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Fluorine-Free Water Repellent Agents in the Textile Industry
White Paper : Industry Status and Future Trends

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Abstract

《White Paper on Fluorine-Free Water Repellents in the Textile Industry 2024》
Jointly released by China Textile Information Center & Dymatic Chemicals ,Inc.
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This white paper provides an overview of the policies and regulations, market size, competitive landscape, technological advancements, and end-use applications of fluorine-free water repellents. It aims to analyze the current status of the fluorine-free water repellent industry, focusing on industry development trends and the resulting changes in the competitive landscape, upstream and downstream interactions, and cooperation models. This paper intends to serve as an information resource for industry participants, with the goal of jointly promoting the development of the fluorine-free water repellent industry and enhancing the health, safety, environmental protection, and sustainable development of the textile industry.



Introduction

Currently, diverse lifestyles have become a way for people to balance the rhythm of life and work and maintain physical and mental well-being. They also serve as a means for the younger generation to express their individuality and self-expression. Under these various emerging lifestyles, consumer spending across clothing, food, housing, and transportation is also trending towards higher quality, greater health consciousness, increased focus on sustainability, and ecological awareness.

Outdoor for all” has become a new lifestyle and social trend.

Outdoor sports are booming as a new daily activity for many people. Short trips and vacations are making camping, hiking, and climbing more popular, with regular people joining in alongside experienced enthusiasts. Camping is a global trend for escaping cities, and hiking groups are starting in urban areas, helping workers relax in nature. Outdoor sports are not just for exercise anymore; people enjoy connecting and working together, and it's a new way for young people to make friends.

Sports events help professional outdoor activities become more popular. Big events like the Winter Olympics, Asian Games, and Olympics are getting more attention, making sports like skiing, BMX riding, and rock climbing popular with the general public. The "300 million people in winter sports" movement is making winter sports widespread. Better facilities and winter tourism are bringing in more participants, helping professional outdoor sports reach a huge market.

Fast-paced living makes young people want to be "new lazy people".

Because work is more specialized and city life is faster, young people really want a good work-life balance. Gen Z especially wants better quality of life and will pay for easy and quick products or services, creating a "new lazy economy". This group wants good value, less housework, and will buy handy, hands-free products to feel less tired and save resources. Besides home, they enjoy socializing, sports, and exploring shops, so outdoor gear and casual clothes that are durable and easy to care for are popular.

“Good quality and safety" is what people mainly want to buy.

Buyers want the best quality. Buying high-quality things is important for people to show what they want in life, and product quality and how well it works are becoming more important when they decide what to buy. The idea of "spending less" actually means people want better quality. Surveys show that almost 70% of buyers agree with "buy less, buy better". When buying outdoor gear, how it works and how useful it is are important, and people want products that can do many things well.

Safety and being eco-friendly are important things that guide what people buy. Living green and healthy is becoming a new way of life. Buyers care more about product safety and if it's good for the environment. They prefer products with eco-safety labels, clear production information, and where they can track where it came from. Ideas like "0 additives" and bio-based products clearly show safety and being eco-friendly, attracting people who want to live healthily. A report in 2023 shows that about 33% of people look for clothes made from sustainable materials, and this will likely continue.

“As outdoor sports become part of everyday life, more regular people are buying things like tents, rain jackets, and ski clothes, not just serious enthusiasts. This means demand is growing fast, and there's a big market. Today's buyers want products that are easy to clean, work well, and are safe. Outdoor sports products that are high-performing and very useful will be the most popular in the future, and the market looks promising.”

Introduction and Development of Water Repellents

What are Water Repellents?

Water and oil repellents are chemicals with parts that repel water and oil, or parts that repel water and oil plus parts that can react with materials.

In the textile industry, these repellents are applied to fabrics to make them resist water and oil. They either stick to the fabric surface or change it so water and oil can't pass through. You find these fabrics in outdoor clothes, home items, and industrial textiles.

History of Water Repellents

Water repellents for fabrics have been around for a long time, and we can look at their history in four main steps, each with something new.

Stage 1: Early Days (1800s to 1950s)

- Back in the early 1800s, they had wax and aluminum soap to make fabric a bit water-resistant, but it would wash off.
- In the early 1930s, companies like ICI and DuPont in Europe and America made water repellents from fatty chemicals. These lasted longer on clothes and made them water-resistant, but they didn't stop oil.
- From the 1940s to the mid-1950s, a company in America called Dow Corning made silicone water repellents for fabrics, but they didn't become the most popular.

Stage 2: Growing Fast (1950s - Late 1900s)

- In the 1950s, American companies DuPont and 3M made new fluorinated water repellents that worked really well. They quickly became the most popular, and most companies making them were in Europe, America, and Japan. Famous brands were Teflon and Scotchgard.
- In the mid-1960s, China started researching fluorine-based treatments for fabrics. By the mid-1970s, Chinese scientists had tried making four different types of fluorine chemicals and got the water repellents they wanted. But they couldn't really use them much at that time.
- By the end of the 1900s, because customers wanted better products, water repellents got better. They could do more things like resist water, oil, and stains, handle high water pressure, stop blood and alcohol from soaking in, and prevent liquids from wicking.



Stage 3: Changing Over (2001 - 2026)

- Because people were worried about chemicals called PFOS and PFOA, Europe and America started looking for replacements for PFOA. Also, more and more people wanted to stop using PFAS altogether.
- In 2001, the company 3M said they would stop making and selling PFOS and PFOA and started making C4 water repellents.
- In 2006, the US government started a program asking companies to reduce PFOA. Eight companies, including Daikin and DuPont, promised to do this.
- In 2011, a group called ZDHC, which includes big clothing and shoe brands like Nike and Adidas, made a promise to stop using harmful chemicals, including all fluorine-based chemicals, by 2020.
- In 2016, companies outside of China started to stop making and selling a type of fluorinated water repellent called C8.
- In 2017, a Chinese company called Sichuan Xiaifluor was the first to make the basic ingredient for C6 water repellents in China, so they could compete with foreign companies.
- In 2020, C8 water repellents made in China were very popular. At the same time, many leading Chinese chemical companies like Demei Chemical and Transfar Chemical started making their own C6 and fluorine-free water repellents.
- In 2021, 3M stopped selling any water repellents that contained fluorine.

Stage 4: No Fluorine (Expected after 2026)

- It's expected that Europe will start banning C6 water repellents after 2026, leading the way back to using no fluorine at all.
- It's predicted that China will ban C8 water repellents after 2027 or 2028. They will be replaced by C6 and fluorine-free options, but getting rid of fluorine in water repellents is definitely going to happen.

How Water Repellents are Made and Applied

There are several common ways to make fabrics waterproof, like padding, dipping, spraying, and using foam.

Padding is the most common way and is used a lot for making fabric waterproof. Dipping is often used for finished clothes. Spraying is good for things like shoes. Foam coating works well for waterproofing just one side, but you need to be careful about the foam used because it can affect how waterproof it is.

Besides these, new ways are being developed with technology, like using plasma, special coatings, and gels to waterproof fabrics. But these aren't widely used in factories yet.

One of these new methods, plasma finishing, uses plasma to treat the fabric so the waterproof stuff sticks to it and makes the fabric waterproof.

Rules About Limiting and Banning Fluorine in Water Repellents

PFAS are a big group of chemicals that have very strong carbon-fluorine bonds. Some of these chemicals, like PFOS, PFOA, PFHxS, and PFHxA, can be made and used in making waterproof treatments for fabrics.

These carbon-fluorine bonds make PFAS really good at repelling water, oil, and stains on fabrics. But they also mean PFAS don't break down easily and can stay in the environment for a long time, travel far, and build up in living things.

Because environmental rules are getting stricter and people know more about how harmful PFAS can be, there's a growing global push to get rid of them. So, different countries and areas are starting to make rules to control them.

China's Rules on Limiting Fluorine in Water Repellents

- In 2014, China started following the Stockholm Convention on Persistent Organic Pollutants. This made people pay more attention to making and using chemicals like PFOS and PFOA. The government also started making rules and standards to control PFAS faster.
- In 2019, several Chinese government departments together announced a rule (Number 10) to follow the Stockholm Convention. This rule said that from March 26, 2019, it was not allowed to make, sell, use, or import PFOS, except for some special uses. Textiles were included in this ban.
- On December 29, 2022, the government released a list of important new pollutants to control (for 2023). This list included PFOS, PFOA, and PFHxS, which are all PFAS. By also controlling PFOA, China's rules became similar to international rules. However, because C8 water repellents are really good at repelling water and oil and are needed to protect workers from dangerous liquids, these special textiles were allowed to still use them. But for all other textiles, PFOS and PFOA-like chemicals were not allowed.



EU Rules on Limiting Fluorine in Water Repellents

- 2010: The EU banned PFOS under rules for persistent pollutants.
- 2013: The EU classified PFOA as harmful and added it to a list of very concerning substances. Norway also banned PFOA in consumer products (including textiles) with limits starting in 2014.
- 2017: The EU set limits for PFOA and related chemicals in products (Regulation 2017/1000), which took effect in 2020. PFHxS was also added to the EU's list of very concerning substances.
- 2020: The EU updated the rules for when PFOS could be used (Regulation 2020/1203). They also added PFOA and related chemicals to the list of persistent pollutants with strict limits that took effect in July 2020 (Regulation 2020/784).
- 2022/2023: The EU banned PFHxS and similar chemicals under the persistent pollutants rules, with limits starting in August 2023.
- 2023: Five EU countries proposed a complete ban on most PFAS (over 10,000 substances). This is still being reviewed. The EU also made the rules for PFOA even stricter (Regulation 2023/866). The EU's chemicals agency proposed new limits on PFHxA and related chemicals in textiles and leather.
- 2024/2025/2026: Denmark announced plans to ban PFAS in clothing, shoes, and water repellents starting in July 2025, with a one-year transition.

US Rules on Limiting Fluorine in Water Repellents

EPA’s Control of PFAS

On October 18, 2021, the US Environmental Protection Agency (EPA) released its plan for dealing with PFAS from 2021 to 2024. This plan has three main goals: to invest more in PFAS research, to stop PFAS chemicals from getting into the environment, and to clean up PFAS pollution faster. This plan made PFAS a big topic again.

State Control of PFAS

After the EPA released its plan, many states in the US started making or changing their own PFAS rules because there weren't many federal laws about it. The laws that have been officially introduced mainly target products for children, things that touch food (especially plant-based food packaging), and carpets. They are also paying close attention to clothing, firefighting foam, home fabrics, padded furniture, textile treatments, cleaning products, and ski wax. (Details are in Table 1).

Table 1: US State PFAS Regulations Summary

State	Date	Regulation	Applies To	Requirements
CA	Oct. 5, 2021	AB 652	Juvenile Products	Ban on intentionally added PFAS; Total Organic Fluorine (TOF) must be < 100 mg/kg. (Document dated October 5, 2021)
	Sept. 1, 2022	AB 1817	Clothing and Textiles	- Effective January 1, 2025: Ban on intentionally added PFAS; TOF < 100 mg/kg. - Effective January 1, 2027: Ban on intentionally added PFAS; TOF < 50 mg/kg. - Exception (until January 1, 2028): Outdoor apparel for severe wet conditions (e.g., offshore fishing/sailing, whitewater kayaking, mountaineering jackets) can be sold if clearly labeled "Made with PFAS chemicals".

Table 1: US State PFAS Regulations Summary

State	Date	Regulation	Applies To	Requirements
NY	Dec. 30, 2022	Bill A07063A	Clothing	Ban on intentionally added (effective Dec. 31, 2023)
	Dec. 28, 2022	Bill A09279A	Carpets	Ban on intentionally added (effective Dec. 31, 2023)
	Mar. 24, 2023	S01322	Clothing, Outdoor Apparel	Ban on intentionally added (effective Jan. 1, 2025); Outdoor apparel for severe wet conditions can be sold until Jan. 1, 2028
CO	Jun. 3, 2022	HB22-1345	Category I: Floor Mats, Fabric Treatments, Children's Products; Category II: Indoor Textile Furnishings, Indoor Upholstered Furniture; Category III: Outdoor Textile Furnishings, Outdoor Upholstered Furniture	Ban on intentionally added (Category I effective Jan. 1, 2024, Category II effective Jan. 1, 2025, Category III effective Jan. 1, 2027)
MN	May 24, 2023	HF2310	Rugs or Carpets; Fabric Treatments; Juvenile Products; Textile Furnishings; Upholstered Furniture	Ban on intentionally added, e.g., carpets, juvenile products (effective Jan. 1, 2025); Notification required for intentionally added PFAS (effective Jan. 1, 2026); Ban on intentionally added for all products (effective Jan. 1, 2032)
VT	May 18, 2021	S.20	Carpets or Aftermarket Stain-Resistant Home Carpets (excluding used goods)	Ban on intentionally added (effective Jul. 1, 2023)
ME	Jul.2 6, 2021	H.P. 1113-L.D. 1503	Carpets, Fabric Treatments, and Various Products	Ban on selling carpets or fabric treatments with intentionally added PFAS (effective Jan. 1, 2023); Ban on selling products with intentionally added PFAS (effective Jan. 1, 2030)
NH	Aug. 2, 2024	HB 1649	Carpets or Rugs; Textile Treatments; Textile Furnishings	Ban on intentionally added (effective Jan. 1, 2027)

International Environmental Regulations on Fluorinated Water Repellents

OEKO-TEX

- Since 2009, OEKO-TEX has progressively increased its restrictions on PFAS, covering a wider range of substances.
- In November 2023, OEKO-TEX released new regulations introducing a limit of 100 mg/kg for Total Fluorine (TF), replacing the previous limit for Extractable Organic Fluorine (EOF). This aims to prohibit the intentional use of PFAS and align OEKO-TEX certifications with US PFAS regulations. This standard took effect on January 1, 2024.
- Since January 1, 2024, the latest limit values for Total Fluorine have been applied to all product classes under OEKO-TEX® STANDARD 100, ECO PASSPORT, LEATHER STANDARD, and ORGANIC COTTON certifications.



Bluesign

- July 2023, Bluesign GUIDE stopped accepting new registrations for articles treated with PFAS chemicals.
- From July 2024, the Bluesign® FINDER platform achieved its PFAS FREE target, and all related chemicals were delisted.
- July 2024, Bluesign® ACADEMY updated its existing PFAS elimination guidance document. This included supplementing and clarifying the original definitions; expanding the scope of elimination to PTFE materials; and further clarifying the application of limited exceptions, such as PPE.
- From January 2025, articles or consumer products containing materials treated with PFAS chemicals will no longer be authorized to use the Bluesign APPROVED or Bluesign PRODUCT labels.



ZDHC

- In December 2015, Version 1.1 of the Manufacturing Restricted Substances List (MRSL) for the apparel and footwear industry was released, setting a limit of 2 mg/kg for PFOS and related substances, and PFOA and related substances in chemical suppliers' commercial formulations.
- In May 2020, MRSL Version 2.0 was released, setting limits for chemical suppliers' commercial formulations at 1 mg/kg for PFOS and related substances, 25 µg/kg for PFOA, and 1 mg/kg for PFOA-related substances.
- On November 1, 2022, MRSL Version 3.0 was released, adding PFAS substances and moving them from the candidate list to the main list.



American Apparel & Footwear Association (AAFA)

- Since releasing its first Restricted Substances List (RSL) in June 2007, AAFA has continuously tracked restricted chemicals in apparel and footwear products. The RSL thresholds have progressively become more stringent, including PFOS and PFOA.
- On February 7, 2023, AAFA released its latest 23rd edition of the RSL. This updated list announced a PFAS limit for Total Organic Fluorine (TOF) of less than 100 mg/kg, consistent with California regulation A.B. 1817, which took effect on January 1, 2025.
- Furthermore, from January 1, 2027, the PFAS RSL limit will be further tightened to less than 50 mg/kg, with limited exemptions for personal protective equipment (PPE), US military apparel, and other specified non-apparel items.



Global Outdoor Brand Trends Driven by Fluorine-Free Water Repellent Policies

In response to the phase-out regulations on fluorinated substances in various countries and regions, and in collaboration with Greenpeace's "Detox" campaign, global outdoor brands are actively taking measures to minimize the number of fluorinated products with water-repellent properties. They are also planning future "fluorine-free" targets, which are summarized below.

Table 2: Global Major Sports Brands’ “Fluorine-Free” Trend Summary

	ANTA	China	By 2030: Increase sustainable product share to 50%, use 50% sustainable packaging, and utilize 50% sustainable raw materials (including high-performance fluorine-free water repellents from renewable biomass).
	Lining	China	Committed to phasing out long-chain fluorocarbons in the supply chain starting January 1, 2015. Targeted 80% PFC removal from all woven products by December 31, 2015; 90% by December 31, 2016; and 95% by December 31, 2017.
	Adidas	Germany	Committed to 99% PFC-free products in the global supply chain by the end of 2017 and a complete PFC phase-out by 2020.
	Nike	United States	Began phasing out PFCs on January 1, 2015, with a commitment to zero toxic discharge by 2020.
	始祖鸟	Canada	After stopping the use of C8 long-chain fluorocarbons in 2014, continues to monitor the environmental impact of C6 water repellents and has launched its first PFC-free shell jackets.
	Patagonia	United States	Plan to fully transition all durable water repellent films and coatings to fluorine-free by 2025, emphasizing environmental responsibility.
	THE NORTH FACE	United States	Committed to sustainable environmental programs; most products already use fluorine-free durable water repellent chemicals.
	MAMMUT	Switzerland	Began adopting fluorine-free alternatives in 2016 and continuously transitioning product lines, committing to being fully fluorine-free by 2025.
	Klättermusen	Switzerland	Actively committed to environmental programs, becoming the first outdoor brand to achieve 100% PFC-free product lines in September 2017.
	Jack Wolfskin	Germany	Achieved 100% PFC-free across all product categories since Spring/Summer 2019, meeting environmental commitments ahead of schedule. Offers PFC-free filter options online, and waterproof products are labeled "100% PFCs free".

Table 2: Global Major Sports Brands’ “Fluorine-Free” Trend Summary

	Marmot	United States	Between 2019 and 2020, 53% of durable water repellent products used PFC-free solutions, phasing out PFOA; established chemical management policies for product safety and environmental protection, safeguarding supply chain personnel and the environment.
	Columbia	United States	Committed to phasing out fluorine in products, gradually eliminating PFAS, with some products already transitioned, and aiming for complete replacement of remaining PFAS-containing products by the end of 2024.
	Salomon	France	Committed that all new waterproof products will be fluorine-free by the end of 2025.
	Deuter	Germany	All product lines have been PFC-free since the Spring/Summer 2020 collection, using eco-friendly DWR treatments to ensure water and stain resistance while advancing environmental goals.
	Schöffel	Germany	Successfully developed fluorine-free products and partners with bluesign® to ensure high environmental standards. While not completely abandoning PFCs, efforts are underway to minimize their use, seeking more eco-friendly measures to reduce PFCs while maintaining product functionality.
	Salewa	Germany	Abandoned long-chain per- and polyfluoroalkyl substances since 2014; waterproof products now use short-chain fluorinated or completely fluorine-free materials. Powertex membranes have been fully PFAS-free since 2020 and are identifiable by eco-labels.
	PRANA	United States	Using PFAS-free waterproofing treatments since Spring 2022, committed to a fully PFAS-free product line by Fall 2023, strictly limiting chemical use and only employing PFAS-containing durable water repellents when necessary.
	VAUDE	Germany	Banned PFCs since 2010, first signed the Greenpeace Detox commitment in 2016, pledging to eliminate hazardous substances in the supply chain and report transparently.

Fluorine-Free Water Repellent Market Status and Forecast: China's Market Size

In recent years, driven by the growth of outdoor sports and increasing consumer emphasis on health and safety, textiles with good waterproof performance have become a consumption hotspot for clothing and outdoor sports goods. China is the world's largest textile water repellent market. Rough estimates indicate that the domestic textile water repellent market size in 2023 was between 1.6 and 2 billion RMB, of which:

C8 **USD 112M - 140M**

Water Repellents

2023 Market Size

Due to the persistence and high toxicity of PFOA and PFOS, threatening human health and the environment, foreign companies stopped producing and selling C8 water repellents in 2016. Concurrently, domestic C8 monomer and water repellent polymerization technology matured to international levels, marking a peak for domestic C8 water repellent development. Over the past three years, domestic demand for C8 water repellents has been stable at approximately 11,000 tons annually, with a market size of RMB 800 million - 1 billion (approximately USD 112 million - 140 million). Driven by both market and technology, domestic C8 water repellents have seen substantial growth, meeting market demand domestically and internationally.

C6 **\$56M - \$70M**

Water Repellents

2023 Market Size

To address safety concerns with C8 water repellents, companies developed the less hazardous C6 alternatives. In 2023, the domestic C6 water repellent market reached RMB 400-500 million (approximately USD 56 million - 70 million). However, due to the inferior technology of domestic C6 monomers and polymerization compared to foreign companies, foreign enterprises held over 90% of the market share. The development of C6 water repellents faces two main obstacles: low cost-effectiveness due to high costs influenced by iodine prices (making it the most expensive among the three types of water repellents), and the risk of PFOA residue. Furthermore, the rapid growth of fluorine-free water repellents has significantly impacted the C6 market.

Fluorine-free **\$56M - \$70M**

Water Repellents

2023 Market Size

Driven by their safety and environmental friendliness, along with policy and technological advancements, fluorine-free water repellents have experienced rapid growth, reaching a domestic market size of RMB 400-500 million (approximately USD 56 million - 70 million) in 2023. Before 2021, European, American, and Japanese companies dominated the market. However, with the improvement of domestic companies' technology, Dymatic Chemical and Transfar Chemical achieved equal market share with foreign companies by 2023, indicating a balanced competitive landscape. In the first half of 2024, DeMei Chemical, through increased R&D investment, enhanced innovation, and excellent application solution development and technical service capabilities, achieved technological leadership, driving rapid growth in its fluorine-free water repellent business and becoming a leader in the domestic fluorine-free water repellent industry.

Fluorine-Free Water Repellent Market Status and Forecast: Development Trends in Other Regions

- The main overseas markets for water repellents are Vietnam, India, Bangladesh, Pakistan, Turkey, and Mexico. These countries primarily export textiles and apparel to Europe, the US, and Japan, resulting in a more pronounced demand for fluorine-free water repellents.
- Imports of fluorine-free water repellents in these overseas countries are still dominated by foreign brands, including Zelan (Chemours), PHOBOTEX (Huntsman), Smartrepel (Archroma), UNIDYNE XF series (Daikin), Scotchgard (3M), RUCO-DRY (Rudolf), NEOSEED (Nicca), BAYGARD (Tanatex), and ECOPERL (CHT). The total export value of these fluorine-free water repellent brands has generally increased from 2019 to 2024 and is projected to reach USD 13.82 million in 2024, with a 5-year CAGR of approximately 35.3%.

- The export value of major foreign brands' C6 water repellents initially increased but then declined, projected to be USD 3.57 million in 2024. Looking at the export value of major foreign brands for both fluorine-free and C6 water repellents, fluorine-free exports surpassed C6 exports starting in 2022, with an estimated ratio of 4:1 in 2024.
- Given the limited exports of water repellents from domestic Chinese companies, we believe that the overseas sales performance of major foreign brands can, to a certain extent, represent the market development trend, indicating a faster pace of fluorine phase-out overseas compared to China.

Fig. 1: Intl. Fluorine-Free Water Repellent Exports (USD 10K) 2019-2024 (Using abbreviation for Figure and International)

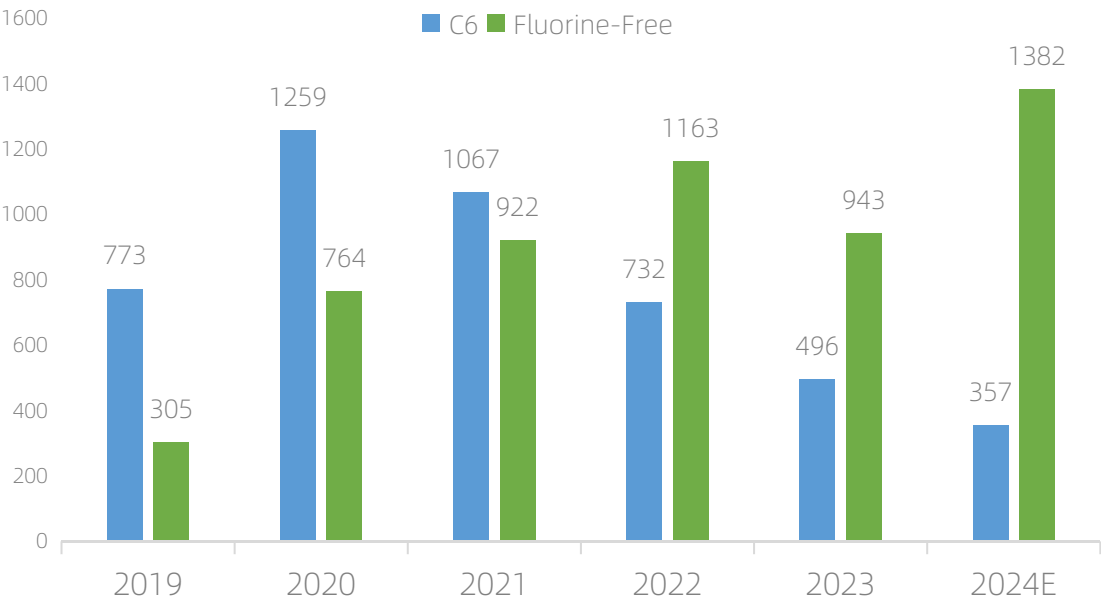


Table 3: Textile and Apparel Exports of Key Countries in the Overseas Water Repellent Market

Country	Year	T&A Export Value	% to EUR/USA/JPN
Vietnam	2022	409.4	56%
India	2022	384.4	45%
Mexico	2022	68.2	96%
Turkey	2022	316	70%
Bangladesh	2021	389.6	69%

Fluorine-Free Water Repellent Market Development Forecast

Based on current technology, fluorine-free water repellents require 2-4 times the usage of C8 water repellents for the same waterproofing performance. Although fluorine-free options are cheaper than C8, the overall cost for equivalent waterproofing is higher. Therefore, the phase-out of fluorine will drive growth in the water repellent market size. The market development of fluorine-free water repellents will mainly benefit from replacing a portion of the C8 and C6 markets, as well as overall growth in the water repellent market.



Impact of C8 Water Repellents on the Development of Fluorine-Free Alternatives

- The progress of fluorine-free water repellent substitution in China is mainly affected by the supply and price of fluorinated alkyl acrylate monomers (C8 and C6 monomers) and government regulations.
- China's annual fluorinated monomer production capacity is 6,200 tons. The textile industry's annual demand is about 1,800 tons for C8 monomers, with lower demand for C6. Key producers include Xiai Fluorine, Shang Fluorine, and Sannong. Before the Xiai Fluorine explosion in May 2024, monomer supply exceeded demand, keeping prices low and giving C8 water repellents a clear market advantage.
- The Xiai Fluorine explosion accelerated the fluorine phase-out. The resulting C8 monomer supply shortage caused prices to surge nearly 100% in the short term, leading to C8 water repellent shortages and soaring costs. To address this, some downstream customers began substituting with fluorine-free water repellents, speeding up the domestic fluorine phase-out.
- Government regulations are also driving fluorine-free water repellent development. 1 Developed regions like Europe, the US, and Japan have restricted PFOA. 2 China's Ministry of Ecology and Environment also restricted PFOA use in October 2023. While exemptions for specific areas weren't detailed, it signals an imminent national ban on PFOA, expected around 2027-2028.

Impact of C6 Water Repellents on Fluorine-Free Development

Fluorine-free water repellents have a significant cost advantage over C6 options:

- Domestic C6 monomer costs are about 1.5 times higher than C8 monomers. Even with improved conversion rates, C6 raw material costs will remain considerably higher than fluorine-free alternatives.
- Strict PFOA bans will eliminate the byproduct value of C8 generated during C6 monomer production, further increasing C6 monomer costs.

Potential EU Restrictions on PFHxA by mid-2026:

- In June 2023, the EU Commission proposed revising REACH to strictly control PFHxA substances with a 36-month transition, indicating potential strict limitations by mid-2026.
- Some European and Japanese companies plan to cease production of C6 monomers and water repellents within 1-3 years. We anticipate this will further accelerate the development of fluorine-free water repellents and intensify competition among manufacturers.

Limitations of Fluorine-Free Water Repellents:

- Despite their cost advantages, the surface tension of fluorine-free water repellents makes it challenging to achieve the same mineral oil repellency as C6 water repellents. Currently, fluorine-free options cannot completely replace all applications of fluorinated water repellents.

Future Market Trends:

- Following strict domestic restrictions on PFOA, the textile water repellent market will likely be dominated by fluorine-free options, with C6 water repellents playing a secondary role, mainly providing mineral oil repellency for specific uses like oilfield workwear.

Technical Advancements in Fluorine-Free Water Repellents

Fluorine-free water repellents have evolved significantly, with earlier types like pyridine-based, metal complex-based, and N-hydroxymethyl modified resin-based options largely phased out due to environmental/health concerns, poor performance, or storage issues. Currently, the main types on the market are paraffin-based, acrylate-based, polyurethane-based, and silicone-based, with their performance characteristics detailed in Table 4.

Despite the varying performance advantages of these types, fluorine-free water repellents generally still have limitations compared to fluorinated options in terms of waterproofness, wash durability, color change, and bonding strength. Over the past decade, the key research focus for manufacturers has been on innovating product structures and application solutions to improve waterproofness, overcome performance shortcomings, and develop unique product features.

Type	Advantages	Disadvantages
Paraffin	Low cost	Moderate waterproofing, high slip, poor wash durability
Acrylate	Lower cost, mature process, excellent initial waterproofing	Harder hand feel, significant color change, noticeable scratches
Polyurethane	Balanced performance, good waterproofing, flexibility, film formation, bonding strength	Higher cost, complex production process
Silicone	Soft hand feel, virtually no scratches, minimal color change	Moderate initial waterproofing, higher cost

Table 4: Performance Characteristics of Main Types of Fluorine-Free Water Repellents

Synthesis Technology Advancements in Fluorine-Free Water Repellents: Wax-Based and Acrylate-Based Products

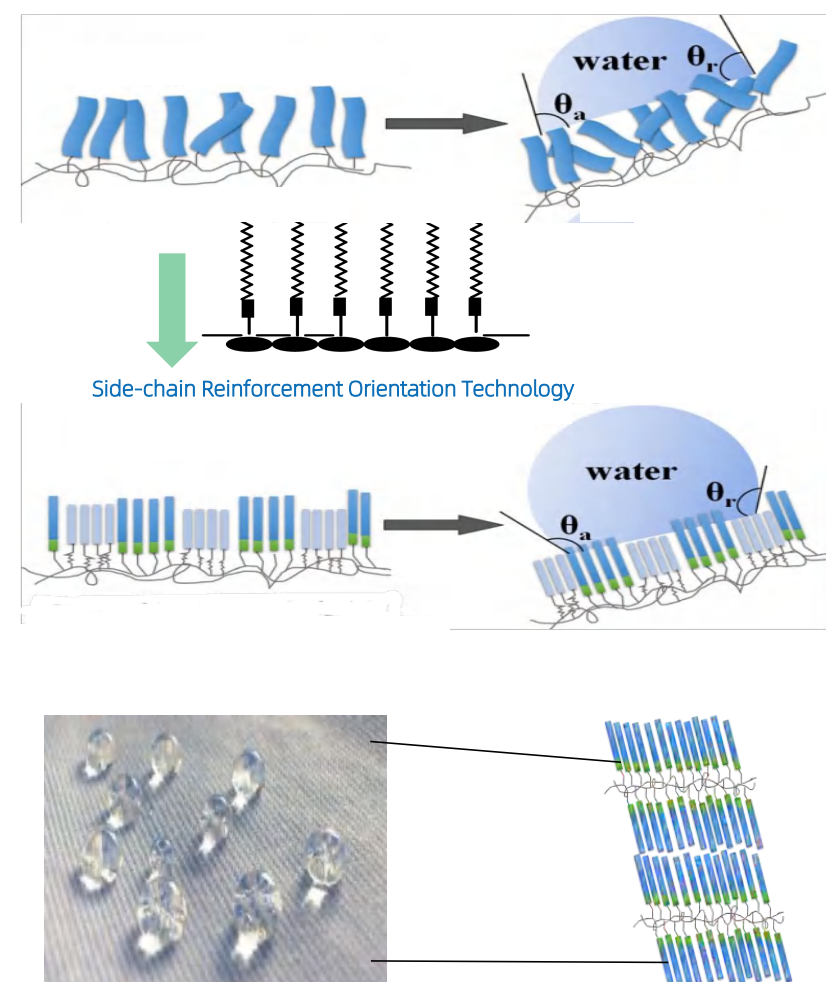
Paraffin-Based Products

- Huntsman employs a paraffin wax compound with crosslinking agents.
- Tanatex built upon this technology to develop a polyethylene wax emulsion.
- Archroma uses oxidized polyethylene wax and crosslinking agents in its formulations.
- Daikin enhances the waterproof performance of non-fluorinated acrylate water repellents by mixing in wax emulsions.
- Dymatic Chemical modifies the paraffin wax structure and then compounds it with acrylate-based fluorine-free water repellents, using chemical bonding to improve wash durability and impart a soft, smooth hand feel, addressing the fabric scratch issue.
- Current technical solutions indicate that paraffin-based products are primarily used as auxiliary components in other types of fluorine-free water repellents.

Acrylate-Based Products

- Current common technology involves using long-chain alkyl monomers, such as octadecyl acrylate and docosyl acrylate, to achieve waterproofing. Subsequently, hydrophobic monomers containing amide, urea, or urethane groups are introduced to further enhance water repellency. To improve wash durability, halogenated olefin monomers, like vinyl chloride and vinylidene chloride, are typically incorporated, utilizing chlorine ions for chemical bonding with fibers to increase the product's adhesion to the fiber.
- Building on these techniques, Fuchsin New Material utilizes biomimicry, inspired by water strider legs, to develop multi-linked polymers. Their molecular structure presents more directionally aligned side chains on the fiber surface, exhibiting excellent waterproof performance.
- Dymatic Chemical employs side-chain enhanced orientation technology to achieve directional alignment of long alkyl side chains, resulting in stronger hydrophobic properties, as shown in Figure 2.

Figure 2 Schematic diagram of Dymatic Chemical's side chain enhanced orientation technology



Synthesis Technology Advancements in Fluorine-Free Water Repellents: Polyurethane-Based and Silicone-Based Products

Polyurethane-Based Products

- Polyurethane-based fluorine-free water repellents are a significant recent research focus. Various manufacturers and academic institutions are developing diverse technical approaches through material selection, incorporating long alkyl structures, and designing polymer structures.
- Chemours and 3M produce alkyl urea urethane fluorine-free water repellents by reacting long-chain alkyl active oligomers with isocyanate-containing compounds.
- DeMei Chemical and Rudolf utilize different processing technologies to design and synthesize hyperbranched polyurethanes. Practical applications demonstrate excellent waterproofing effects. Figure 3 illustrates the hyperbranched polyurethane structure.

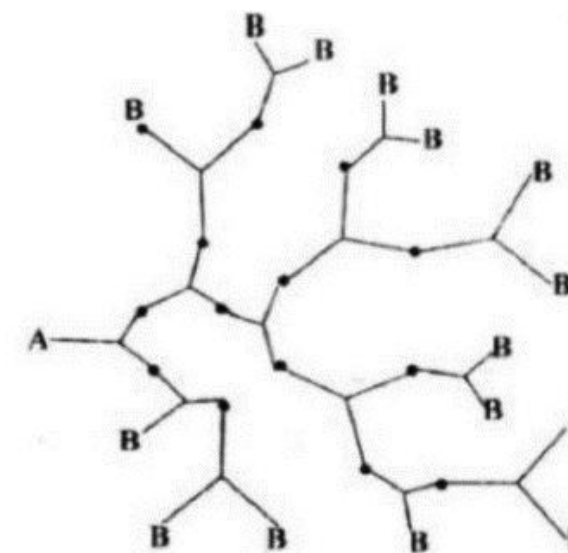


Figure 3: Schematic Diagram of Hyperbranched Polyurethane Structure

Silicone-Based Products

- Silicone offers a soft and smooth hand feel.¹ Early hydrogen-containing silicone oil provided some water repellency but was gradually replaced by better-performing fluorinated water repellents due to its instability (releasing hydrogen gas) and lack of oil repellency.
- Research into silicone-based fluorine-free water repellents has significantly increased in recent years due to the restrictions on fluorinated water repellents.
- Dow and Nicca have developed fluorine-free water repellents with excellent waterproofing and hand feel using amino-modified silicone, silicone resin, and alkyl polysiloxane. These also effectively inhibit excessive fiber elongation and stiffening, providing excellent seam slippage.
- DeMei Chemical introduces multi-functional crosslinking monomers into linear silicone. This combination forms a three-dimensional, tightly packed spherical structure on the fiber surface, resulting in stronger hydrophobicity, as shown in Figure 4.

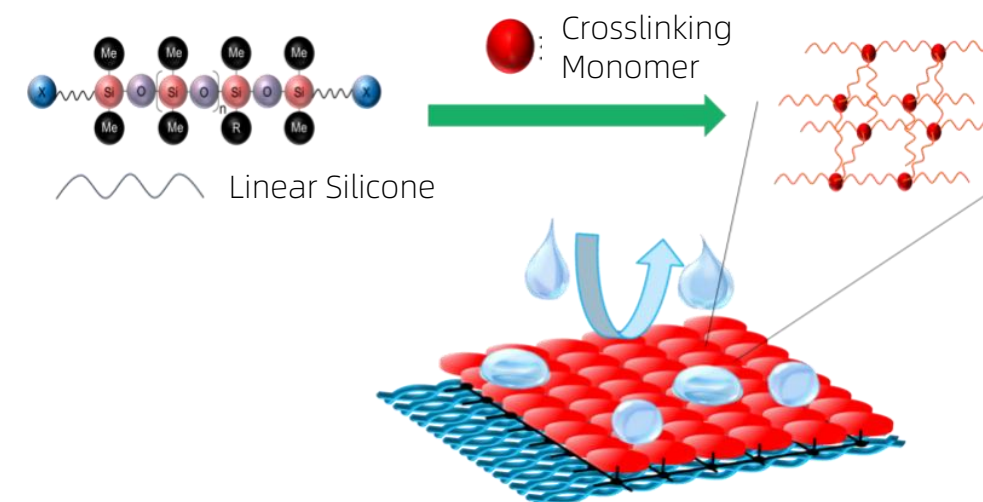


Figure 4: Schematic Diagram of Dymatic Chemical's Silicone Water Repellent Technology Principle

Synergistic Effects of Combining Different Polymer Types in Fluorine-Free Water Repellent Synthesis

Current technological advancements show that combining different types of polymers to achieve synergistic effects is an effective approach to enhance waterproof performance and overcome limitations. This is a key technical direction for manufacturers with strong R&D capabilities.

- Daikin: Uses physical mixing to combine waterproof polyurethane, acrylate, silicone polymers, and wax dispersions, creating water-repellent compositions with enhanced performance through synergistic effects. They also use an organic-inorganic approach, incorporating hydrophobically treated silica and alumina into fluorine-free waterproof polymers to effectively improve water droplet sliding and speed. Additionally, they employ chemical modification to produce stearyl group-containing polyurethane acrylate polymers.
- Nicca: Enhances the waterproofness and hand feel of fluorine-free acrylate by compounding it with organically modified silicone. Rudolf achieves good waterproof performance by combining polyurethane and silicone.
- Dymatic Chemical: Through polymer structure design, has developed polyurethane acrylate modified silicone and waterborne polyurethane with hyperbranched silicone oil side chains, resulting in excellent waterproof effects, soft hand feel, minimal scratches, and low color change. Regarding synergistic effects, DeMei Chemical utilizes the self-assembly behavior of alkyl-modified silicone and hyperbranched polyurethane to achieve an orderly arrangement of silicone structures with lower surface energy on the fiber surface, further improving the overall waterproof effect and providing excellent comprehensive performance, as illustrated in Figure 4.

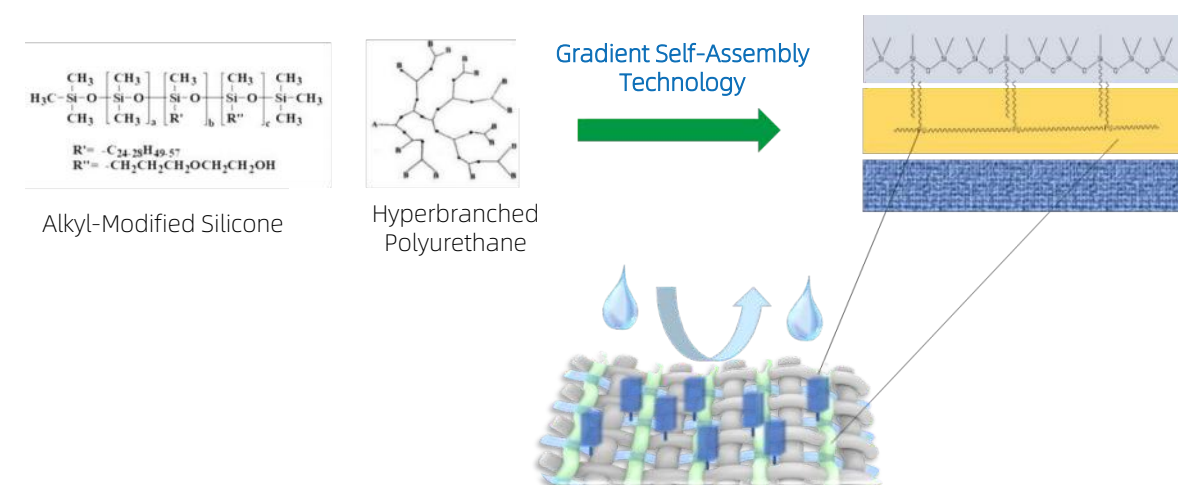


Figure 5: Technical Principle Diagram of Dymatic Chemical's Alkyl-Modified Silicone and Hyperbranched Polyurethane

Synthesis Technology Advancements in Fluorine-Free Water Repellents: Bio-Based Fluorine-Free Water Repellents

Bio-based fluorine-free water repellents are currently a significant research focus. Bio-based chemicals offer raw material sustainability and renewability, with prominent environmental benefits, aligning with increasingly stringent environmental laws and regulations and representing an important aspect of social sustainable development.

Several manufacturers have taken the lead in introducing bio-based fluorine-free water repellents to promote low-carbon development in the textile and apparel industry. Examples include Chemours' ZELAN R3, containing 63% renewable resource content, and Dymatic's bio-based brand PalmDry series, with DM-3699 achieving a bio-based content of 87%.



palmDry
Palm-derived bio-based fluorine-free
water repellent

87%

Bio-based content up to

Summary of Fluorine-Free Water Repellent Synthesis Technology Advancements

After years of technical research, the development and production technology of fluorine-free water repellents have significantly improved. Leading domestic companies, like Dymaitc Chemical, are now at the forefront in terms of innovation, application performance, and developing solutions for various end uses. Their products and solutions have reached or even surpassed fluorinated water repellents in all performance aspects except mineral oil repellency.

Currently, improving oil repellency (especially against mineral oil) and achieving easy stain release with fluorine-free water repellents are key challenges for the industry. Solving these issues will allow fluorine-free options to replace fluorinated water repellents in more applications, further promoting the environmentally friendly and safe development of the textile industry.



Application Research Progress of Fluorine-Free Water Repellents

Currently, industry companies and academic research institutions are mainly studying the application performance issues of fluorine-free water repellents from two perspectives and proposing corresponding solutions:

First, addressing common problems like hand feel and scratches by developing specific application techniques. This research is quite common, with companies such as Dymatic Chemical, Transfar Chemical, Fuchsin New Material, and Archroma launching related products and solutions.

Second, developing corresponding technical solutions for specific end-use applications. This research involves creating specific technical solutions based on the fabric and performance requirements of different applications. It also further explores "waterproof +" multi-functional composite technologies to better meet the performance needs of fabric manufacturers and brands. This trend is driving the overall transition to fluorine-free waterproofing. Currently, few companies have achieved significant research results in this area, with comprehensive textile auxiliary manufacturers like DeMei Chemical and Transfar Chemical being among the early companies to introduce technical achievements.

Terminal application scenarios with significant waterproofing needs mainly include sportswear, outdoor jackets, home textiles, shoe materials, tents, luggage, and workwear. We have summarized the application technology progress of fluorine-free water repellents in these application scenarios below.

Application Research Progress of Fluorine-Free Water Repellents: Sportswear Sector

The focus for sportswear fabrics is the comfort of wear, the functionality and protection offered in different sports environments, and the resulting comfort and safety experience. Waterproof and breathable technology is a key area of research. These fabrics are typically high-density weaves that use special structures between fine fibers or finishing processes to quickly absorb sweat and promote its evaporation and wicking, ensuring the body stays cool and not sticky during intense exercise.

Currently, a one-way moisture-wicking process is often used to improve the dryness and comfort of sportswear fabrics. This involves printing a water repellent onto the fabric. Compared to fluorinated water repellents, fluorine-free options tend to show a significant decrease in waterproof performance with this processing method. Currently, the reduction in waterproof performance of fluorine-free water repellents is generally minimized by adjusting the amount of water repellent added to the printing paste and the type of thickener used.

Beyond just waterproof and breathable properties, "waterproof +" solutions that combine water repellents with functional auxiliaries like antibacterial agents, deodorants, and UV protectants can give sportswear fabrics multiple functions, meeting the demand for high-value sportswear with antibacterial, deodorizing, and sun protection features.

water repellent
+
Antibacterial

water repellent
+
Antibacterial

water repellent
+
Anti-UV

water repellent
+
Far-Infrared

"Waterproof +" solutions require fluorine-free water repellents to have good compatibility to ensure the stability of the processing solution and the fabric's functionality. Currently, a small number of comprehensive textile auxiliary companies are beginning to launch "waterproof +" solutions for sportswear fabrics, such as Dymatic Chemical's waterproof + antibacterial, waterproof + deodorizing, and waterproof + anti-mosquito offerings.





Application Research Progress of Fluorine-Free Water Repellents: Outdoor Jacket Sector

As a piece of outdoor sports gear, outdoor jackets need to be waterproof, windproof, breathable, and abrasion-resistant to provide good protection for the wearer. Common fabrics for outdoor jackets are laminated waterproof and breathable fabrics and coated waterproof and breathable fabrics. The fabric's own properties or the use of coatings and films can provide good windproof, breathable, and abrasion-resistant performance, while waterproof performance usually requires treatment with water repellents to meet the necessary standards.

“ During the fluorine-free water repellent finishing process for outdoor jacket fabrics, common problems include scratches, low peeling strength of coatings or films, and a decrease in waterproof performance after coating. ”

- To address the issue of scratches on outdoor jacket fabrics, one approach is to add softeners to increase the fabric's softness and reduce scratches. However, this method may also lead to a decrease in the waterproof performance and peeling strength of the fluorine-free water repellent. Another approach is to choose polyurethane-based fluorine-free water repellents, which offer better elasticity and softness, reducing scratches while still providing good waterproof performance and peeling strength.
- The use of larger amounts of fluorine-free water repellents and silicone-based options can both cause a decrease in the peeling strength of outdoor jacket fabrics. To address this, polyurethane-based fluorine-free water repellents are often selected, and isocyanate crosslinking agents are added during processing to improve the fabric's peeling strength.

Currently, many outdoor jacket fabric manufacturers still use toluene-containing coating adhesives to process outdoor jacket fabrics. Compared to fluorinated water repellents, fluorine-free water repellents have a weaker resistance to toluene. Some coating adhesives can penetrate the fabric, leading to a decrease in the fabric's waterproof performance. There is currently no good solution for this problem in the industry.

Application Research Progress of Fluorine-Free Water Repellents: Curtain and Sofa Sector

Curtains and sofas are important elements of home decoration, and their fabric types are quite diverse. Curtains are mainly made of cotton, linen, chemical fibers, and their blends, while sofas primarily use cotton, linen, and flocked fabrics. The core requirements for home textiles are self-cleaning, easy care, and safety and health. Curtain and sofa fabrics need to be water and stain repellent, oil repellent, abrasion-resistant, and some also require multi-functional properties like antibacterial and flame retardancy.

Compared to curtain and sofa fabrics treated with fluorinated water repellents, those treated with fluorine-free options show significantly poorer water and stain repellency, stain resistance, and abrasion resistance. To promote the phase-out of fluorine in curtain and sofa fabrics, leading fluorine-free water repellent companies have focused their efforts in the past two years on researching technologies for fluorine-free liquid stain resistance, fluorine-free dry stain resistance, and fluorine-free easy stain removal, and they have made some progress.

- Regarding the prevention of everyday stains, Fuchsin New Material has launched a fluorine-free water repellent effective against vegetable oil.
- Dymatic Chemical has also achieved significant breakthroughs in fluorine-free water repellents that resist liquid stains like vegetable oil and dry stains like dirt and dust, with current product performance superior to competitors on the market.
- In terms of fluorine-free easy stain removal, both Dymatic Chemical and Transfar Chemical have launched fluorine-free hydrophilic easy stain removal products.
- Anti-fraying is also an important performance requirement for fluorine-free water repellent solutions for curtain and sofa fabrics. A common approach to solve this is to reduce the slipperiness of the fluorine-free water repellent.

However, for removing complex stains like oil, ink, and pen marks, there are currently no good fluorine-free technologies or products in the industry.





Application Research Progress of Fluorine-Free Water Repellents: Shoe Materials (Mesh Fabric, Synthetic Leather) Sector

With consumers increasingly demanding better product performance, waterproofing has become an essential property for shoe materials. Shoe material fabrics are diverse, including polyester mesh and microfiber leather. The core performance requirements for shoe materials are resistance to rain impact, anti-wicking, stain resistance, and weather durability.

1. How do fluorine-free water repellents enable good anti-wicking performance in shoe materials?

Selecting appropriate fluorine-free water repellents to adjust the surface energy and water contact angle of shoe material fabrics can enable good anti-wicking performance.

“ Dymatic Chemical's anti-wicking fluorine-free water repellent for leather shoe material fabrics can achieve a static anti-wicking rise of less than 10mm in 24 hours and withstand more than 20,000 dynamic anti-wicking flex cycles, meeting the performance requirements of shoe materials for various applications. ”

2. Compared to fluorinated water repellents, fluorine-free options show relatively average weather durability and resistance to rain impact on shoe material fabrics. How can this be solved?

The weather durability issue of fluorine-free water repellents can be addressed by selecting suitable raw materials and improving their adhesion to shoe material fabrics.

However, there is currently no good technical solution in the industry for **the rain impact resistance of fluorine-free water repellents** for shoe material fabrics. This requires joint efforts from fluorine-free water repellent companies and shoe material fabric manufacturers to promote the fluorine phase-out in the shoe material industry.

Application Research Progress of Fluorine-Free Water Repellents: Tents and bags

In recent years, the high popularity of outdoor activities like camping has led to rapid growth in the demand for tents and luggage. China has become the world's largest tent producer. Common tent fabrics are polyester taffeta and nylon spinning, while luggage fabrics are mostly polyester and Oxford cloth. The core performance requirements for tent and luggage fabrics are waterproofing (resistance to heavy rain), windproofness, sun resistance, and durability.

Compared to fluorinated water repellents, fluorine-free options do not perform as well in terms of waterproofing (especially against heavy rain) on tent and luggage fabrics and often show issues like scratches and fraying. Because Europe and the US have the highest camping participation rates globally and import large quantities of fluorine-free tents and luggage, the application problems of fluorine-free water repellents on these fabrics urgently need to be solved.

- To address the waterproofing performance issue, current approaches include designing fluorine-free water repellents with special structures, improving waterproof finishing processes, using multi-layer waterproof structures on the fabric, and strengthening post-treatments like heat setting of waterproof fabrics to enhance the waterproof performance of fluorine-free water repellents on tent and luggage fabrics.
- Problems like scratches and fraying can be improved by using polyurethane-based water repellents and reducing the slipperiness of fluorine-free water repellents.

Solving the performance issues of fluorine-free tent and luggage fabrics requires collaboration among tent and luggage manufacturers, fabric manufacturers, and fluorine-free water repellent companies to make improvements at each stage, thereby achieving defluorination in the tent and luggage sector faster and better.

Besides waterproofing, there is increasing demand for "waterproof +" solutions in tent and luggage fabrics, including waterproof + UV resistance, waterproof + flame retardancy, and waterproof + antibacterial properties. Similar to most other application areas, multi-functionality has become a new market trend.



Application Research Progress of Fluorine-Free Water Repellents: Workwear field

Workwear and protective clothing are mainly used in industries like firefighting, military, shipbuilding, petroleum, chemical, painting, cleaning/disinfection, and laboratories to protect workers from workplace hazards. Common fabrics include pure cotton drill, polyester drill, and polyester-cotton blended drill. These garments usually require multiple functions, such as oil resistance, water resistance, easy stain removal, wash durability, and antistatic properties.

- Due to several performance limitations of fluorine-free water repellents on workwear and protective clothing fabrics, along with high technical barriers and a slower pace of technological progress in this sector, the rate of fluorine-free substitution is relatively low.
- Fluorine-free resistance to mineral oil and solvents, as well as easy stain removal in waterproof applications, have become key technical development areas for many domestic and international textile auxiliary companies. It is hoped that significant breakthroughs can be achieved in these areas in the near future, promoting the phase-out of fluorine in the workwear and protective clothing industry.

Summary of Application Research Progress of Fluorine-Free Water Repellents

In conclusion, the application technology of fluorine-free water repellents has progressed from addressing general performance issues to targeting the specific performance needs of different end-use applications, with significant advancements made through the efforts of industry researchers. Although there are still some performance gaps compared to fluorinated water repellents in certain specialized areas, the application performance of fluorine-free options has become increasingly mature in sectors like sportswear, outdoor jackets, and shoe materials, creating conditions for defluorination. At the same time, the development of "waterproof +" solutions for fluorine-free water repellents will provide greater added value to fabrics and lead to an improved product experience for consumers.

Development Analysis of Fluorine-Free Water Repellent End-Use Application Scenarios

In recent years, the popularity of outdoor activities like camping has significantly increased, leading to rapid growth in demand for tents and luggage. China has become the world's largest tent producer. People's lifestyles and consumption habits have changed greatly since the COVID-19 pandemic, and the outdoor industry has moved from a niche market to one enjoyed by everyone. Statistics show that over 400 million people in China participate in outdoor sports, boosting the development of related industries and creating a large demand for outdoor goods in the country.

China's outdoor goods market size grew from 159.1 billion RMB in 2019 to 197.1 billion RMB in 2022 and is expected to exceed 240 billion RMB by 2025, according to the "China Outdoor Sports Industry Development Report (2022-2023)"

Outdoor goods include all kinds of clothing, footwear, equipment, and gear needed for outdoor sports. According to data released by the Outdoor Products Branch of the China Textile Commerce Association, outdoor sports goods can be divided into clothing, footwear, backpacks, equipment, accessories, and gear. The rise of outdoor sports has not only led to booming growth in the outdoor apparel and footwear markets but has also increased demand in other specific outdoor equipment markets. Looking at the market share of different outdoor product categories released by COCA, **outdoor clothing accounts for nearly half of the market at 46%, while camping equipment and outdoor footwear account for 17% and 12% respectively.** These product categories not only hold significant shares in the overall market but are also showing a continuous upward trend year by year.

Table 5: Classification and Definition of Outdoor Goods

Category	Scope of Application	Products
Clothing	Textile products specifically made for outdoor sports, worn on the body for protection and decoration	Clothes, pants, socks, etc.
Footwear	Products specifically made for outdoor sports, worn on the feet and in direct contact with the ground	Mountaineering shoes, hiking shoes, climbing shoes, alpine boots, etc.
Backpacks	Single, independent pouch-like products specifically made for outdoor sports to hold items	Mountaineering backpacks, travel backpacks, cycling backpacks, framed backpacks, etc.
Equipment	Foldable products specifically made for outdoor sports to provide protection during camping	Tents, sleeping bags, pads, awnings, furniture, etc.
Gear	Large mechanical appliances specifically made for outdoor sports	Bicycles, boats, paragliders, etc.

Outdoor conditions are unpredictable, and weather like rain and snow can greatly affect outdoor enthusiasts. Therefore, the waterproof performance of outdoor goods is crucial for ensuring the safety and comfort of users. In the textile industry, waterproofing is a key function, and existing waterproof textiles are usually made by post-processing with either fluorocarbon-based or fluorine-free water repellent finishes.



As consumers increasingly seek more specialized and technologically advanced outdoor goods, waterproof textiles have been widely adopted in outdoor products, such as various styles of sportswear, outdoor footwear, tents, luggage, equipment covers, and tablecloths. This chapter focuses on the rapidly growing segments within outdoor goods, including outdoor jackets, outdoor down jackets, hiking/trekking shoes within outdoor footwear, and tents within camping equipment. It also discusses the brands and representative products that stand out in these segments. By analyzing the market size, brands, products, and functional attributes of these specific categories, we will explore the importance of waterproof function in each segment and future development trends, hoping to provide a strong reference for the market development of fluorine-free water repellents.



Outdoor Jackets:

Market Size and Development

Outdoor jackets, as a core category of outdoor clothing, are rapidly becoming a part of people's everyday lives. They are widely used not only for outdoor sports like camping, mountaineering, and fishing but are also increasingly popular for everyday activities like city walks and commuting, becoming a new fashion staple. Trends like "mountain style" and gender-neutral outfits featuring outdoor jackets have also become popular topics on social media.

Since 2020, the market size of outdoor jackets has been continuously growing. By 2023, the sales volume of outdoor jackets reached 12.466 million units, and the sales revenue reached approximately 6.26 billion RMB. This represents explosive growth compared to 2022, with sales revenue increasing by 81% year-on-year, which is higher than the average growth rate of general sports products.

Figure 6: Sales Revenue Trend of Outdoor Jackets on Taobao and Tmall Platforms

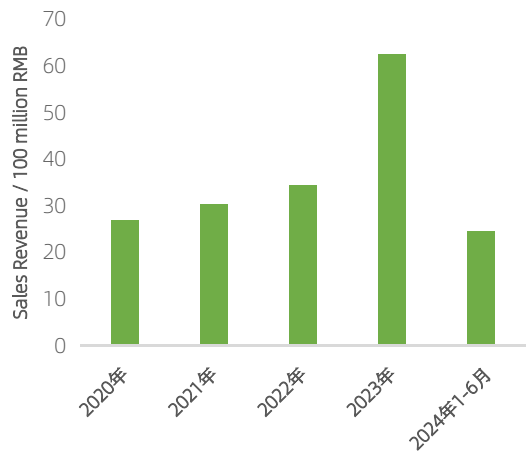
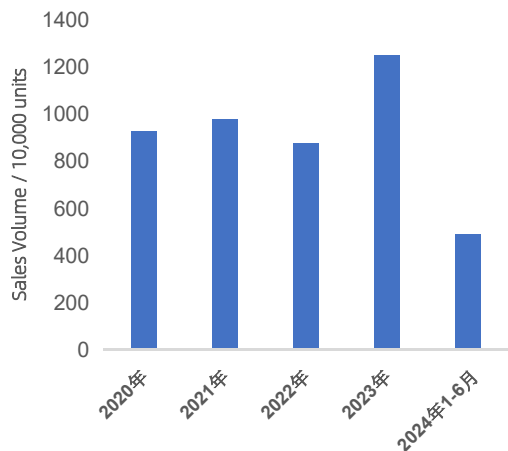


Figure 7: Sales Volume Trend of Outdoor Jackets on Taobao and Tmall Platforms

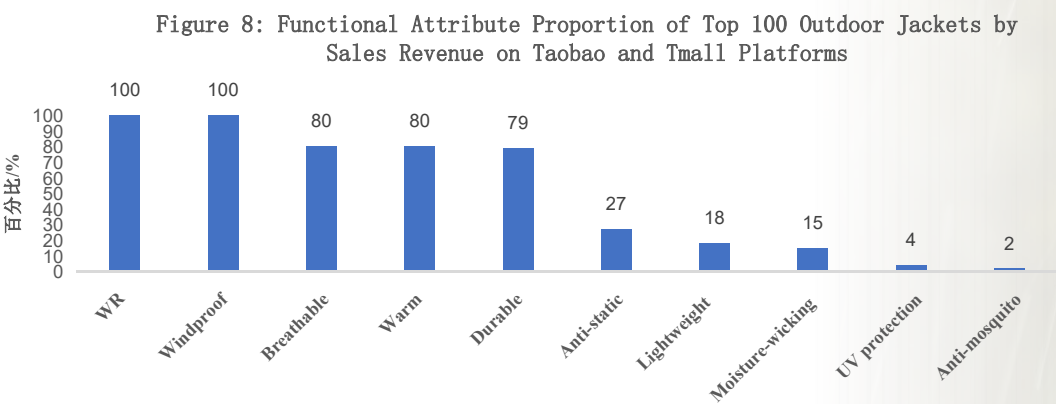


Outdoor Jackets:

Functional Attribute Analysis

As professional outdoor apparel, outdoor jackets need to have functions like waterproofing, windproofness, and breathability to handle complex outdoor environments. Therefore, functionality is the most emphasized selling point for outdoor jackets.

Analysis of the top 100 outdoor jackets by sales revenue on the Taobao and Tmall platforms shows that waterproofing and windproofness are basic and essential functions for every jacket.



Data Statistics Time: August 2023 - July 2024

In addition, consumers focus on different functions depending on the application scenario. General sports enthusiasts pay attention to the functionality of outdoor jackets while also placing more emphasis on their appearance. Professional athletes focus more on functional requirements such as being sturdy and wear-resistant, windproof and rainproof, lightweight, and breathable.

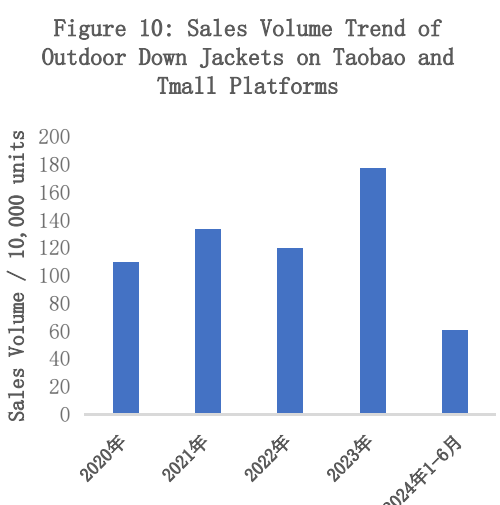
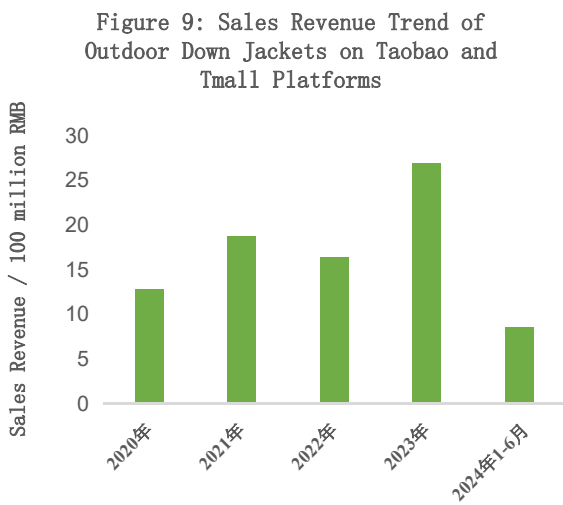
In the future, as outdoor jackets continue to develop towards mid-to-high-end products, their functional requirements will become even higher. Waterproof and breathable standards will become stricter than they are now, and the environmental friendliness of the materials used will also become increasingly important.



Outdoor Down Jackets: Market Size and Development

In autumn and winter, down jackets have become an essential item in consumers' wardrobes due to their excellent cold-weather protection. With changes in lifestyles and consumer attitudes, people's demands for down jackets are becoming more diverse. The rise of outdoor sports, the popularity of ice and snow sports after the Winter Olympics, and the tourism boom brought by places like Harbin ("尔滨") have all helped to make outdoor down jackets a new growth area in the market.

Online sales data from Taobao and Tmall show that the market size of outdoor down jackets has been on the rise since 2020. Although there was a slight decrease in 2022 due to economic slowdown and weak consumption recovery, **the outdoor down jacket market saw a significant increase in 2023. Sales volume reached 1.7745 million units, and sales revenue was about 2.686 billion RMB, a 65% increase compared to 2022. It is expected that the popularity of sports events like the 2024-2025 Harbin Winter Asian Games will likely lead to another peak in the consumption of sports and outdoor down jackets.**

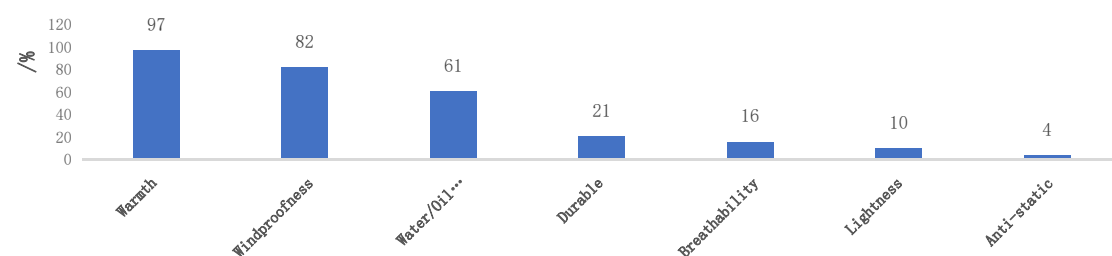


Outdoor Down Jackets: Functional Attribute Analysis

The cold wind and low temperatures of autumn and winter definitely bring significant challenges to outdoor sports enthusiasts. Outdoor down jackets, as indispensable gear, act as a bridge connecting people with nature thanks to their excellent warmth, windproofness, water-repellent, and lightweight, comfortable wearing experience. When choosing outdoor down jackets, consumers consider not only basic warmth but also how well they meet the functional and technological needs of outdoor sports activities.

Analysis of the top 100 outdoor down jackets by sales revenue on the Taobao and Tmall platforms shows that, besides the essential warmth and windproofness needed for winter, **water-repellent and oil-repellent functions have become the biggest selling points for outdoor down jackets.**

Figure 11: Functional Attribute Proportion of Top 100 Outdoor Down Jackets by Sales Revenue on Taobao and Tmall Platforms



Data Statistics Time: August 2023 – July 2024

For example, in urban outdoor settings like frisbee and travel, consumers need down jackets that are not only warm but also multifunctional, keeping them dry and breathable in bad weather. For serious professional outdoor activities like mountaineering and skiing, consumers need down jackets with high water-repellent performance to withstand harsh weather.

In the future, as mid-to-high-priced outdoor down jackets become more favored by the market, consumers will increasingly value the functional benefits of high-quality down jackets, and the demand for these features will continue to grow.

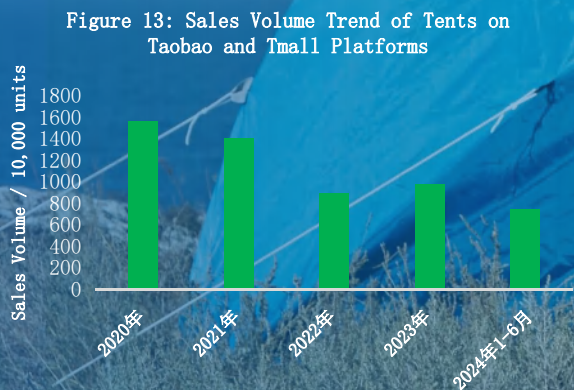
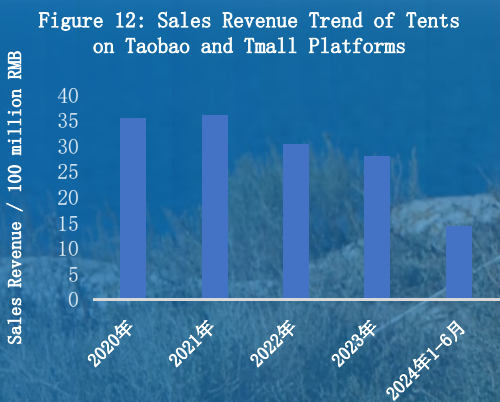


Tents:

Market Size and Development

With the growth of the parent-child market and the influencer economy, outdoor camping has become integrated into people's lives as a healthy, environmentally friendly, trendy, and high-quality lifestyle. Tents, as essential camping gear, have also entered a golden age of development along with the camping industry.

Online sales data from Taobao and Tmall show that China's tent market size exceeded 3.5 billion RMB in 2020-2021, showing a significant increase. In the past two years, with the camping craze cooling down and the impact of factors like a sluggish macro-economic environment, weakened demand for outdoor goods, and lower market confidence, the tent market size has slightly shrunk since 2022 but has remained relatively stable overall. Based on sales performance in the first half of 2024, the overall market size is expected to grow in 2024.



Research institutions predict that in the future, with the spread of information through social media, more consumers will participate in camping activities. Furthermore, as regular campers gain more experience and become more willing to independently buy and upgrade camping gear like tents, the tent market will see some recovery and growth as the overall Chinese outdoor industry shows signs of recovery.



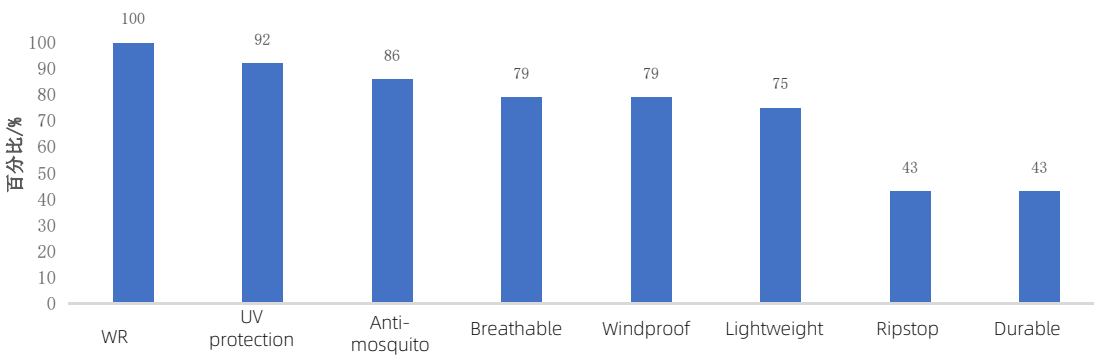
Tents:

Functional Attribute Analysis

According to surveys by Imarcgroup and iimedia, functionality is the most important factor for consumers when buying tents. However, consumer preferences for tent features vary depending on the season and campsite. For example, beach sun shelter tents with high sun protection are very popular for summer beach camping. For regular campsites in summer, lightweight, breathable, and rainproof family tents sell better. For winter camping, double-layered, windproof, and warm tents with reinforced poles are more favored by the market. Moreover, consumers from different regions and age groups have different functional needs for tents. For instance, highly functional tents are more popular with overseas consumers, while younger consumers tend to choose tents with fashionable designs and multiple functions.

Analysis of the top 100 tents by sales revenue on the Taobao and Tmall platforms shows that water repellency is an essential function for all tent products. **Tents need to have good water-repellent performance** and hydrostatic pressure resistance to cope with outdoor weather changes.

Figure 14: Functional Attribute Proportion of Top 100 Tents by Sales Revenue on Taobao and Tmall Platforms



Data Statistics Time: August 2023 – July 2024

In the future, the water repellent market will inevitably change along with the tent market size, and products with high water-repellent performance will be more favored by overseas markets and younger consumers.



Outdoor Footwear:

Market Size and Development

Outdoor footwear generally refers to all types of shoes specifically made for different kinds of outdoor sports, each with its own unique functions. On the Tmall and Taobao platforms, outdoor footwear is categorized into seven main types: hiking/trekking shoes, outdoor casual shoes, canyoning shoes, snow boots, trail running shoes, beach shoes/sandals/slippers, and other outdoor shoes. With the rise of outdoor sports, the popularity of hiking/trekking shoes has greatly increased in the past two years, attracting a large number of new customers and showing a trend of significant market growth.

According to the 2023 sales ranking of segmented outdoor apparel and footwear categories released by Magic Mirror Insight, hiking/trekking shoes hold the top position, leading the market share in outdoor footwear. Online sales data from Taobao and Tmall also indicate that from 2020 to 2023, the sales revenue of hiking/trekking shoes has shown a year-on-year growth trend. In 2023, the market size reached 1.395 billion RMB, a year-on-year increase of 67%, and it is expected to continue growing and surpass 2023 in 2024.

Figure 15: Sales Revenue Trend of Hiking/Trekking Shoes on Taobao and Tmall Platforms

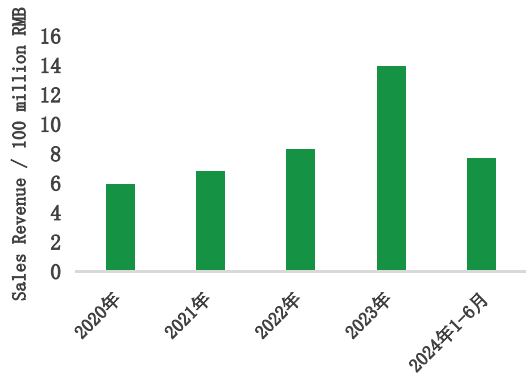
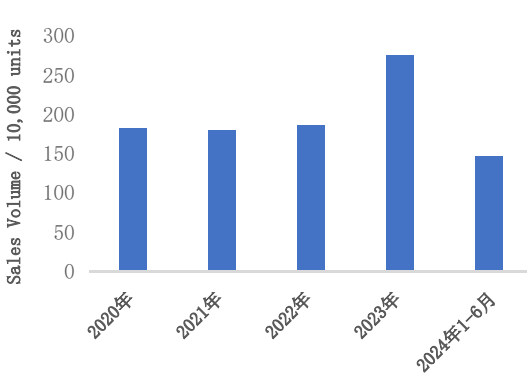


Figure 16: Sales Volume Trend of Hiking/Trekking Shoes on Taobao and Tmall Platforms



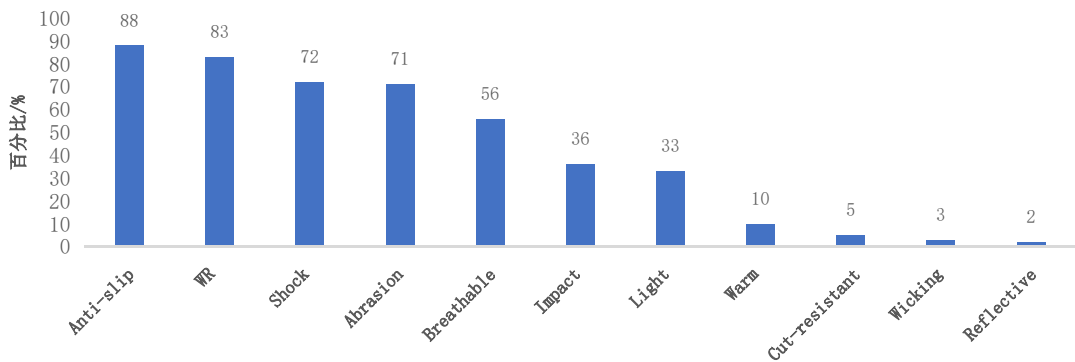
Outdoor Footwear:

Functional Attribute Analysis

Compared to other categories like trail running shoes, hiking/trekking shoes place a greater emphasis on "protection" while ensuring basic performance, and further enhance functions based on specific application scenarios.

Analysis of the top 100 hiking/trekking shoes by sales revenue on the Taobao and Tmall platforms shows that, besides the anti-slip/grip ability needed for outdoor environments like mountains,, **water repellency holds an important position in the functional attributes of hiking/trekking shoes.**

Figure 17: Functional Attribute Proportion of Top 100 Hiking Shoes by Sales Revenue on Taobao and Tmall Platforms



Data Statistics Time: August 2023 - July 2024

In changing weather conditions, hiking/trekking shoes with good water-repellent performance can protect feet from rain. Many well-known brands use water-repellent and breathable membranes to enhance the water-repellent of their products. Therefore, the water repellency and breathability of hiking/trekking shoes are unmatched by ordinary sports shoes.

In recent years, with camping, skiing, and mountaineering being core application scenarios, young people have become the main consumer group for hiking/trekking shoes, and their demand for functionality like water repellency is increasingly strong, which will further drive the development of the water repellent market.



Conclusion

With the increasing implementation of stricter defluorination policies and regulations by countries and regions worldwide, the development of synthesis and application technology for fluorine-free water repellents, and the growing emphasis on environmental awareness among end consumers, defluorination has become an inevitable trend in the textile industry and a common goal for all industry participants. To accelerate the progress of defluorination, collaboration is needed among all stakeholders in areas such as fluorine-free water repellent synthesis, application technology research, fabric processing techniques, and guiding end-consumer behavior. This collaboration should focus on technically solving challenges like oil resistance in fluorine-free water repellents and improving key performance aspects such as water repellency and heavy rain impact resistance. Furthermore, efforts should be made to guide consumers with health and environmental protection concepts, collectively promoting the textile industry's development towards a safer and more sustainable future.