Practical application of advanced bioengineering plastics in sports facilities and fitness equipment

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Abstract. As a new type of engineering material, advanced bioengineering plastics have been gradually applied in sports equipment for its properties, common materials, and advanced bioengineering plastics. The application and performance advantages of advanced bioengineering plastics in sports equipment and protective equipment mainly include: low density, high strength, strong toughness, not easy to be corroded and aged, and easy to be processed and formed, etc. In this paper, the future development space of plastic composite materials is further analyzed, and some feasible application strategies are put forward, in order to provide some feasible references for relevant practitioners.

Key words: Sports facilities; fitness equipment; plastic composite materials.

1. Introduction
With the gradual transformation from national sports to competitive sports in China, more and more high-level competitions have taken place, which has brought huge demand for sports industry, and promoted the development of various types of sports equipment, sports facilities and construction equipment to the direction of green, environmental protection and lightweight. Traditional metal and wood materials are gradually replaced by plastic, carbon fiber and other composite materials.

With the rapid development of China’s plastic and composite sports equipment processing industry, many manufacturers and brands have gradually developed composite sports equipment with high performance and quality, which can effectively improve the safety of sports. However, due to the low level of recognition and recognition of new materials, it has not been promoted nationwide. Common sports equipment is still mainly made of plain carbon steel. After being eroded by sweat, rain, etc., this kind of material is very easy to appear corrosion phenomenon, which affects the service life of the instrument, and at the same time, it is very easy to cause injury to the personnel participating in the movement. Therefore, to improve the quality of sports equipment and the stability in the use process is very important for the development of sports industry in our country.
2. Performance advantages of advanced bioengineering plastics as raw materials for sports equipment

2.1. Low density and light weight
The chemical structure of the material is relatively special, its density is relatively low, and it is more light-weight. The existence of sports equipment is mainly to improve the physical fitness level of the exerciser. For most of the equipment, the structural sports are promoted by the way of manpower. Such a way can not adapt to the current exercise needs, and will greatly reduce the comfort. And the emergence of light sports equipment will help athletes to better play the competitive level, so as to show the charm of sports. This is more suitable for the middle-aged and elderly groups. Light sports equipment can better match the physical fitness of such groups, and it is relatively less difficult in the follow-up maintenance work, which can significantly enhance the durability of the equipment.

2.2. Excellent mechanical properties
The plastic material represented by fiber reinforced resin has excellent tensile properties, and its elastic modulus and flexibility are obviously better than that of metal material. The use of sports equipment is usually faced with high frequency or intensity of use, such as mountain bike downhill, sailing, tennis and so on. These instruments are usually faced with the impact of high-speed landing, stretching during the sail blowing and the impact with the ball during the non-stop swing. Therefore, in the actual design and processing process, it is necessary to consider the strength of the device under long-term use. However, considering that most sports are gradually lightweight design of sports equipment, sometimes through reducing the use of materials to achieve the effect of weight reduction of equipment, inevitably reducing the overall use strength and flexibility of the equipment. Therefore, the processing materials used in sports equipment and protective equipment must meet the dual requirements of low density and high strength at the same time. New bioengineering materials such as carbon fiber materials meet this requirement. Taking the carbon fiber reinforced resin composite as an example, the carbon fiber composition of this type of material has the characteristics of high strength and high flexibility. If the reinforced resin material, the overall density has been greatly reduced. Therefore, carbon fiber reinforced resin composite has been widely used in the processing and manufacturing of skateboards, bicycles, sailboats, rackets and other sports equipment. Compared with the traditional metal, wood and so on, the application prospect of new carbon fiber reinforced resin composite is more extensive.

2.3. Long service life
The vast majority of sports equipment put forward higher requirements for the use of the environment, some sports materials need to bear a sustained load, while some equipment need to be eroded by the sun and rain for a long time. Based on the plastic composite material, it can effectively resist the influence of various factors. At present, the plastic floor based on the plastic composite material has been widely used, such as badminton court or volleyball court, and its specific content is shown in Figure 1.

Fig.1 A schematic diagram of a plastic floor
3. Performance test of advanced bioengineering plastics
Based on the experimental study on the properties of ABS, GFRP and Pu, the advantages and disadvantages of typical advanced bioengineering plastics are analyzed and summarized from three aspects of impact strength, bending strength and tensile properties.

Compared with the traditional metal or wood equipment, the processing requirements of engineering plastics are relatively low. Some equipment can be directly molded by injection molding process, such as tennis racket, badminton racket, etc. On the one hand, the characteristics of easy processing greatly reduce the processing cost, on the other hand, it also lays the foundation for large-scale, low-cost processing. Therefore, some metal sports equipment has been gradually replaced by engineering plastic equipment.

| Experimental Condition | Impact speed /(m/s) | Bending speed / (mm/min) | Tensile test speed / (mm/min) |
|------------------------|---------------------|--------------------------|-----------------------------|
| ABS                    | 3                   | 5                        | 6                           |
| FRP                    | 3                   | 5                        | 6                           |
| PU                     | 3                   | 5                        | 6                           |

The results show that the properties of the three materials have their own advantages and disadvantages, among which, the bending rate of ABS material is only 14%, and the shape variable is significantly smaller than the other two materials, which are mostly used for processing equipment requiring long-term or large force use of constant type, such as horizontal bar, double bar, etc;

The tensile strength of FRP material is 455kgf/cm², which is significantly better than the other two materials, and it is mostly used to process the handle of some stretching equipment; the impact strength of PU material is 30kgf/cm², which is superior to the other two materials, so it is mostly used to make all kinds of ball equipment, such as football, basketball and so on. In addition, the composite material processed by a certain proportion can have the advantages of multiple materials at the same time, so it can provide more abundant processing technology.

4. Advanced bio engineering plastic sports facilities and fitness equipment
4.1. Water sports facilities
There are rowing, canoeing, sailing boat, water motorcycle and so on, which are often used in water sports equipment or facilities. Among them, aramid material is widely used in canvas design of various types of boats because of its low density, strong water resistance and strong corrosion resistance; carbon fiber materials and unsaturated polyester resin composite, glass fiber and other materials are often found
in hull and hull of ship; carbon fiber reinforced plastics, epoxy composite and foam laminates are used for processing various types of materials.

Oars or paddles. In addition, vinyl ester resin and PVC composites are used to process the inner layer of surfboards and water skiing boards, while the outer layer is made of fiber-reinforced plastics (FRP) and polyurethane foam composite (RPFC).

4.2. Ball Games facilities
The most typical ones are golf, bowling, etc., which are widely used in plastic composite materials. For golf, foaming ion resin is the main material, while the framework of tennis racket is mainly composed of carbon fiber reinforced plastic and polyethylene. The main application of softball bat is glass fiber reinforced plastic.

4.3. Skateboarding
The slide plate is composed of bracket, plate body and other parts. As for the plate body, rubber, clay and metal are used at first, but under the influence of plastic composite materials, polyurethane plastic is the main one at present. As for the wheel part, there are also differences in the polyurethane materials used for different roads, and different hardness requirements can be achieved by controlling the amount of materials. For the plastic panel, polypropylene and polycarbonate are mainly used, both of which have mechanical properties.

It is better to ensure the structural integrity even under the continuous load. In addition, the plastic material also has light-weight characteristics, thus enhancing the convenience of carrying.

4.4. Playground and runway
The traditional form of cement ground has been phased out and replaced by the plastic runway, which has been widely used in stadiums and school playgrounds. Based on the plastic runway, it can bring better shock absorption effect, and also meet the requirements of aesthetics. About the composition of the plastic runway, The fourth layer is composed of plastic and sand, which is a very important transition layer; the next layer is plastic layer, which is mainly composed of rubber particles, and also uses a proper amount of emulsion vinyl acetate. Ester, the top layer is mainly used for polyacrylate material. It is worth noting that the runway based on the modified polyurethane material can also have environmental friendly effect when it is used to enhance comfort. In this context, there are a lot of researches on polyurethane material. At present, the nano modified polyurethane material is better, its elasticity and strength are better, and it also has excellent fire resistance.

4.5. Other Sports
Other sports facilities made of advanced bioengineering plastics include

Bicycle, swimming pool, diving board, sportswear, sports playground, etc. Carbon fiber bicycle frame, double wishbone and other new parts have gradually become the standard parts of high-end bicycles or racing bicycles, greatly reducing the weight of bicycles and improving the rigidity and durability of the body, but the disadvantage is that the price is relatively expensive; swimming pools are mostly made of twistless glass cloth and unsaturated polyester resin composite materials by hand paste and lamination, which can It can ensure the completion of the construction of the swimming pool in a short processing period and the long-term use of the swimming pool without falling off, deformation and cracking. The multi-layer material composite processing runway has gradually replaced the traditional cement and sand, which is not only beautiful and easy to clean, but also can provide greater friction to improve the competitive level of athletes. At the same time, the plastic runway made of advanced bioengineering plastics has more environmental protection features.
5. Conclusion

Compared with the traditional sports goods processing materials such as wood and steel, the advanced bioengineering plastics have more excellent comprehensive properties, easier processing and forming, and more extensive uses. Therefore, the combination of this type of materials and various types of sports equipment can significantly enhance the stability of the equipment, and increase the service life of the equipment or equipment while reducing the weight of the equipment. Based on the comprehensive analysis of the properties of plastics and composites, the application of plastics and composites is summarized and prospected. At present, the research on the application of plastics and composite materials in the field of sports in China is relatively less, which is not consistent with the large-scale application of plastics and composite materials in the sports industry in China. This paper summarizes the application of advanced bioengineering plastics in sports equipment and protective equipment, and studies the advanced bioengineering plastics used in high-end competitions or sports bikes, wearable equipment, ball games related equipment, sailing, ice and snow sports and ground of sports ground. The development of national sports industry is one of the important bases to measure the people's living standards. China's sports industry and sports facilities production industry have gradually become one of the most important links in the global sports industry. The combination of advanced bioengineering plastics and sports equipment processing field undoubtedly plays a very strong role in promoting the development of China's sports industry. Therefore, the research process and conclusions can provide theoretical and experimental basis for the field of materials science and sports equipment processing.

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