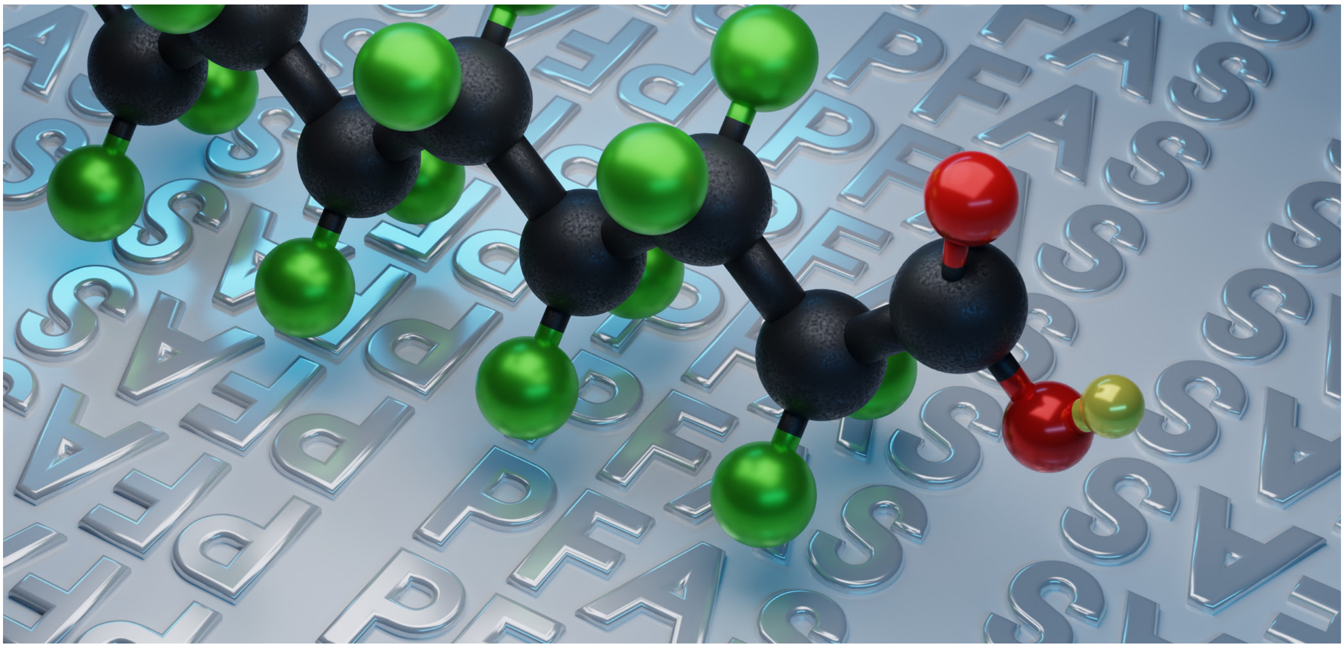



# PFAS – Never-ending story of the „Forever Chemicals“?

**What do frying pans, outdoor gear, stadium roofs, aircraft, pacemakers and heating pumps have in common? They are likely to contain per- or polyfluoroalkyl substances, commonly referred to as PFAS. Despite the wide variety of uses from household appliances to high-tech industry, until recently only a small and specialized community was familiar with this class of chemicals. This is now changing fundamentally.**

PFAS-based materials have unique properties that make them essential for modern societies and economies. However, some PFAS compounds have been associated with harmful health effects. In light of this, the European Union is now contemplating a blanket ban for almost the entire substance class. At the same time, PFAS already present in the environment are seen increasingly critical and claims for compensation and remedial actions are being raised.

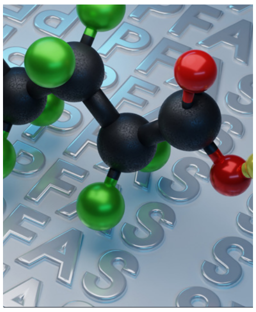
**Three numbers may illustrate the magnitude of the issue:**

— 100 % of participants in recent biomonitoring surveys had PFAS in their bloodstream.

— > 100,000,000,000 USD are expected in PFAS-related claims against insurers, according to a 2024 economic study by a German bank.

— 0.0000000044 grams per liter is the proposed limit value for certain PFAS in surface and groundwater proposed under draft EU legislation.

This poses major challenges for companies, entire industry sectors and not least regulators and environmental authorities. First, they need to deal with PFAS in the environment due to past emissions and uses which is now considered pollution and, second, they must adapt quickly to current and upcoming regulation.



**Here‘s what you should know.**

## First a bit of chemistry…

PFAS are a large and heterogeneous group of man-made chemicals. According to estimates by the U.S. Environmental Protection Agency, there are nearly 15,000 known PFAS compounds with very different properties. Some of the more commonly known compounds are perfluorooctanoic acid (PFOA), perfluorooctanesulfonic acid (PFOS), and polytetrafluoroethylene (PTFE).

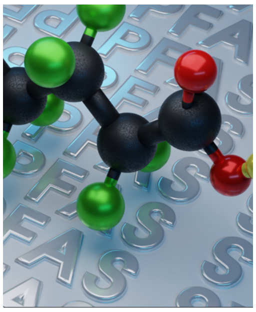
All PFAS have the common structure of carbon atom chains of varying lengths with fluorine attached to some or all carbon atoms. The characteristic carbon-fluorine bond is one of the strongest links known to chemistry. It is so stable that it is almost fully persistent in nature. The chemical bond is only destroyed at extreme temperatures of > 400 °C and/or or under enormous pressure, hence the widespread moniker „forever chemicals“. Naturally, this extreme stability is also what makes PFAS products durable, water-resistant, and non-corrosive.

First discovered by a DuPont chemist in 1938, PTFE was used in the Manhattan Project in the Second World War, one of the first practical applications of PFAS. The nuclear scientists used PTFE to contain toxic uranium hexafluoride, a by-product of uranium enrichment. UF6 is highly corrosive and would quickly destroy conventional pipes, seals and valves – but not PTFE-coated equipment. Not long after, DuPont commercialized PTFE under the well-known trademark name Teflon for non-stick coatings for cookware. Since then, countless PFAS variants have been developed and industrialized to mass production with use-cases ranging from fast-food wrapping paper to high-end semiconductors.

## …and epidemiology

However, early lab experiments have shown that high dosages of certain PFAS compounds have an adverse effect on the liver of rodents. Later epidemiological studies linked certain PFAS to birth defects, reduced responsiveness to vaccines and tumor diseases. In December 2023, the International Agency for Research on Cancer of the World Health Organization evaluated one of the most ubiquitous PFAS compounds, PFOA, to be (proven) carcinogenic to humans.

Some PFAS bioaccumulate. When ingested, e.g., via food or drinking water, they build up in human blood and organs. Also, due to their characteristic stability, the human body is unable to break up PFAS compounds. For PFOA, the half-life in humans is approx. 2.5 years. I.e., without any additional ingestion the PFOA, concentrations in blood and organs drop by 50 per cent only every 30 months. This means that even very low intake of PFAS can over time result in concerning concentrations.



Therefore, the European Food Safety Agency released an opinion in 2020 proposing for four PFAS compounds, including PFOA and PFOS, a tolerably weekly intake of as little as 4 ng per kilogram of body weight.

In contrast, larger molecules compiled of small PFAS compounds (e.g., fluoropolymers) do not have the same properties. Specifically, several studies have shown that fluoropolymers are nonbioaccumulative and nontoxic.

Despite substantial and increasing scientific efforts, much remains unknown. Most studies come from the field of epidemiology, i.e., their conclusions are based on statistical correlations rather than on specific medical/physiological proof of causation. E.g., the EFSA study has been criticized for its methodology. Nonetheless, there is widespread concern over the presence of PFAS in humans.

## Forever – and everywhere?

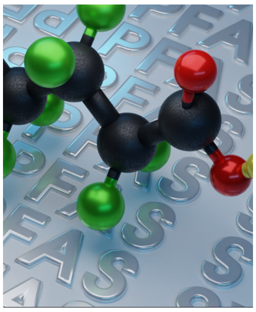
**The downside of chemical stability is persistence in the environment.**

Traces of PFAS are now found nearly everywhere in the environment – even in remote corners of Antarctica. One of the most common sources of PFAS in the environment is aqueous filmforming fire-fighting foam (AFFF) which contains highly effective fire-extinguishing PFAS compounds like PFOS. Typical PFAS hot spots are therefore found in the vicinity of military and civil airports as well as at industrial sites with high-powered sprinkler systems. By leaching through soil and into the groundwater, animals and humans can be exposed when affected groundwater reservoirs are used as a drinking water source. Air emissions are less common, but at few production sites, PFAS were also released via the air in significant quantities.

The example of PFOA-containing AFFF embodies the dilemma of PFAS: Life-saving and state of the art technology until only a few years ago; now considered a major source of environmental contamination.

The widespread presence of PFAS in the environment also makes remediation a challenging task. Depending on the length of their carbon atom chain, PFAS molecules are well adsorbed by activated carbon, an established and proven filtration method. The technology therefore allows for local PFAS plumes in groundwater to be cut off by a pump-and-treat hydraulic barrier. Also, abstracted groundwater can be purified before it is introduced into the public drinking water supply grid.

In contrast, extracting PFAS from soil is often less effective. Measures to wash soil are only available for certain soil qualities. Incineration destroys not only the PFAS compounds but also all organic content of ecologically valuable soil, apart from enormous energy consumption and greenhouse gas emissions. Therefore, the only ecologically and economically sustainable option is often to leave PFAS in soil untouched and to develop smart concepts to deal with soil that is excavated for construction projects.




## Litigation and Legislation

### Settlements in the U.S.

The enormous impact of PFAS in the environment leads to the question of responsibility and regulation.

In the United States, leading PFAS producers 3M, DuPont and its spin-offs Chemours and Corteva have in the recent past settled classaction lawsuits from affected individuals and public water suppliers for billions of dollars. In May 2024, German chemicals company BASF has agreed to pay over USD 315 million to settle a multi-district U.S. class action on alleged drinking water contamination. While the amounts may be driven by the particularities of the U.S. legal system, the tide of litigation seems to be coming in across the Atlantic. Just in April 2024, eleven environmental NGOs jointly announced to sue the Dutch government alleging that it failed to take appropriate measures to protect the people and the environment against harmful effects of PFAS.

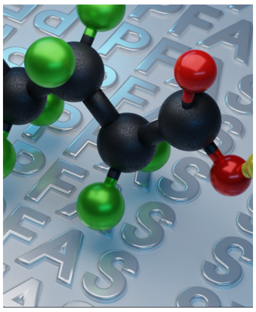
The stakes are high: Decades of water purification and disposal of contaminated soil come at enormous costs, let alone personal injury claims that might come up as well. And the question of legal and moral responsibility is often tricky, particularly since PFAS may have been used legally and for the most valuable purposes.

The debate is fueled further by a dynamic development in environmental legislation. Just in the last two years, EU and German regulators have adopted and/or proposed much stricter standards for PFAS in soil, drinking water, groundwater, animal-derived food, and waste. The new levels are typically orders of magnitude lower than before. This progressive tightening of the regulatory framework has material economic repercussions: Construction projects are put on hold because the excavated soil needs to be incinerated or disposed of in designated landfills. Municipal water suppliers have to install activated carbon filters to purify drinking water. Food producers cannot place their products on the market.

### ESG obligations and proposed PFAS ban

PFAS are also on the radar of German and EU ESG efforts. Both the German Supply Chain Diligence Act (Lieferkettensorgfaltspflichtengesetz) and the recently adopted EU Corporate Sustainability Due Diligence Directive (CSDDD) identify non-compliance with the Stockholm Convention on persistent organic pollutants as a risk to be assessed and mitigated by larger companies. The Stockholm Convention, implemented in the EU by the socalled POPs Regulation (Regulation (EU) No 2019/1021 concerning Persistent Organic Pollutants), prohibits manufacture, use and placing on the market of certain PFAS. I.e., every company in scope of the supply chain diligence legislation must already consider PFAS-related risks.

The seismic shift, however, still lies ahead. So far, only the three relatively well researched PFOA, PFOS and PFHxS are almost completely banned under the POPs Regulation. Initiated by the governments of Denmark, Norway, Sweden, the Netherlands and Germany, the European Chemicals Agency has recently proposed a blanket ban on nearly the entire sub-



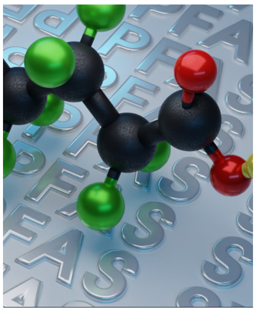
stance class of PFAS comprising almost 15,000 different compounds. While the proposal provides for certain longterm exemptions and derogations for so-called essential uses, e.g., in implantable medical devices, this catch-all approach breaks with established principles of EU chemicals law. Specifically, the restrictions would not be based on a substance-specific scientific risk assessment but on the categorization as PFAS – although not nearly all PFAS are suspected of having harmful health effects.

The proposal has sparked hot debate. ECHA has received more than 5,600 comments during the public consultation phase for its initial proposal. Representatives of numerous industrial branches are raising grave concerns. For many PFAS applications there are currently no viable alternatives available. This holds true for the high-tech sector (e.g., semiconductors), medical devices and key technologies for the transformation towards a carbon-neutral economy (e.g., solar panels, fuel cells, electromobility, electrolyzers), as was emphasized by the three major German industry associations VDA, VDMA and ZVEI.

PFAS are therefore (still) indispensable. A blanket ban on PFAS could weaken the already troubled EU chemicals industry further and increase Europe's dependence on suppliers from Asia – in stark contrast to geopolitical ambitions of derisking in key sectors such as semiconductors and (green) energy. A rift even appears to run through the German federal government. While the Minister for Environment and Consumer Protection has been among the most ardent supporters of a strict PFAS ban, the Federal Ministry of Economics and Climate Protection cautioned against paralyzing restrictions on essential chemical substances. In a joint forum with representatives of the chemicals industry, the federal government advocated for risk-based and targeted restrictions on PFAS.

Momentum appears to be shifting: In April 2024, the conservative opposition held an expert hearing in the Bundestag, calling for a balanced triad in PFAS regulation: „Continue utilizing the advantages of PFAS – Preserve creation of added value – Protect health and environment". This was echoed by Commission President Ms von der Leyen who in May 2024 indicated that there should be permanent exemptions for certain essential uses, including medical devices and energy transformation.

From blanket to net? The outcome of the legislative process at EU level remains to be seen. ECHA plans to evaluate comments and to finalize its proposal throughout the year 2024. The European Commission will then consider ECHA's opinion and likely present to the Council and the European Parliament a proposal for additional PFAS restrictions.



## Outlook

While the EU and Member States are debating the right approach to regulating PFAS, some major manufacturers of high-performance materials have already drawn their own conclusions. The fluoropolymer pioneer 3M has in December 2022 announced to phase out all PFAS products globally by the end of 2025, citing, among other reasons, „accelerating regulatory trends“ around PFAS. According to media reports, German chemicals heavyweight Lanxess has already stopped production of PFAS-based flame retardants in light of stifling regulatory requirements.

There can be no doubt about it: PFAS will continue to concern both businesses and regulators – be it the burdens of the past or the adaptation to ever-tightening regulatory requirements in the future. One way or another, the „forever chemicals“ are here to stay and their scientific, socioeconomic and – not least – legal challenges will remain for decades to come.

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