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Research on the Influence of New High-performance Fiber Materials in Tennis Sports

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Abstract:

The rapid development of modern materials and their processing technology is the basis for improving the performance of sports equipment such as bicycles, skateboards, rackets, and clubs. Taking tennis as an example, the article analyzes the impact of new high-performance fiber materials on tennis and other sports. Dimensions generally have the characteristics of high strength, light weight, and good wear resistance. Therefore, this can help sports equipment to further improve its own performance. Quality, especially in the development of sports equipment at this stage, the wide application of fiber materials has become a common material used in the entire sports products. In order to obtain a more solid and elastic carbon fiber tennis racket, we have proposed a optimization method of the adhesive used for the bonding of carbon fiber tennis rackets. The advantages and applications of carbon materials in sports equipment, and looked forward to the application prospects of carbon materials in the field of sports equipment in the future.

Keywords*: carbon fiber composite material, tennis ball; racket design.*

I INTRODUCTION

Tennis is one of the earlier sports and competitive categories that have come into contact with high-performance fiber composite materials. In 1953, the British Dunlop Company first tried to apply vulcanized fiber reinforced sheet to the shoulder position of a tennis racket. It was the first exploration of the use of composite materials in the field of tennis racket processing. A tennis racket is composed of a racket head, a throat, and a handle. It also needs to be used with accessories such as tennis lines and shock absorbers. This kind of sports that requires a combination of physical and intellectual strength has been gradually promoted in China, where the overall economic strength is steadily increasing, and is accepted by more and more sports enthusiasts. In the process of preparing tennis rackets, adhesives play an important role as auxiliary materials. However, the common adhesives for tennis rackets currently on the market generally have problems such as low viscosity, low bonding strength, and penetration [1-3]. It is necessary to prepare them suitable for tennis rackets. It’s a special adhesive, but the current specific composition ratio affects the performance of the adhesive and plywood is not clear [4].

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Carbon fiber is a polymer material with a carbon content of more than 90%. Because of its high elastic modulus, high specific strength, high temperature resistance and friction resistance, it has been widely used in sports equipment, aerospace, automotive and other fields. Different from general carbon materials, carbon fiber has significant anisotropy and softness. In the actual production and application process, it can be processed into fabrics of various shapes and widely used [5]. For example, carbon fiber composite materials can be processed. Tennis rackets, skis, bicycle racks, aircraft landing gear doors, etc. In recent years, as tennis has attracted the attention of sports enthusiasts from all over the world, the application of carbon fiber/epoxy composites in tennis rackets has been unearthed by manufacturers and research institutes [6], and is recognized as having a wide range of applications in the future Prospect of new carbon fiber composite materials. This article analyzes the comprehensive application of carbon fiber composite materials in the field of sports equipment, and analyzes the performance of products such as poles, golf clubs [7], tennis rackets, fishing rods, bicycles, bows and snowboards, etc., which are widely used in the field of sports equipment [8]. The parameters and product characteristics are comprehensively analyzed, and the future application of carbon fiber materials and the material selection of practitioners in the processing of sports equipment have a certain reference significance.

With the development of new materials, the materials and production methods of tennis rackets have undergone tremendous changes, but each change is based on the development of new materials [9]. In the beginning, the industry was not developed. The materials for making tennis rackets were all taken from nature, and then developed by skilled craftsmen who spent a lot of energy. Therefore, the cost was high, and it was only available among the nobles [10]. There are several types of rackets now: Wooden tennis rackets: The earliest tennis rackets were made of wood and looked very similar to badminton rackets. At that time, wooden tennis rackets had a smaller frame and a longer handle. At that time, due to the limited development of materials, the method of making tennis balls was simple, mainly using ropes to connect the wooden handle and the frame head, so the firmness was poor [11]. Metal tennis rackets: After 1967, due to the extensive production and application of metal materials, metal materials such as iron and aluminum were also used in the production of tennis rackets [12]. Later, with the development of alloys, alloys have more excellent properties than pure metals. So it is also widely used in the production of tennis rackets [13-14].

Carbon fiber tennis racket: In recent years, with the development of new materials, carbon fiber materials have been used in the production of tennis rackets because of their high strength, good friction resistance, and fatigue resistance. In addition, resin adhesives have Excellent elasticity and bonding ability. Carbon fiber and resin adhesive are materials with very low density. Combining the two and applying them to a tennis racket can significantly reduce the weight of the racket while improving the racket's elasticity, rigidity, shock resistance and wear resistance.

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II. MATERIALS AND METHODS

2.1 Fluid type of adhesive

Ideal fluid The so-called ideal fluid is a liquid that obeys Newton's second law and is incompressible and has zero viscosity. Therefore, this liquid can also be called a Newtonian liquid [15]. Researchers have established the following equation of motion based on the motion of an ideal fluid：

$$\tau = \eta \cdot \frac{dx}{dr} = \eta \cdot \gamma \tag{1}$$

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2.2 Determination of thixotropy index

If the viscosity value of the viscometer is Vr when the speed is 5r/min, and the viscosity value is Vo when the speed is increased to 60r/min, then the thixotropy index can be calculated according to the following formula：

$$TI = Vr \quad \backslash \tag{2}$$

In the formula, if TI=1, then the fluid has no thixotropy; if TI >1, it indicates that the fluid is a positive thixotropic fluid. At this time, the greater the shear rate, the smaller the corresponding viscosity value, and the greater the TI value, the thixotropy The stronger; if TI<1, it indicates that the fluid is a negative thixotropic fluid. At this time, the greater the shear rate, the greater the viscosity value. Therefore, it is used in the production of carbon fiber tennis rackets. The greater the positive thixotropy of the adhesive, the better.

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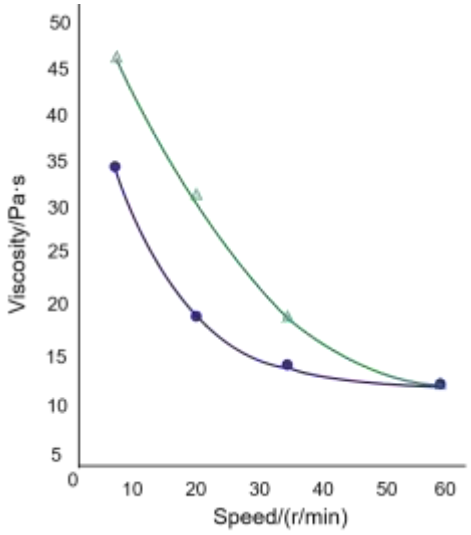

Fig.1 Adhesive viscosity curve after formulation optimization

Figure 1 shows the viscosity change curve of the adhesive of the optimized formula obtained by the measurement. From the viscosity data obtained by the above measurement, we can calculate that the thixotropy index of the adhesive is 5.02, which is beneficial to the production of carbon fiber tennis rackets.

2.3 Lignin adhesive preparation racket

Table 1 shows the effect of alkali concentration on the bonding strength of lignin adhesives. The comparative analysis shows that the viscosity, solid content and bonding strength of the adhesive when the alkali concentration is 8%, 12% and 16% are greater than that of the adhesive with the alkali concentration of 4%, and the plywood of the first three adhesives has no penetration phenomenon. This is mainly because the alkali concentration in the adhesive affects the condensation reaction of phenol and formaldehyde. In different alkaline environments, phenol and formaldehyde react to form hydroxyl groups. Methyl phenol, which has an impact on the performance of the adhesive, the plywood has the greatest bonding strength when the alkali concentration is 8%.

TAB.1 The effect of alkali on centration on the bonding strength

Serial number	A=Adhesive				Plywood	
	Alkali concentration/%	Viscosity/mPa•s	Solid content/%	Formaldehyde/%	Bonding strength/MP	Penetration
A	3	39	38.5	0.378	0.31	have
B	6	49	38.3	0.120	0.50	without
C	9	84	41.1	0.082	0.43	without
D	12	79	46.0	0.086	0.44	without

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III. CONCLUSION

The viscosity of the adhesive first increases and then decreases. The plywood bonding strength shows a gradual decrease. However, the viscosity of the adhesive without lignin is too low. The application of carbon fiber composite materials in the field of sports equipment has formed a vast consumer market. Modern competitive sports is no longer purely higher, faster and stronger, but the development of national science and technology and the improvement of comprehensive strength. Therefore, the application of carbon fiber composite materials is also a concentrated expression of scientific and technological innovation in sports competitions.

REFERENCES

[1] Gao Lijun. Study on bonding properties of composites for tennis instruments [J]. Aging and application of synthetic materials, 2021,50 (05): 112-113 + 146.
[2] Zhang Feng. Study on the influence of new high-performance fiber materials on tennis [J]. Aging and application of synthetic materials, 2021,50 (04): 155-157.
[3] Ke Sun,Xiaoyu Hu,Da Li,Guodong Zhang,Kui Zhao,Haiyang Zhao,Shuzhan Bai. Analysis of Bubble Behavior in a Horizontal Rectangular Channel under Subcooled Flow Boiling Conditions[J]. Fluid Dynamics & Materials Processing,2021,17(1).
[4] Sheng Bai,Feng Bao,Fengzhi Zhao. On the Efficiency of a CFD-Based Full Convolution Neural Network for the Post-Processing of Field Data[J]. Fluid Dynamics & Materials Processing,2021,17(1).
[5] Ding Ning. Mechanical properties of new material table tennis and its influence on table tennis competition [D]. Shanghai Institute of physical education, 2020.
[6] Yuli D. Chashechkin,rey Y. Ilinykh. Complete Coalescence, Partial Bounce and Rebound: Different Regimes Resulting from the Interaction of a Free Falling Drop with a Target Fluid[J]. Fluid Dynamics & Materials Processing,2020,16(4).
[8] Li Jiang, Li Chun, Xie Yongmin. Study on hitting characteristics of composite table tennis racket [J]. Contemporary sports science and technology, 2020,10 (15): 243-248.
[9] Lou Lichao. Research on the technical and tactical impact of new material table tennis on Chinese elite male athlete Ma Long [D]. Northwest University for nationalities, 2020
[10] Xia yongeucalyptus, Liu Ye. Effect of tennis racket line material on impact load of holding forearm and analysis of forearm surface electromyography [J]. Chinese Journal of sports medicine, 2020,39 (04): 282-287.
[11] Science - Applied Sciences; Reports Outline Applied Sciences Study Findings from Manchester Metropolitan University (Materials Have Driven the Historical Development of the Tennis Racket)[J]. Science Letter,2019.
[12] Ji Li, Chen Guowen. Mechanical properties analysis of carbon fiber table tennis racket base plate material [J]. Aging and application of synthetic materials, 2019,48 (05): 87-90.
[13] Luca Taraborrelli,Robyn Grant,Matthew Sullivan,Simon Choppin,James Spurr,Steve Haake,Tom Allen. Materials Have Driven the Historical Development of the Tennis Racket[J]. Applied Sciences,2019,9(20).

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[14] Zhao Manman. Study on mechanical and wear resistance of carbon fiber composites for table tennis table [J]. Aging and application of synthetic materials, 2019,48 (04): 62-66.
[15] Zhang Menghan. Study on the influence of table tennis with two different materials on the techniques and tactics in the Stalemate Stage of men's singles competition [D]. Shandong Institute of physical education, 2019.