



PRESCOUTER

May 2022

Alternative PFAS Chemistries

How can we reduce our dependence on forever chemicals?



Companies must be proactive and remove dangerous forever chemicals from their product life cycles to meet sustainability goals and comply with new regulations.

“Perfluoroalkyl and polyfluoroalkyl substances (PFAS)” is a broad term for manufactured chemicals that are designed to make products resistant to heat, oil, stains, grease, and water. PFAS are known to persist in the environment for a long time and are more notoriously known as “forever chemicals.” Some types of PFAS have been linked to serious health problems such as low birth weight as well as kidney and thyroid issues.

These forever chemicals are currently used in a wide variety of consumer products and industrial processes. While the FDA announced a voluntary agreement with manufacturers to phase out PFAS from food packaging, a recent report still found alarming levels of these chemicals in the food wrapping of several well-known fast-food and grocery store chains. This has been especially relevant in the past two years of the COVID-19 pandemic when the public has heavily relied on takeout and grocery deliveries.

To address these rising concerns, a Minnesota House committee considered three bills that would ban the PFAS family.

To meet their individual sustainability goals, companies need to effectively phase out PFAS and use environmentally friendly alternatives to comply with novel consumer needs and government policies.

In this Intelligence Brief, we provide an overview of recent legislation banning PFAS substances and profile three examples of alternative PFAS chemistries for essential and nonessential applications across industries.

Naming Conventions and Physical and Chemical Properties of Per- and Polyfluoroalkyl Substances (PFAS)

PFAS encompass a wide family of hundreds of substances^[1] with very different physical and chemical properties, including:

- Gases (e.g., perfluorobutane)
- Liquids (e.g., fluorotelomer alcohols)
- Surfactants (e.g., perfluorooctane sulfonate)
- Solid high-molecular-weight polymers (e.g., polytetrafluoroethylene [PTFE]).

The PFAS families can be divided into 2 primary categories: polymers and nonpolymers, as shown in Figure 1.

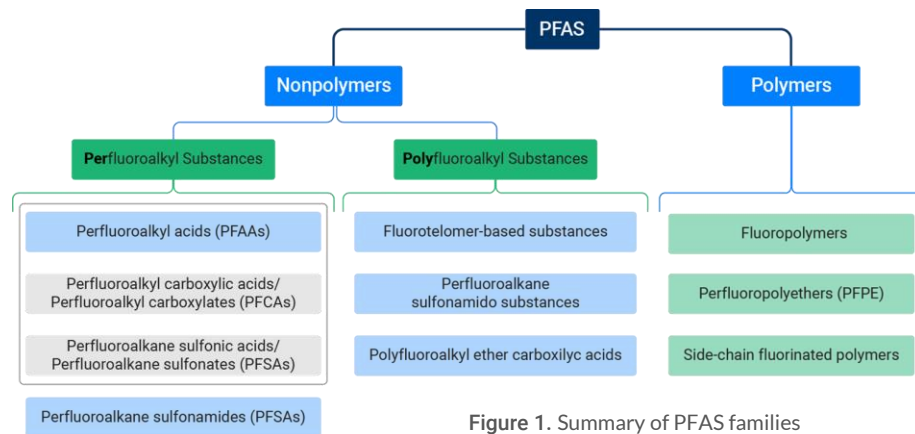


Figure 1. Summary of PFAS families

PFAS Sources



Photography



Firefighting
Foams



Stain-Resistant
Products



Fast Food
Packaging



Nonstick
Cookware



Paints



Pesticides



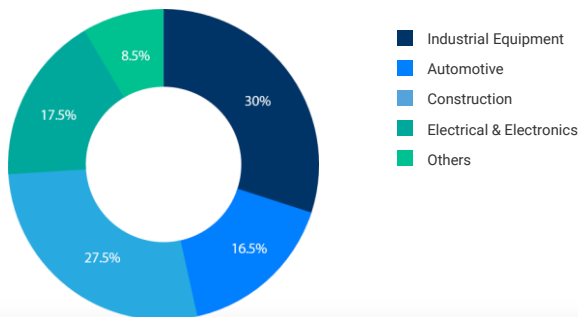
Shampoo



Potential Business Opportunities for Championing PFAS Alternatives based on Market Size

Fluoropolymers provide vital performance characteristics to products and production processes. Collectively, this creates socio-economic value far beyond the direct impact created by the industry itself. Key strategically important sectors are as follows:

Global Fluoropolymers Market Share, By End-Use, 2020



GLOBAL MARKET SIZE

The global fluoropolymers market is projected to grow from \$7.23 billion in 2021 to \$10.31 billion in 2028 at a CAGR of 5.2% in the forecast period 2021-2028



Electronics: The largest downstream sector by sales, fluoropolymers are critical to the semiconductor manufacturing process.



Transportation: Fluoropolymers are critical for the performance of key components in the automotive and aerospace industries, as they provide resistance against heat, cold, fire, smoke, humidity, and vibrations.



Medical: Fluoropolymers are used in surgically implantable medical devices, increasing the lifetime of implants and reducing the likelihood of infection and invasive surgery.



Chemical and industrial processes: Fluoropolymers enable a high level of efficiency and safety in various chemical and industrial manufacturing processes.



Consumer products: A \$1.5 billion industry, fluoropolymer-coated cookware provides easy-clean, nonstick properties, saving time, water, and energy. Products last longer and facilitate cooking with less added fat.



Building and construction: Fluoropolymers provide durable, thermally stable, easy-to-clean building materials that can reduce both building cooling costs and energy use.



Energy: Fluoropolymers have contributed to significant technical advances in solar power generation, production efficiencies in wind turbines, and the development of lithium-ion batteries.

Short-chain fluorocarbon analogs as a stopgap measure

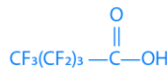
As described in the article *The Shrinking Case For Fluorochemicals*, the industry has initially shifted to short-chain fluorocarbon analogs as a potential solution to replace long-chain compounds. Short-chain fluorochemicals are still persistent in the environment; however, they are much less bioaccumulative in the human body and therefore expected to be less toxic.

Although the long-chain compounds are being banned, scientists and advocacy groups are issuing calls for the short-chain analogs to be discontinued too, as they feel the initial shift from long to short chain may not solve the problem and experts currently disagree on whether the replacement compounds are safer than their predecessors. There is a body of legislation that emerged in the last decade aimed at banning the PFAS family altogether.

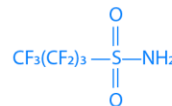


Fluorotelomer alcohol

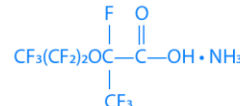
Short Chain



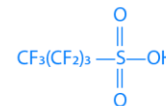
PFEBA



Perfluorobutane sulfonamide

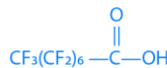


Perfluoroether-based surfactant

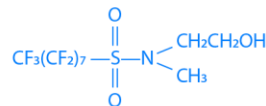


PFBS

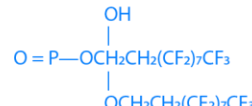
Long Chain



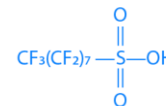
PFOA



A perfluoroalkyl sulfonamidoethanol (PFASE)



Fluorotelomer phosphae surfactant



PFOS

Overview of current PFAS legislation

Country-specific legislation on forever chemicals:

- The EU recently (Feb 23, 2022) banned PFAS in firefighting foam^[2].
- Three new bills were recently discussed in the US in 2022^[3], with states such as Washington, New York, and Maine prohibiting PFAS in packaging by December 2022^[4].
- In Canada, PFAS are already prohibited since 2022^[5].
- Belarus, Kazakhstan, Russia, and China ban a category of perfluorooctane sulfonate (PFOS) and its salts, but do not indicate future bans or restrictions on PFAS^{[6][7]}.
- India is taking the first step toward regulating PFAS^[8].
- Parts of Australia (New South Wales) recently passed a PFAS ban in fire fighting foam that came into effect on 1 April 2021^[9].
- Middle East, South Africa as well as South America have loose PFAS regulations^[10].

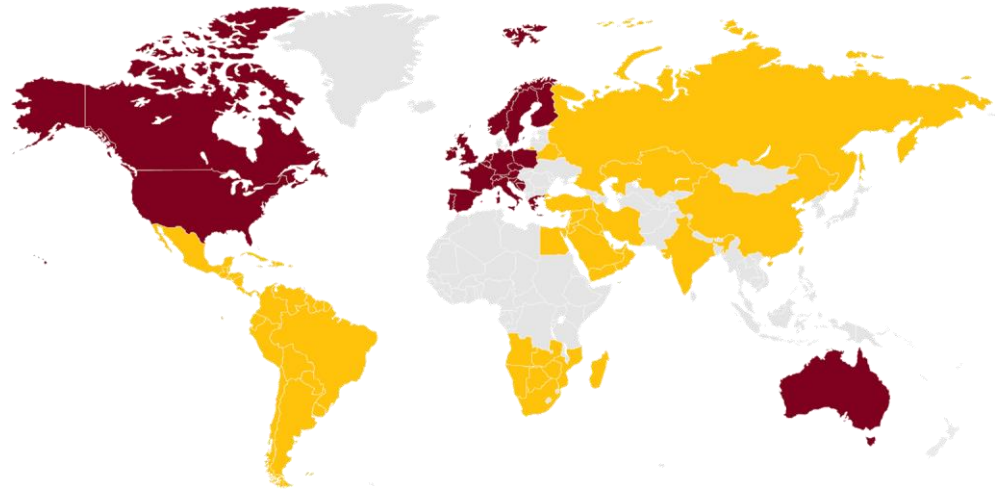


Figure. Countries highlighted in Red currently have legislation in place where PFAS are regulated or banned. Yellow indicates loose regulations.

Three categories of products in which PFAS can be phased out

Challenges persist in finding smart alternatives to this valuable class of chemicals



Nonessentials: Products that are not essential for the health and safety or the functioning of society. The use of PFAS substances is driven primarily by market opportunity and can be phased out or banned.

Example: Perfluorodecalin in makeup and lipstick.

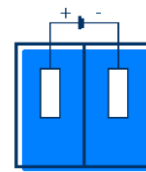
Company: **AXIOLOGY**



Substitutable: Products that are essential because they perform key functions, but for which alternatives have been developed that have similar or equivalent performance. PFAS use can be phased out or banned.

Example: Polytetrafluoroethylene (PTFE) membranes on waterproof products.

Company:  **bumbl ride**



Essential: Products that are essential because they are necessary for health and safety or other important processes and for which alternatives have not yet been developed. R&D is needed to replace toxic substances and find alternatives.

Example: Nafion membranes for water electrolysis.

Company: **KRATON**

Source: [The concept of essential use for determining when uses of PFASs can be phased out](#)

Retailer commitments

While most of the industry focus to date has been on eliminating PFAS from food packaging^[11], other industries are starting to get involved:



PFAS FREE
ECO-FRIENDLY



Lowe's will no longer sell fabric protectors with PFAS, announced in 2021 following its pledge to nix PFAS-treated indoor carpets and rugs from its inventory.



That same year Office Depot released a list of items it will restrict, including not only food ware but furniture and textiles containing PFAS.



Around the same time, VF Corporation, owners of The North Face, Vans, Timberland, and other outerwear apparel brands, announced it will phase out most PFAS from its products by 2025.



The strategies and information provided in this report are an example of the insights clients rely on PreScouter for.

PreScouter is helping companies implement more sustainable practices throughout the entire product lifecycle, while ensuring the safety of products for consumer health, through the services listed on the right.



PreScouter's Proven Track Record

500+

Clients Worldwide

5000+

Challenges Conquered

150K+

Hours of Research



"Working with PreScouter is like having a secret information drawer. When you need perspective and insight you can open the drawer and, presto, you have what you need."

Rowena Pullan, Strategic Innovation Leader, VP Wellness R&D at Pfizer

PreScouter's research consultancy has helped drive strategic planning and specific solution development decisions for some of the most sustainable and prominent companies in the world, for years.

1

Identifying novel biobased and/or natural sources with similar or better efficacy compared to currently sourced ingredients.

2

Assessing actionable technologies that enable consumers to tailor the use of active ingredients to their specific needs.

3

Reviewing and ranking competitor activity to determine areas of opportunity and differentiation.

SUMMARY OF THE COMPANIES PROFILED

	# of Employees	Country	Product Name	Composition / Source	Aims to Replace / Function	End Industry Application	PFAS Replacement
AXIOLOGY	1-10	USA	Axiology Cosmetics and Lipsticks	A mix of vegan and cruelty-free oils including avocado, castor, and grapeseed oils and natural wax	Products with the highest fluorine levels (PFAS) are the ones labeled as waterproof and long-lasting — namely foundations, lipsticks, and waterproof mascaras, as per the study.	Cosmetic products, personal care, beauty, and spa markets	PFAS in long-lasting lipsticks
	11-50	USA	Strollers and Car Seats	Bumblertime uses the Durable Water Repellent (DWR) treatment to achieve waterproofing that coats an OEKO-TEX Standard 100 material that is certified free from harmful chemicals	Durable Water Repellent (DWR) treatment that is PFAS free.	Baby care and infant industry, strollers and car seats	PFC as a waterproofing agent
KRATON	1500	USA	Nexar Polymer Membranes	NEXAR polymers are used in industrial water transport, filtration, and separation - without the use of toxic fluorinated processes	NEXAR membranes are a greener alternative to Nafion in applications such as water electrolysis and electricity generation.	Water management and filtration but also high-performance breathable fabrics	Perfluorinated sulfonic acid (PFSA)

3 NONTOXIC ALTERNATIVES to PFAS

COSMETICS WITHOUT FOREVER CHEMICALS



Derived from organic and vegan ingredients

Personal care, beauty, spa products



AXIOLOGY

STROLLERS AND CAR SEATS THAT ARE WATERPROOF WITHOUT PFAS



Made out of cork and recyclable PET

Baby care and infant products



bumbleride.

POLYMER MEMBRANES FOR INDUSTRIAL APPLICATIONS



Membranes without the use of toxic fluorinated processes

Water management and filtration, high performance breathable fabrics



KRATON



"In my review, one of the drivers to reduce PFAS in commerce is that the regulators will be investigating the known and suspected sources of manufacturing plants that use PFAS in their products and will know by their water, ground, and air emissions if they are a source to be regulated further. This should motivated these companies to be as pro-active as possible and do their own emissions sampling to determine if they are a potential environmental source."

John Baker, President, Alan Environmental

COSMETICS WITHOUT FOREVER CHEMICALS

AXIOLOGY



Derived from organic
and vegan ingredients



Personal care,
beauty, spa products

AXIOLOGY – Planet-Friendly Beauty

TECH Overview:

The personal care and cosmetics industry commonly uses PFAS to make lotions, cosmetics, and hair products more water resistant, durable, and spreadable. Axiology Beauty is a PFAS-free and vegan line of cosmetics made with 10 natural ingredients or less. Axiology uses ingredients including avocado, coconut oil, and candelilla wax that give their lipsticks, balms, and creams a soft, buttery texture.


AT A GLANCE

AXIOLOGY

 <https://axiologybeauty.com/>

 +1 (541) 480-3252

 Bend, Oregon, USA

 1-10 employees

SUMMARY



PFAS REPLACEMENT

Waterproof and long-lasting PFAS for lipsticks



APPLICATIONS

Personal care, beauty, spa markets



COMPOSITION

Plant-based oils



END PRODUCT USE

Cosmetics

AXIOLOGY – Planet-Friendly Beauty

AXIOLOGY

Technical Data:

Axiology produces lipsticks and balms in the effort to eliminate harmful chemicals in nonessential products. All their products, including lipsticks, are free of synthetic fragrances, alcohol, gluten, and animal products/derivatives.

What are the ingredients?

Organic Coconut Oil, Organic Avocado Oil, Organic Castor Oil, Soy Butter, Sunflower Seed Wax, Organic Grape Seed Oil, Vitamin E Oil, Organic Orange Oil, Elderberry Extract, Organic Neem Oil. May Contain: Mica, Titanium Dioxide, Tin Oxide, Iron Oxide Manganese Violet, Synthetic Fluorophlogopite, Silica.



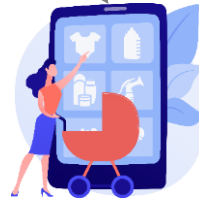
Figure. Axiology Natural Lipstick

STROLLERS AND CAR SEATS THAT ARE WATERPROOF WITHOUT PFAS

 bumbleride®



Made out of cork and
recyclable PET



Baby care and infant
products





BUMBLERIDE – Eco-Friendly Strollers

TECH Overview:

Making fabrics and padding water and dirt resistant involves the use of several chemical processes, some of which can be harmful for babies. With their line of strollers, car seats, and accessories, Bumbleride targets eco-conscious parents, as these products have traditionally been made using long-chain fluorocarbons. Bumbleride uses the Durable Water Repellent (DWR) treatment that coats an OEKO-TEX Standard 100 material^[12] that is certified free from harmful chemicals including fire retardants, lead, phthalates, PVC, BPA, polyurethane, formaldehyde, chlorine, and PFAS.

AT A GLANCE



 <https://bumbleride.com/>
 +1 (619) 615-0475
 San Diego, California, USA
 11-50 employees

SUMMARY



PFAS REPLACEMENT

PFC as a waterproofing agent



APPLICATIONS

Baby care accessories, strollers,
and car seats



COMPOSITION

Plant-based oils



END PRODUCT USE

Baby care and infant industry

BUMBLERIDE – Eco-Friendly Strollers



Technical Data:

Durable Water Repellent (DWR) treatment is defined as a liquid chemical treatment for fabrics that creates a microscopic barrier to water. This is often found in high-performance sporting apparel as well as in baby fabrics to protect against spills and dirt. However, most common DWR treatments contain PFAS-related chemicals that are harmful to babies and adults. These chemicals are often referenced with acronyms such as C-8 or C-6. Bumbleride's innovative approach lies in a novel DWR treatment that is PFAS free. This process is achieved by the replacement of these chemicals with plant-based oils to provide waterproofing performance that lasts through machine washes as well as being safe for babies.



Figure. Water repellent stroller using the new DWR technology

BUMBLERIDE – Eco-Friendly Strollers

(Cont'd):



Technical Data:

- STANDARD 100 by OEKO-TEX®^[12] is a well known label for textiles tested for harmful substances.
- When a textile article carries the STANDARD 100 label, it means that every component of that very article has been tested for harmful substances and is certified to be harmless for human health. The test includes details such as every thread, button and other accessories that are part of the garment tested. The test is conducted by independent partner institutes on the basis of a specific OEKO-TEX criteria catalog and protocols. In the test, many regulated and nonregulated substances that may be harmful to human health are taken into account.
- The criteria catalog and protocols are updated at least once a year and expanded with new scientific knowledge or regulatory requirements.



OEKO-TEX®
INSPIRING CONFIDENCE

POLYMER MEMBRANES FOR INDUSTRIAL APPLICATIONS

KRATON



Membranes without the use
of toxic fluorinated processes



Water management and filtration, high
performance breathable fabrics

KRATON CORP – Water Management

TECH Overview:

Industrial water management, electrolysis, and electricity generation are essential areas of renewable energies that require the use of membranes that are often produced with toxic fluorinated processes. Electrolysis converts electrical energy into chemical energy by the process of storing electrons in the form of stable chemical bonds. Since these products remain essential for industrial applications, with no greener alternatives available yet, Kraton addressed these needs with a new nontoxic sulfonated polymer membrane technology called NEXAR^[13] that can be used in applications such as water transport, filtration, and separation.

AT A GLANCE

KRATON

 <http://www.kraton.com>
 +1-281-504-4700
 Houston, Texas, USA
 1001-5000 employees

SUMMARY



PFAS REPLACEMENT

Sulfonated polymer membrane technology



APPLICATIONS

Water management and electricity



COMPOSITION

Nontoxic sulfonated polymer membrane



END PRODUCT USE

Their technology is applicable in water filtration as well as high-performance breathable fabrics industries

KRATON CORP – Water Management



Technical Data:

Current membrane solutions require multi-stage equipment pretreatment to reach chlorine resistance and high flux rates to process water.

Kraton produces the NEXAR family for water transport, filtration, and separation applications that increase throughput/efficiency at a lower energy cost. This novel polymer architecture technology demonstrates strong specs such a high ion exchange capacity of 1.5-2.0 meg/g.

NEXAR polymer membranes feature:

- Ion selectivity
- Low electrical resistance
- Chemical resistance to chlorine
- High water flux & transport rates
- Mechanical strength and stability



Figure. Representative image of NEXAR membranes.

References

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13. https://kraton.com/products/pdf/NEXAR_brochure.pdf

Potential Next Steps

- ✓ PreScouter can look for more companies developing technological solutions for phasing out forever chemicals
- ✓ PreScouter can conduct anonymous interviews with vendors, experts and research groups
- ✓ PreScouter can organize direct consultations between you and Subject Matter Experts (SMEs) in the space



TECHNOLOGY
LANDSCAPING



TRENDS
MAPPING



TECHNOLOGY
ROADMAPPING



INTERVIEWING
STARTUPS



IP
LANDSCAPING



SUPPLIER
OVERVIEWS



COMPETITIVE
INTELLIGENCE



MARKET
ANALYSIS



PARTNER
OVERVIEWS



TECHNO-ECONOMIC
ANALYSIS

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Daniel is an alumnus of PreScouter's Advanced Degree Researchers Network and has worked with PreScouter for more than three years and on over 70 projects, spanning across areas such as innovation strategy and roadmapping, product and process improvement and development, sustainability, and technology trends throughout the CPG industry. Daniel earned his PhD in Chemical Engineering from North Carolina State University, where his research focused on developing stimuli-responsive polymer networks for microrobotics applications. After his graduate studies, he completed postdoctoral work at INSA Toulouse, France, where his work focused on the intersection of nanoparticle assembly, nanofabrication, and microfluidics to develop novel sensors. Before joining PreScouter, Daniel gained industrial experience in pharma manufacturing, polymer processing, and science manuscript editing. He is based in Raleigh, North Carolina.



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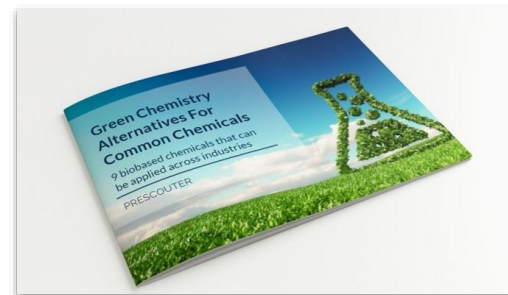
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