption, a reduction of noxiousness, dimensional stability, reduced maintenance costs etc.

The use of composites in constructions is of major importance, because "the structures obtained with certain composite materials have an important seismic resistance. Composite materials reduce inertia ("dead load") and weight, and absorb shock and vibration from earthquakes and other mechanical sources" [8]. They are used in the construction of bridges, tunnels, panels, corrosion protection and waterproof coating, for household objects, baths, sinks and also for reinforce some strength elements of buildings such as beams [9].

In sports, composite materials are widely used and are found in the composition of tennis rackets, surfboards, golf clubs, hockey clubs, kayaks, bicycle frames, etc.

In fig 2 we can see such an example of using composite materials in recreational sports. It shows a boat built almost entirely of composite materials [5].

Fig. 2. Boat built almost entirely of composite materials[5]

Being resistant to corrosion, the composites are ideal for use in severe chemical, thermal, humidity, etc., environments [10,11]. Thus, they are encountered in pipes, tanks, power plants, electronic equipment, etc.

Nor should we forget the use of composite materials in medicine, where they have an important role in orthopedics, dentistry and are used in hip prostheses, knee prostheses, bone implants, dental implants, etc.

In order for all the products made from composite materials to meet the quality requirements of the beneficiaries, the condition of using the composite materials of adequate quality is also required. In this sense, different methods can be used to control, assure and evaluate the quality of composite materials. The classic and modern tools of quality management, used in many fields of activity [12,13,14], offer the possibility to identify the causes that generate defects or the measures for quality assurance in the case of composite materials. The quality control of the composite materials involves techniques of measurement and control appropriate to the current state of the art in this field.

3. CONCLUSIONS

Composite materials have appeared since ancient times and, in recent years, have seen a rapid development revealing multiple advantages and uses. Due to their mechanical, physical, and chemical properties, these materials can be used in many areas, in everyday life. Although they use different reinforcement elements, when they are inserted into a matrix, the material that is formed has properties far superior to the materials from which it is formed. The obtaining methods, the time required to get them and the multiple fields of their application, make composite materials widely used today.

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