

## The application of composite fiber materials in sports equipment

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**Abstract:** This paper introduces the application of composite fiber materials in the field of sports equipment, mainly from the aspects of its application in sports equipment advantages, as well as the principle of select material, product varieties, application example and the present situation and so on are expounded.

### Introduction

With the development of economy, people's living standards improve, more and more modern people relaxing into all kinds of sports venues. And the development of the modern athletic sports in the sports experts focuses on scientific training at the same time, also attaches great importance to the improvement and development of sports equipment. Because of the fiber reinforced composite materials with light weight, high strength, large degrees of freedom of design, easy processing and forming characteristics, obtained widespread application in sports equipment.

### The advantages of fiber reinforced composite material is applied to sports equipment.

As is known to all, before the advent of fiber reinforced composites is not, as a sports equipment materials mainly wood, steel, stainless steel, aluminum alloy, etc. Compared with these materials, fiber reinforced composite material has obvious advantages in the following aspects.

**Light.** Most of the sports equipment is to rely on human to make the movement, the lighter the better, therefore requires equipment such as tennis racket, golf clubs, bikes, Skis, etc. Fiber reinforced composites in this aspect has the incomparable advantage. Such as the golf clubs made of carbon fiber reinforced materials, adopting the take-up molding in carbon fiber cloth, the mechanical properties of a metal rod improved many, 30% ~ 50% and the weight is lighter than the metal rod.

**Mechanical performance is good.** Sports equipment should have good usable performance must have excellent mechanical properties. Fiber reinforced composite material has outstanding than strong. Degrees, modulus and elastic modulus, more suitable for used in sports equipment. Composite material has a good damping shock absorption performance is also one of the reasons its as raw materials for the sports equipment.

**Can design.** Composites forming technologies development greatly enhanced its design degrees of freedom than traditional materials, all kinds of products can always find the corresponding. Forming method, thus, according to the different situation of player itself and design respectively, and easy maintenance, low cost.

**Other aspects.** In the process of the development of sports equipment, environmental protection and cost performance is also must consider the problem. Composite materials in use process will not. Send out harmful gas, and thermoplastic composite materials can be recycled use, usually at the same time, in the production of composite material prices of raw materials is compared commonly low, low processing cost, conducive to the dissemination and promotion of the product.

### **Reinforced with fiber materials and fabric structure**

Enhanced with fibre materials mainly include common glass fiber, carbon fiber, synthetic fiber, etc. These fiber materials can be processed into yarn, cloth, belt, used in the form of a mat, chopped strand, etc.

**Inorganic fibers. Glass fiber.** Low hygroscopicity, size stability, heat resistance, aging resistance, good chemical resistance and flame retardant, elastic modulus, tensile strength and lower elongation. Glass fiber reinforced composite material is a kind of wide application development earlier, composite material, its tensile, bending, impact strength and stiffness are larger.

**Carbon fiber.** With high strength and modulus, it with the resin poor wettability, adhesion, before the preparation of composite materials, table should be carried out of the fibers. The surface activation treatment. Carbon fiber reinforced composite material is a kind of strength, stiffness and heat resistance are good composite materials

**Silicon carbide fibers.** Silicon carbide fiber tensile strength, high modulus, good heat resistance, resistance to high temperature of 1250 e, good compatibility. Silicon carbide fiber resin. Matrix composite compressive strength, impact strength and abrasion resistance is better than that of carbon fiber reinforced resin.

**With high strength and high modulus synthetic fiber. Aromatic polyamide fibers.** The fiber characteristic is low density, high strength, high modulus, high temperature resistant, and resin has a good bonding effect. It has enhanced the tensile strength of the composite material is better than that of the glass fiber and carbon fiber reinforced material, the modulus of elasticity is 2 times of glass fiber reinforced material, but lower than that of carbon fiber reinforced materials.

**Ultra high modulus polyethylene fiber.** This fiber has high strength, chemical stability and good biological adaptability, low density, but the viscosity difference when used in composite materials. Limit, must pass a plasma ablation, radiation - induced grafting of different methods, such as surface modification processing.

**Hybrid fiber.** Hybrid fiber reinforced refers to two short fiber hybrid or filament one-way enhancement, also can be composed of two different fiber core complex. Yarn as reinforced material, and then with a kind of resin matrix composite. Hybrid fiber reinforced composite materials in addition to the single fiber characteristics, there are some special performance, can meet different application needs.

**Increase with the fabric structure.** Fiber reinforced composites reinforced phase in addition to using the dispersion of short fibers or filament bundle, can also through the fabric forming method. Made of rope, belt, felt and all sorts of different fabric structure, namely the pre in scattered it has no fiber no tangles, shear effect between the fibre and other defects. This estimate can be according to the need of the composite material of the final product, made of different structure and different shapes, such as woven fabric, knitted fabric, woven fabric and nonwoven fabric, multi-layer structure, such as fabric, three-dimensional fabric by these forms of textile structural materials for enhanced phase, don't need to machining, it can be made a molding h-beam, l-shaped beams, cross beams, conical, such as spiral shaped structure.

### **Made of fiber reinforced composite material sports equipment**

There are many different kinds of sports equipment, the following are common fiber reinforced composite material sports equipment to make a simple list (see table 1), and makes detailed introduction of some products.

Table 1 Examples of fiber reinforced composite materials application in the sports equipment

Form	Application
Plate-like structure	Skis, surfboards, windsurfing, table tennis boards, slats and gliding wing spar etc.
Tubular structures	Tennis, badminton, fishing rods, golf clubs, baseball bats, hockey sticks, pole shaft, etc.
Sheet structure	All kinds of helmets, golf club heads, the hull structure of the various boat classes
Other structures	Match with a variety of vehicles, Sword, climbing ropes, various lines etc.

**The skis.** Skiing, snowboarding is related to the athletes' life safety and performance, and the structure of the skis and material is more complex..General skis have wood, metal and fiber composites (general glass fiber). Wooden light and cheap, but easy to be affected with damp be affected with damp is out of shape. Aluminum alloy metal skis price is higher, the requirement to the snow, high adaptability is poor. Fiber composites of skis is suitable for any types of snow, snow, and easy in maintenance. Skis are typically on the market performance of sandwich composite materials. The skis core material is made from wood or PU, PVC, etc, the elasticity of the skis is from this; Carbon fiber is located in the upper core layer, can strengthen the skis flexion degree; Glass fiber in the core layer above, can play a role in connection, can connect the panel and the core layer, increase the toughness of skateboarding, also can let slide more powerful.

**Golf clubs.** Shakespear companies in the United States in 1972 by filament winding legal system into a golf club, in the same year, the United States G.B rewer using CFRP (carbon fiber reinforced composite material) made the cue, after that, in order to adapt to the distance and direction of the ball's flight stability requirements, in terms of weight, size and load to improve them. Now high-end golf clubs, using carbon fiber composite material, small density, high strength, high elasticity, impact resistance, make golf clubs can be used repeatedly, but also make the athlete can give full play to the golf ball strength and technology.

**The bicycle.** In the mid - 1980 - s, Italy, France, Britain and the United States have developed the stick with carbon fiber tube and aluminum alloy joint.The carbon fiber bicycle into the frame. Its frame chrome molybdenum steel frame light in weight and strength, stiffness is higher than chrome molybdenum steel frame, once developed, so it is used as a special race car. Well-known German driver, who won men's cycling road race ulrich/mount 0 is made of carbon fiber reinforced composite material support, the quality is only 715 kg. The current commonly used resin transfer molding (RTM) to batch production bike process.

**Tennis racket.** The high, middle-grade tennis rackets in the world today are mostly made of carbon fiber composite materials. The carbon fiber used in tennis racket at the earliest.Several companies such as the United States Chemold is 1974. Carbon fiber composite materials can be big tennis racket, absorb shock absorption performance is good, design freedom. Compared with other materials, carbon fiber used in tennis racket has the following advantages: creates can manufacture large tennis racket: wooden compared with the past, under the same weight, the racket area can increase about 115 times, the tension of cable than the average increased by 20% ~ 45%. DHS absorb shock absorption performance is good: carbon fiber composite vibration damping performance outstanding, it is not easy to start up, also easy to stop after start up. »design degrees of freedom.

## The conclusion

In recent years, the developed countries use their advantages in the field of materials and engineering technology, the application in the field of composite materials in the sporting goods expands unceasingly, has made remarkable achievements. Has developed the use of GF, CF, aramid fibers or ceramic fiber reinforced composite materials for the skeleton of tennis rackets; Ski sticks to the use of laminated composite materials manufacturing; Paddle, golf, hockey stick has a similar situation. In mainland China in manufacturing FRP sports equipment has also made a lot of work. Such as Shanghai institute of FRP structure in the early 1960 s by nanjing fiberglass research and design institute to develop high modulus glass fibers made of FRP poles. Zhejiang fuchunjiang unit such as water sports equipment factory and fuchunjiang sports equipment factory developed ACM (advanced composite) series rowing, except for domestic players, but also exported abroad to participate in international competition, sports equipment for the development of fiber reinforced composites made an important contribution. Fiber reinforced composites in the field of sports equipment has formed a larger market. In 1997, the world sports equipment in compound material. Material consumption for 50, 000 t, the proportion reached 25%. Analysis of the personage inside course of study thinks, with the sports of sports equipment. The more stringent requirements, the fiber reinforced composite material applied to the sporting goods to is the mainstream in the development of sports goods industry in the 21st century.

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