Dean&Francis
ISSN 2959-6157

The application of polyurethane synthetic leather and microfiber leather materials on basketballs

Chenming Zhang[1 *]

[1] Tianjin Yinghua experimental school, Tianjin, China
*Corresponding author: Zhang. cm031X@tjyh2003.com

Abstract:

Basketball is a very popular sport in all parts of the world and the quality of a ball significantly impacts on the performance and experience of players. The external surface material is especially important, since it defines grip, durability and playability overall. The present article presents the developments in the basketball materials, especially the epidermal materials. These are polyurethane synthetic leather (PU leather) and microfiber leather, which are highly durable,performance and cost-efficient. They not only compare their different properties such as abrasion resistance,tensile strength and breathability but also emphasizes their principles,preparations and the actual performance of these materials in real basketball scenarios. The research indicates that while both materials have advantages,PU leather is commonly for producing relatively affordable basketballs,especially those designed for outdoor use.It offers good abrasion resistance and water resistance,but breathability and comfort are relatively lower.For microfiber one,it is more commonly found in high-end basketballs,mainly used in those professional competitions. It provides superior breathability , comfort and durability,making it ideal for high-intensity use.

Keywords: Basketball, Polyurethane synthetic leather, Microfiber leather.

1. Introduction

Nowadays, basketball is a sport loved all over the world, and it has become an important part of people's lives . But as society develops and technology improves, athletes have higher and higher requirements for the quality of basketballs. To get a better, safer and more comfortable experience when playing, choosing the right material for a basketball's outer cover has become more and more important. Traditionally,some professional games,such as NBA already used basketballs with genuine leather covers all the time.Players appreciate this material because of its premium feel and long-lasting durability.But this kind of leather also exists some clear drawbacks. It has expensive price and long break-in period.

ISSN 2959-6157

Besides, it only suitable for indoor courts .By the mid-1980s, manufacturers began developing synthetic materials to replace genuine leather. These alternatives aimed to cut costs while matching or even exceeding leather in performance, making basketballs more affordable and accessible to everyone.So PU leather and microfiber leather represent effective substitutes for natural leather, helping to overcome the scarcity of natural leather resources while offering superior wear resistance and corrosion resistance. Polyurethane synthetic leather is a man-made leather alternative in which textiles, knitted fabrics, or non-woven fabrics are coated or impregnated with polyurethane resin to form a surface layer[1]. Moreover, PU leather exhibits high mechanical strength, low cost, water resistance, and processability. However, drawbacks include limited breathability, it's not stable against hydrolysis, it doesn't last as long and a tendency to crack or harden under extreme conditions. The microfiber leather also termed microfiber-reinforced polyurethane leather. It as a high-performance artificial leather made from a three-dimensional non-woven structure of ultrafine fibers impregnated with polyurethane resin[2]. The resulting structure mimics natural leather's collagen fiber network, offering superior softness, better feel , good breathability, and moisture absorption. In addition, microfiber leather demonstrates excellent abrasion resistance and long-term durability.At the same time, it's also really good at resisting wear and bending. So it is one of the most advanced synthetic leathers for high-performance applications .

Besides, from an economic perspective, PU synthetic leather offers better value for money, and its price is much lower than that of microfiber leather. That's why it has become the main choice for mid-to-low-end basketballs.

On the other hand, microfiber leather uses more advanced processing techniques and has better performance, so its price is usually not low—it's two to three times that of standard PU synthetic leather. For this reason, it's mostly used in high-end basketballs, which often show up in professional games or indoor sports scenarios[3].

However, there are still some problems today, namely, the absence of comparisons and analysis of the two types of basketball surface materials, as well as the description of the different situations under which they can be applied. Thus, it is in this spirit that this report will serve as a comparison and analysis of the two materials, their preparation principles and methods, along with chemical structures. To illustrate, it will discuss the manufacturing rules of PU leather and microfiber leather, outlining the pros and cons of each preparation process.It will be utilized as a reference guide to allow the manufacturers to choose the materials and optimize the performance of basketballs.

2. Polyurethane Synthetic Leather: Overview of Preparation

The preparation of PU leather is based on the physical and chemical properties of its polyurethane polymers. Through specific processing techniques, these polymers are transformed into a porous yet durable structure. Physically, polyurethane is an exceptional elastic, flexible material with high abrasion resistance and dimensional stability, which is important to guarantee the basketballs maintain their shape and longevity as they are played with. Molecularly, it is characterized by carbamate (urethane) bondage formed by the interaction of polyols and isocyanates that give it high intermolecular forces, solubility and hardness that can be customized by molecular design[2].

2.1 Preparation principles of PU leather

The core principle of preparing PU leather for basketballs is to create a „fiber-resin" composite structure. This structure not only replicates the tactile feel, elasticity, and durability of natural leather but also ensures the material has better grip, wear resistance, and dimensional stability . Besides, PU synthetic leather usually adopts a multi-layer design, which consists of a textile or non-woven fabric base, a microporous PU foam middle layer, and a dense or textured surface layer. And it is precisely because of this special structure that PU leather has become one of the preferred materials for basketballs[4].

2.2 Methods of PU leather

There are basically two methods for preparing PU leather: The first is the wet coagulation process, and the second one is the dry process.

In the wet process, manufacturers coat a PU solution in dimethylformamide (DMF) onto a textile base and then immerse it in water. Phase separation is caused by the solvent-nonsolvent exchange, which is a microporous PU matrix. This design creates breathability and flexibility to the material[5]. The microstructural architecture is fundamental to the functional performance of polyurethane (PU) materials, as it confers a range of desirable properties. By optimizing formulation parameters—such as polyurethane concentration, solvent-to-non-solvent ratio, coagulation bath temperature, and immersion duration—we can precisely tailor pore morphology and distribution. For instance, increased polymer concentrations generally produce denser, less porous structures, while reduced concentrations yield more open pore networks, potentially affecting mechanical integrity. Additionally, regulating the coagulation bath temperature influences the diffusion kinetics of dimethylformamide (DMF), thereby impacting

pore uniformity. The dry phase process involves solvent removal via thermal treatment post-coating, resulting in a dense PU film characterized by enhanced surface homogeneity but reduced permeability. To meet the needs of basketball use, manufacturers usually apply a multi-layer design. The textile base, often polyester or nylon, gives the ball stability. A PU foam layer adds softness and cushioning. On top, a thermoplastic polyurethane (TPU) layer improves grip and resistance to wear. Recent research has believed waterborne PU, no solvents are toxic, do not require DMF and are more environmentally friendly. It also maintains the soundness and firmness of the basketball surfaces. This is a tensile strength of over 18 MPA and abrasion resistance of over 120,000 cycles passing ASTM D4157. With the right manipulation of the chemical constituents, scientists such as Mr.Wang[4].He compared the PU sample with various ratios of polyether diol/ triol found that PU-4 formulation values are 27% stronger than PU-1. So, the findings are justified to be that PU leather become harder and more resistant to wear. This indicates that design of smart materials can significantly enhance performance of basketballs[6].

3. Microfiber Leather: Perparation and Analysis

The design principle behind ultrafine fiber leather is to emulate the collagen fiber bundle structure found in natural leather. It consists of ultrafine fibers, typically polyester or polyamide, with a linear density of less than 0.5 denier, woven into a three-dimensional non-woven network and impregnated with polyurethane resin[7]. This microstructure not only replicates the hierarchical pore characteristics of natural leather but also gives ultrafine fiber leather outstanding softness, elasticity, and moisture management capabilities.

The preparation of microfiber leather involves multiple steps, starting with melt spinning and fibrillation to produce ultrafine fibers, followed by the formation of a three-dimensional non-woven network with an island-in-sea structure.Polyurethane is then impregnated to bind the fibers and introduce elasticity, and surface treatments such as embossing, retanning, or laser texturing are applied to enhance tactile qualities. Currently, the main research areas in ultra-fine fiber leather materials are the modification of materials in the form of raw materials, improvement of base materials and development and improvement of polyurethane materials[8]. Wu Qian and others summarized and discussed the primary pros and cons associated with waterborne polyurethane ultra-fine fiber leather and also, gave some insight into its further evolution. To alter the synthetic leather material[9].Ye Yan chose modified nano-titanium dioxide and waterborne polyurethane. The findings indicated that the synthetic leather had a high wear resistance and flexural strength, enhanced hydrolysis resistance and hygiene properties with increased nano-titanium dioxide content of 3%. The results indicated that, compared to untreated fabrics, the tensile strength of the ultra-fine fiber leather base fabric was significantly improved[10].Compared with PU synthetic leather, microfiber leather is more complex to produce but achieves performance metrics closer to natural leather. For instance, studies report tensile strengths above 20 MPa, tear resistance over 60 N/mm and water vapor permeability of 65–80 mg/(cm²·24h).These performance are now very similar to those of cowhide leather[11]. Nowadays, there are a lot enterprises use microfiber leather.For example, Spalding EVO series uses a PET-PA6 microfiber composite with TPU coating.

4. Comparative Analysis of PU and Microfober Leather Preparation

PU synthetic leather and microfiber leather differ most in how they copy the structure of natural leather. PU leather uses a simple fiber–PU matrix. Microfiber leather uses a finer network of ultrafine fibers combined with PU. This network is more complex and closer to real leather. PU leather is easier to produce and also very cheaper. In contrast, microfiber leather needs special spinning and fibrillation machines. That makes the process slower and more costly. The two materials also perform differently. Microfiber leather breathes better. Its water vapor permeability ranges from 65–80 mg/(cm²·24h).In comparison, polyurethane synthetic leather produced via wet processing typically exhibits water vapor permeability of only 30-40mg/(cm²·24h) [11]. PU leather can last through more than 160,000 abrasion cycles.However, microfiber leather stays flexible at –20 °C and survives over 30,000 bends without cracks . It also resists hydrolysis for a longer time. Microfiber products can last 8–10 years.But regular polyurethane synthetic leather lasts only 3–5 years [7]. Even the microfiber has these benefits, PU leather still dominates mid- to low-end basketballs. The reason is cost. PU leather is about 30% cheaper than microfiber.So this point has attracted many producers to choose it.

For the comparisons,it is also important to summarize the main advantages and disadvantages of each material. Firstly,PU leather offers lots of benefits,like low cost,easy to scalable production and good abrasion resistance,which make it suitable for training balls and recreational use. Nevertheless, it still would have certain shortcomings

ISSN 2959-6157

such as lower breathability, reduced hydrolysis resistance, and a lower quality of the feel when compared to more expensive materials. In the other one,microfiber leather offers a superior level of touch and breathability, higher durability and longer service life, which is closer to the natural leather in functionality. However, its manufacture is more complicated and expensive and is primarily restricted to professional or high-end basketballs. Thus, the PU or microfiber leather decision may be associated with the necessity to trade the performance requirements with economical arguments.

Ultimately, although polyurethane synthetic leather and microfiber leather have become indispensable materials in basketball manufacturing now, they are still continuously developing and innovating. In the future, basketball surface materials will trend toward balancing sustainability and high performance. This will involve further research into water-based polyurethane technologies and gradually reducing the cost of microfiber leather to bring it closer to the price level of PU. Let basketball production become sustainable growth.

5. Conclusion

The paper has provided a comparison between polyurethane synthetic leather and microfiber leather as the two major materials currently applied in the production of basketballs. As it has been analyzed, the PU leather is constructed within a simple fiber-PU matrix and its advantages consist of low cost, scalable processing and solid abrasion resistance. Such attributes render it powerful in mid- to low-end training products and basketballs. Nevertheless, other disadvantages of PU leather include less breathability, reduced resistance to hydrolysis and reduced service life. Microfiber leather is in contrast made to look like collagen-like bundles of fibres of natural hide by using an ultra thin network of fibres that are impregnated with PU. Consequently, it exhibits superior tactile characteristics, better breathability, higher durability and higher hydrolysis resistance, but with a more complicated method of preparation, is thus more costly. This difference is already found in applications, with PU being popular in recreational and mass-market basketballs, microfiber leather replacing leather being the choice in high-end and professional models. Finally, the two materials are necessary in the sector but they constitute a trade-off between price and performance. In the future, advancing water-based polyurethane formulations, enhancing structural engineering techniques, and implementing cost-reduction strategies for microfiber leather will be crucial. These innovations will also facilitate the development of sustainable, high-performance basketball materials that are accessible and affordable for a wide range of athletes and markets.

References

[1] GB/T 15119 1994. Leather and Fur—Physical and Mechanical Tests—Determination of Tensile Strength and Percentage Extension. Beijing: Standards Press of China, 1994.

[2] GB/T 2493 2010. Synthetic Leather—General Test Methods. Beijing: Standards Press of China, 2010.

[3] Chen Min, Zhou Dongliang, Chen Yong, et al. Analyses of Structures for a Synthetic Leather Made of Polyurethane and Microfiber. Journal of Applied Polymer Science, 2007, 103(2): 903 908.

[4] Wang Xiao. Preparation Process and Performance Advantages of Polyurethane Synthetic Leather Material for Basketball. Plastics Additives, 2025, 2: 79 82.

[5] Wu Yong, Wang Anhua, Zheng Ruirong, Tang Huiqin, Qi Xiaoyan, Ye Bo. Laser-drilled micro-hole arrays on polyurethane synthetic leather for improvement of water vapor permeability. Applied Surface Science, 2014, 305(1): 1-8.

[6] Wang Xiao. Polyurethane synthetic leather material for basketball surface. Plastics Additives, 2024, (6): 91-94.

[7] Yong Chaoduo, Yao Qian, Qian Xiaoming, et al. Micro/Nano Microfiber Synthetic Leather Base with Different Nanofiber Diameters. Journal of Industrial Textiles, 2021, 50(8): 1194 1211.

[8] Wu Qian, Liang Fugen, Li Xiang, et al. Research Progress on the Preparation of Functional Waterborne Polyurethane Microfiber Leather. China Leather, 2024, 53(3): 87 93.

[9] Ye Yan. Research on the Preparation of Synthetic Leather Materials for Sporting Goods. China Leather, 2023, 52(7): 154 158.

[10] Wu Xin. Processing Technology and Advantage Analysis of Microfiber Leather Materials for Sports Basketball. Aging and Application of Synthetic Materials, 2024, 53(5): 84 86.

[11] Yong Chaoduo, Yao Qian, Qian Xiaoming, et al. Improving Hygiene Performance of Microfiber Synthetic Leather Base by Mixing Polyhydroxybutyrate Nanofiber. Journal of Engineered Fibers and Fabrics, 2019, 14: 19.