# Supporting European Sustainability and Competitiveness: An Alternative Approach to the Proposed Universal PFAS Restriction

*September 2023*

## PROPOSING AN ALTERNATIVE APPROACH TO REGULATION

In February 2023, authorities in Denmark, Germany, the Netherlands, Norway, and Sweden submitted a proposal to the European Chemicals Agency (ECHA) that calls for a complete phase-out of the manufacture, import, sale, and use of per- and polyfluorinated substances (commonly known as PFAS). PFAS are a class of thousands of chemicals, each with different safety profiles and uses.

Unfortunately, the proposal of the five member states of the European Economic Area (EEA) is flawed. It uses a grouping approach based on chemical structure that also includes fluoropolymers, and in doing so, makes assumptions and false equivalencies about hazards and risks. In fact, the proposal aims to ban fluoropolymers, a subgroup of PFAS, even though they provide significant socio-economic benefits to European society while meeting the OECD criteria for "polymers of low concern". In other words, fluoropolymers enable technology and innovation in almost all major European industries, from clean energy to semiconductors and batteries to transport and healthcare, and they have been demonstrated to not pose a risk to human life or the environment.

Hence, in its current form, the restriction proposal threatens to jeopardize a range of critical technologies and industries crucial for the EU Green Deal and other ambitious policy programs promoting the sustainable transformation of the European economy. It would slow down innovation, increase Europe's geo-political dependencies, and have devastating consequences for European companies and business.

There is a better way: A more targeted approach to regulation could ensure the safe manufacturing and use of fluoropolymers while harnessing their socio-economic benefit.

- First, given their significant socio-economic value and provenly positive safety profile, the European Chemicals Agency (ECHA) should provide a time-unlimited derogation for, or exempt, fluoropolymers from a potential PFAS restriction.

- Second, the EU can use this opportunity to create a benchmark for global chemical regulation by setting science-based and most robust and rigorous standards for chemical manufacturing.

This would lead to a future where the use of safer, better-performing chemicals will fortify the European economy, safeguard important policy priorities, and ensure global competitiveness.

## TIME-UNLIMITED DEROGATION FOR FLUOROPOLYMERS

A time-unlimited derogation, or exemption, from the proposed regulation is necessary when it comes to fluoropolymers, given their socio-economic benefits, distinct health and safety profiles, and, as we will demonstrate below, safe use and responsible manufacturing.

Fluoropolymers are high-performance materials with a unique combination of properties that make them the building blocks for an extraordinary range of product and industry applications. They are durable, have a high mechanical strength, inertness, and thermal stability, and they are resistant to chemical, biological, and physical degradation. This makes them indispensable across many sectors where applications must withstand the most challenging and high-stress conditions, and where failure is not an option.[1] **In fact, fluoropolymers are used in components that touch 50% of the EU's $16 trillion economy.**[2]

If fluoropolymers were eliminated through regulation, the EU would face exponentially reduced chances of meeting its ambitious policy goals within their intended timeframe — including goals of the EU Green Deal, the EU Chips Act, and its strategic autonomy. In addition, a phase-out of fluoropolymers would cause economic instability, likely job loss, and increased uncertainty around manufacturing safety and environmental impact of unproven substitutes.

### *Enabling the Clean Energy Transition*

As just one example of fluoropolymers' criticality to countless product applications is their use in the production of green hydrogen. One way to produce renewable hydrogen is through the electrolysis of water, powered by renewable energy sources. In this context, fluoropolymer-based ion membranes (widely known through the leading brand name Nafion™) are key. Used in so called polymer electrolyte membrane water electrolysis (PEMWE) and polymer electrolyte membrane fuel cells (PEMFCs), these membranes are highly durable, ensure reliable operations, and provide high ionic conductivity, high electrical resistivity, as well as low gas permeability. There are no equivalent alternatives with the same combination of properties offered by these membranes.

As the advancement of PEMWE and PEMFC technology highly depends on the use of Nafion™ membranes, they are essential not only to today's green hydrogen initiatives but also to tomorrow's clean energy ambitions. Their use across industry has enabled the development of lighter weight, low maintenance, and more robust fuel cells used in the transportation industry and in sufficiently small-scale water electrolyzer technologies.

Hence, fluoropolymers are essential to green hydrogen's increased production, infrastructure, usage, and deployment. A ban of fluoropolymer-based Nafion™—for which there are currently no alternatives—is projected to result in minimum economic losses to the European economy of between €976 million and €1.4 billion.[3]

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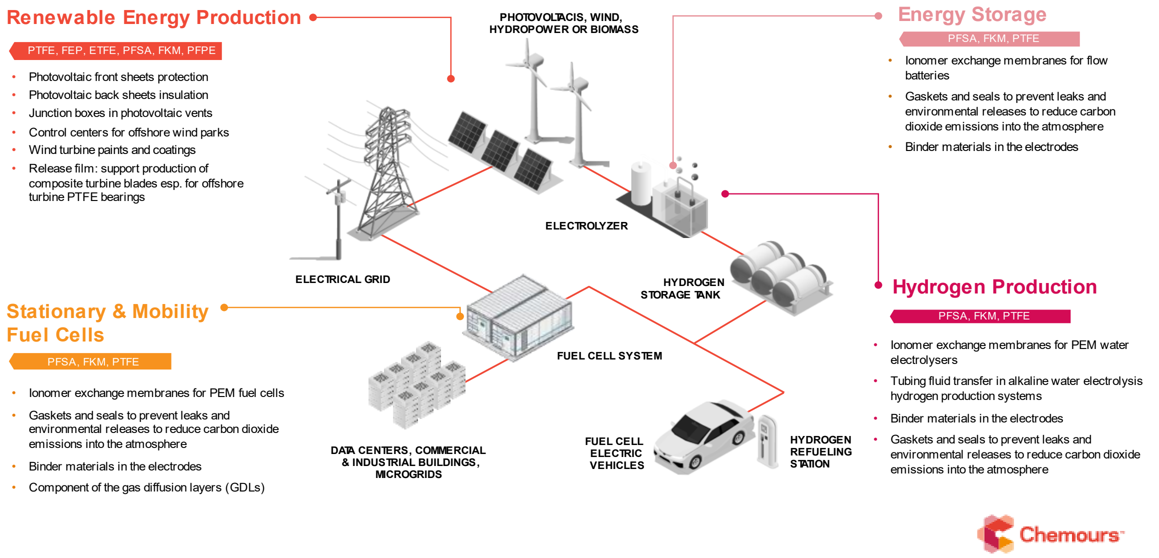
1 A critical review of the application of polymer of low concern and regulatory criteria to fluoropolymers
2 Socio-economic Analysis of a potential REACH restriction on Fluoropolymers Teflon™ Perfluoro Alkoxy, attached as Reference E in Chemours submission 9 Aug 2023, receipt reference 4e266294-5779-4bd1-bd6c-9465a3079202
3 Socio-Economic Analysis of a potential REACH restriction on Fluoropolymers, Nafion™ Ion Exchange Membanes attached

*Energy production components containing fluoropolymers*




An overly broad ban on PFAS promises to hinder EU policy ambitions, including the EU Green Deal and REPowerEU initiative, both of which directly rely on the use and expansion of green hydrogen in order to reduce dependence on fossil fuel imports and achieve climate targets. Moreover, a ban would severely disrupt or reroute a significant amount of industry investment into green hydrogen projects, further stifling the European economy. Without fluoropolymers, it would be impossible to harness hydrogen at the scale and scope required to meet these clean energy goals.

If the energy transition is indeed among the EU's highest priorities, fluoropolymer-based ion exchange membranes are essential and require exceptional consideration—among other fluoropolymers—to exist outside of REACH regulations. This is critical to advance and scale clean hydrogen energy and reach the EU's policy goals.

## *Bolstering Resilience & Competitiveness in Advanced Electronics*

According to the European Chemicals Agency (ECHA), the semiconductor sector consumes 45% of the fluoropolymers used in the electronics industry.[4] This is not least because fluoropolymers offer a whole range of specific physical and chemical characteristics that are vital for semiconductor manufacturing. They exhibit low surface tension, stability and chemical compatibility, inertness, purity, chemical and permeation resistance, a wide range of temperature stability, a low coefficient of friction, electrical properties, bacterial growth resistance, non-flammability and a long lifetime (more than 25 years).[5]

In particular, fluoropolymers' high resistance to various external influences, especially their chemical inertness, which ensures an extremely high degree of purity for the aggressive

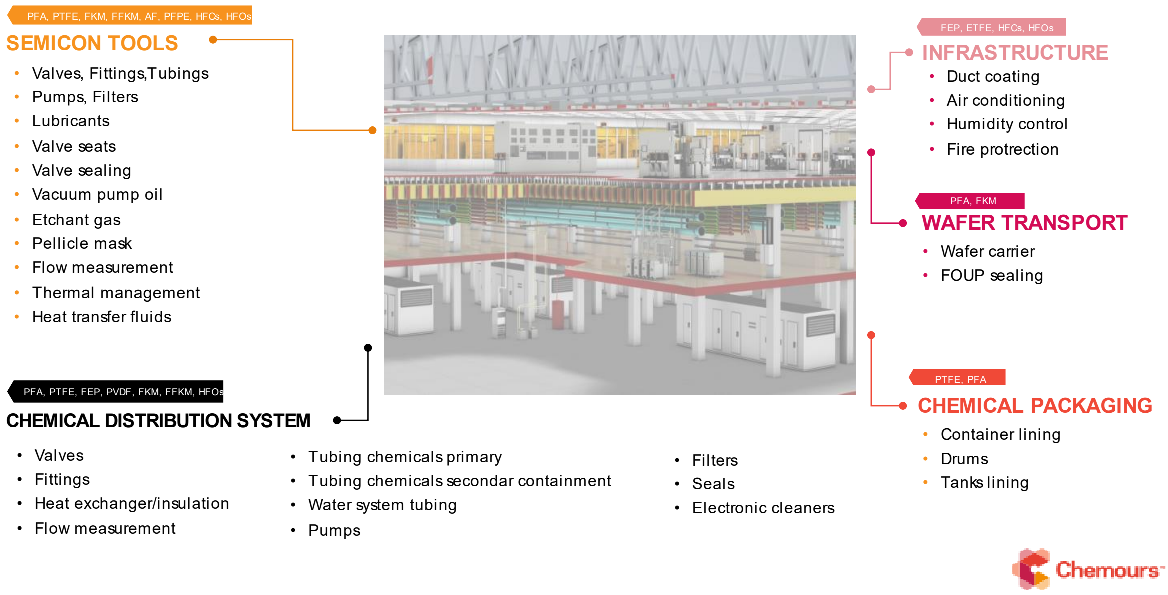
as Reference G in Chemours submission 9 Aug 2023, receipt reference 4e266294-5779-4bd1-bd6c-9465a3079202

[4] https://www.ft.com/content/76979768-59c0-436f-b731-40ba329a7544
[5] ESIA submission, doc 18 ref 4449

chemicals used throughout the production process, is key for the manufacture of semiconductors. Fluoropolymers also have the advantage of ensuring high durability and reliability, which is critical for operational safety. To date, no alternatives have been found that can meet the range of performance requirements on a par with fluoropolymers. Hence, to maintain and promote a competitive semiconductor industry in Europe, the use of fluoropolymers remains indispensable.

In addition, the risks of banning all PFAS do not apply just to the fabrication plants themselves. Semiconductor chips are essential in virtually all sectors that require advanced electronics, including internet connectivity, communications, computing, aerospace, national security, and transportation—to name only a few. Fluoropolymers help enable 5G transfer speeds and digitization, with implications in medicine, finance, education, entertainment, connected household devices, and beyond. They increase the capacity to improve signal quality over a wide frequency range and increase the durability of 5G systems. The future of 5G will require more cables, antennas, and data centers—fluoropolymer-based components are integral to a connected future.

*Semiconductor manufacturing components containing fluoropolymers*




As such, fluoropolymers are key to achieve the EU's 10% global market share in semiconductor manufacturing and to meet or even expand the policy objectives set out in the EU CHIPS Act. Otherwise, industries would become entirely reliant on semiconductor supply sources in North America and Asia—to the extent importation was not also affected.

Moreover, it is likely that companies currently investing hundreds of billions in European manufacturing sectors would stop making those investments or re-route them elsewhere around the globe if fluoropolymers would be banned. Tens of thousands of jobs would be lost, not just in direct manufacturing but up and down the supply chain. In fact, it has been projected that the broader European supply chain could suffer economic losses of up to €63.4 billion.

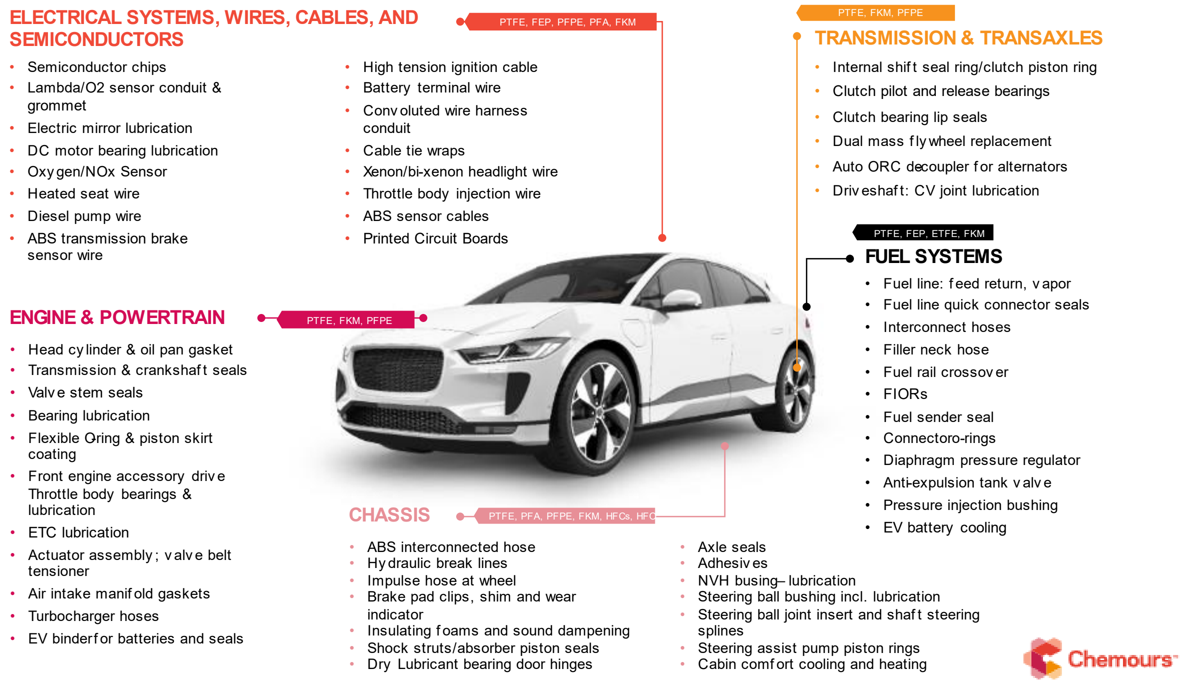
Based on the ubiquity of semiconductors within a massive range of high-impact industries, it is an economic imperative for the ECHA to grant a time-unlimited derogation for fluoropolymers in semiconductor manufacturing from the proposed PFAS restriction.

## *Advancing the Next Generation of Transportation*

Due in part to their role in advanced electronics and communications, fluoropolymers are also vital in the transport sector.

In the automotive industry, for instance, machinery and equipment often have to withstand harsh (outdoor) environments and extreme operating conditions, while also providing a high level of reliability and safety. In this context, fluoropolymers, with their unique set of properties and characteristics, are used to ensure that different automotive components meet their respective quality and performance requirements to ultimately allow for safe and efficient operations.

*Automotive components containing fluoropolymers*

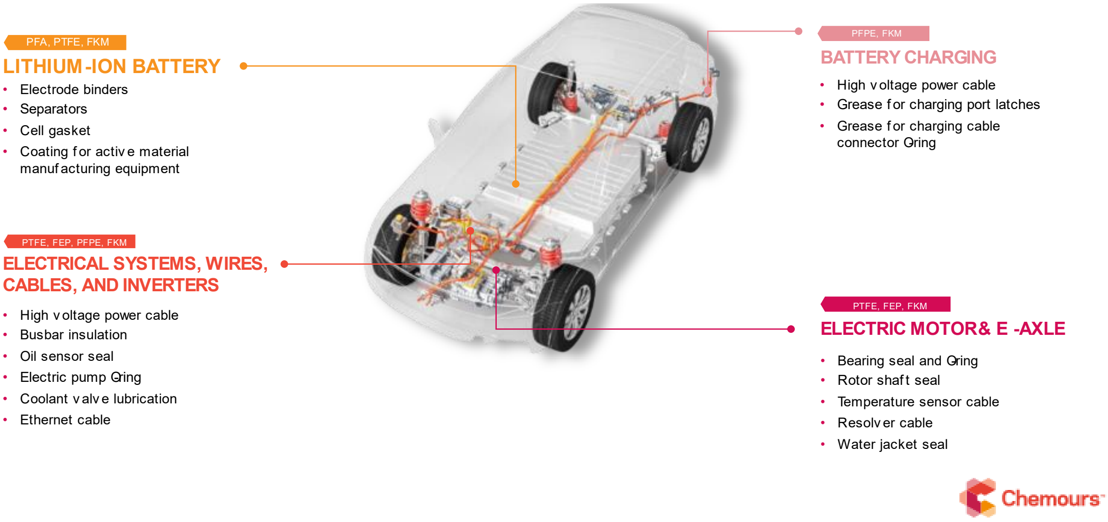



In other words, fluoropolymers keep cars running smoothly and efficiently and contribute to overall safety, performance, sustainability, and durability, thus increasing efficiency and extending their lifespan.

For instance, today's internal combustion engines and hybrids vehicles rely on fluoropolymers for their high-temperature and chemical resistance, which helps to reduce emissions, and meet Euro6 Norm for example. Among others, fluoropolymers make lambda sensors highly temperature and fire resistant, provide high insulation strength and a low water vapor permeability. They are used in seals such as O-rings and fuel hoses to prevent unwanted fuel leaks throughout the life of the product, as well as dry lubricants to lower friction to achieve higher efficiency and lower emissions.

The same importance holds true for fluoropolymers in electric vehicles (EVs), the demand for which is projected to grow 5-10X in the next decade.[6] At the heart of the growth of EVs—including the promise they bring to fundamental energy transition in transportation—are lithium-ion batteries. Fluoropolymers are used in key components for all high performance and lithium-ion battery technologies as they provide high chemical resistance and tolerance to a wide range of operating temperatures, both of which are critical for batteries. To be more precise, in batteries fluoropolymers are used in active material compounds, electrolytes, valves, seals, washers and membranes, and battery coatings.[7] No alternative chemistry can be used that offers the same advantages without significantly affecting safety and performance.

*EV components containing fluoropolymers*




Without a time-unlimited derogation for fluoropolymers from a potential PFAS restriction, the automotive industry in Europe would collapse. EV manufacturing would be curtailed and investment in innovation and manufacturing—including significant resources devoted to battery gigafactories—would diminish substantially. The EU would be unable to rely even on imports of any fluoropolymer-based components required for EVs and other transportation manufacturing. As a result, costs would significantly increase for manufacturers and consumers, resulting in lower adoption and dramatically reduced net benefit of more EVs on the road. Industrial deployment would be hamstrung by a lack of EU-based solutions.

### *Fortifying Medical & Healthcare Technologies*

In the medical industry, fluoropolymers are used in a number of different applications in different medical segments, including medical devices, medical and pharmaceutical infrastructure, and medical imaging and analysis. In this context, fluoropolymers' low surface energy and barrier properties, lubriciousness, temperature and chemical resistance, mechanical strengths, flexibility and high product purity help to create a highly sterile environment and protect medical devices, equipment, and drugs against contaminants.

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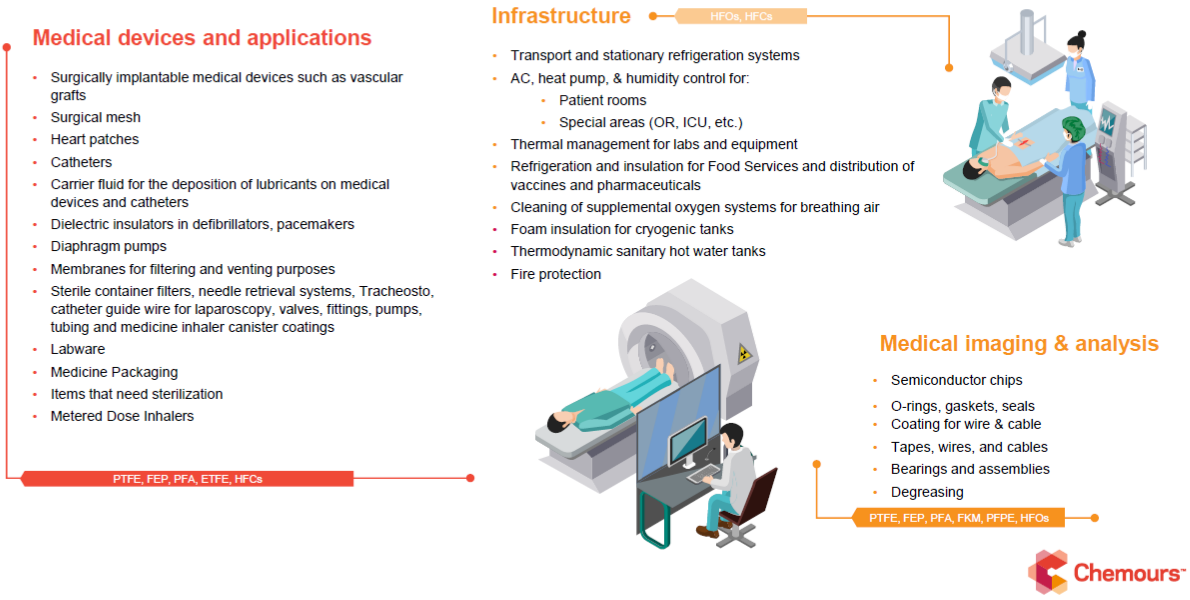
[6] National Blueprint for Lithium Batteries

[7] RECHARGE (2023). *Comments on the Annex XV report*. PFAS Restriction Proposal Consultation. Doc 13 ref 4276, appendix page 7.

*Medical components containing fluoropolymers*




For example, fluoropolymers' high product purity is specifically critical in equipment used in vaccine and medical production because impurities or contact with other materials risk the possibility of contamination. Similarly, during the COVID-19 crisis, fluoropolymer-based manufacturing played a major role in meeting the needs of the medical industry, including the production, effectiveness, and transport of vaccines, ventilators, test kits, and inhalers. Fluoropolymers also play an essential role in catheter tubing that are used for endoscopic procedures which, compared to traditional operating practices, significantly increase patient comfort, reduce risk of complication, and reduce the duration of hospital stays.

As such, patient therapies, lab equipment, and prescription drugs—to name only a few—all require fluoropolymers within their manufacturing cycles. Yet, it goes further than that: fluoropolymers also increase the lifespan of components, in large part by reducing the risks of failure, replacements, and cross-infections. They also help lower cleaning and maintenance costs and lead to decreased levels and risk of workforce exposure, relative to inefficient or less chemically secure alternatives.

Companies around the world have invested in the next generation of healthcare technologies that rely on fluoropolymers, and a total ban would present a significant disruption to the European economy. If fluoropolymers were eliminated through regulation, the availability of equally high-performing and durable medical device components produced in the EU would be dramatically reduced, forcing hospitals and medical providers to seek solutions elsewhere around the globe. Any components manufactured without the use of fluoropolymers run the risk of being meaningfully less durable, reliable, affordable, or safe.

## *An Interconnected Network of Fluoropolymer Dependence*

The sector and industry applications detailed above are just some of the many examples of the critical uses of fluoropolymers. In fact, there are many more essential applications throughout other sectors of the EU and global economy, including chemical, aerospace, marine, industrial machinery, food production, electronics—to name just a few.

When looking at these numerous uses of fluoropolymers in different applications, it is important to consider the links between industries as well as cross-industry dimensions of these uses.

First, there are many common fluoropolymer applications in industrial and professional uses across different sectors. For instance, fluoropolymers are used for valves, O-rings, seals, fittings, pumps, pipes, filters, and vessels in numerous contexts in all sectors described above. Chemours alone provides fluoropolymers to over 1,400 different combinations of different sectors and their applications in the EMEA region. Where these applications are used, they generally provide important safety and performance benefits, as downstream users have an inherent economic incentive to use comparatively cheaper alternative materials wherever possible.

Second, a number of applications that require the use of fluoropolymers are used in products which in turn are part of another product, and which are indispensable in this second product. In other words, fluoropolymers are often used at the beginning of a value chain, but the downstream value chain relies on this initial use of fluoropolymers – at least to a certain degree. For instance, cars and electronic equipment rely on semiconductors. And hydrogen-powered heavy-duty vehicles partly rely on electrolysis.

As such, it is misleading to assess the functions and benefits of fluoropolymers within the scope of individual applications. Instead, it is important to also consider the use of specific fluoropolymer-containing applications within and across industries and value chains. For this reason, the only practical way to regulate the use of fluoropolymers in the restriction dossier is to exempt them or, if this is not possible, to provide a very broad derogation for fluoropolymers in industrial and professional use.

Moreover, considering the very high amount of individual uses of fluoropolymers as well as their relevance within and across industries, the approach of use-specific derogations is not appropriate to provide for an effective regulatory framework.

Such an approach would result in a need for potentially thousands of individual use-specific derogations. Evaluating and implementing such a large number of specific use or sector-specific derogations would require significant time and administrative effort on the side of both industry as well as enforcement authorities, which in turn would be likely to create high regulatory uncertainty within industries, which could result in investment decisions being delayed and hindering innovation within the EEA.

## LACK OF FLUOROPOLYMER ALTERNATIVES

There are currently no viable alternatives to fluoropolymers that offer the same unique combination of properties, uses, and societal benefits. Some alternatives have similar performance for a very particular parameter or property—but it is precisely the combination and range of properties that make fluoropolymers so uniquely useful in a vast range of industries and sectors. It is important to note that fluoropolymers are expensive and complex to handle, making them materials of last resort. For this reason, it goes without saying that if alternatives that met industry requirements were already available, they would be used.

As high molecular weight molecules with unique properties attributable to the strong Carbon– Fluorine bonds, the strongest bond in organic chemistry, fluoropolymers are unlikely to be replaced by an alternative material, regardless of the resources invested. Applications requiring a combination of these properties, fluoropolymers are the superior and, often, only solution.

Notably, the proposal's own assessment notes that there is uncertainty in understanding of alternatives.[8] But the known downside risks of eliminating fluoropolymers are very clear: Any alternatives, while they will differ across specific applications, have the potential to suffer from a range of performance and quality issues ranging from reduced efficiency, durability, compatibility, and versatility to higher initial investment costs and maintenance costs. There would also likely be uncertainties around the safety of product breakdown, given that any alternatives with the same chemical resistance and persistency as fluoropolymers have the potential degrade into toxic substances when they become unstable. If an alternative were to exist or be invented, it would be able to handle the extreme environments and durability, meaning that, like fluoropolymers, it would also be very persistent.

Moreover, the production and design process to produce any viable alternatives will require significant time, effort, and resources, with the potential for major product qualification issues, a narrower band of operating condition requirements, higher risk of exposure to hazardous substances, or higher safety risk and increased emissions from technical regression.

Additionally, information about alternatives is extremely limited and lacks expert vetting and full testing before commercialization. That means alternatives, if they can be produced in the first place, will require extensive time and effort if they are to clear legal or regulatory barriers, let alone reach industry-leading safety, emissions control, and recycling standards.[9]

In many cases, there simply is no alternative. To elevate the most prevalent example: Semiconductor chips cannot be manufactured without fluoropolymers; in other words, every industry, sector, and consumer in the EU that relies on semiconductor technology will be put at a significant disadvantage.

There are currently no viable alternatives to fluoropolymers in many other important applications, especially when it requires high-speed, high-volume transmission of data (data centers, radar systems, 5G, etc.), miniaturization (computers and electronics), and extremes in temperature (like air travel, space applications, or high-hazard manufacturing). From aerospace and defense to advanced electronics and clean energy, there is often no domestically manufactured alternative replacement.

Simply put, replacing these fluoropolymers in their most critical applications would require an outsized investment of time, energy, and resources across the EU—if doing so is even

[8] Annex XV Restriction Report

[9] Plastics Europe: Socio-economic Analysis of the European Fluoropolymer Industry – Executive Summary

possible. No other polymers, plastics, or metals can match fluoropolymers' capabilities. When their unique properties, categorically different safety profile, irreplaceable role within entire sectors, and responsible management of manufacturing and end of life emissions are taken as a whole, the only viable, sensible, and science-backed solution is that fluoropolymers must be exempted from the proposed PFAS regulations.

## ENVIRONMENTAL & HUMAN HEALTH AND SAFETY

Fluoropolymers are now subject to restriction merely because they fit the PFAS structural definition of PFAS as described by the OECD, meaning they are persistent.

However, backed by a substantial body of scientific data, fluoropolymers have been demonstrated to meet the requirements of "polymers of low concern" as defined by the Organization for Economic Cooperation and Development (OECD). Based on in-depth data and scientific rigor, the "polymer of low concern" criteria were developed over time, within regulatory frameworks from around the world.[10]

Along those lines, fluoropolymers have documented safety profiles and are thermally, biologically, and chemically stable, negligibly soluble in water, nonmobile, nonbioavailable, nonbioaccumulative, and non-toxic.[11] They do not degrade into other PFAS and have been proven safe during their intended use phase.

In fact, an in depth-assessment of the fluoropolymers which accounting for approximately 96% of the global commercial fluoropolymer market against thirteen widely accepted polymer hazard assessment criteria, showed that these polymers are of low concern (PLC) and pose no significant risk to human health or the environment.

Moreover, as high molecular weight molecules with unique properties attributable to the strong Carbon–Fluorine bonds, fluoropolymers' highly stability is not an intrinsic hazard—in fact, it provides an immeasurable value for sustainability and durability.

These characteristics remain true for fluoropolymers throughout their life cycle and even when industrial or consumer use has ceased. There is considerable data demonstrating that, at this "end-of-life" period, where fluoropolymers are typically disposed via landfill, incineration, or recycling, they do not degrade in the environment or release substances of toxicological or environmental concern. Industry observes stringent end-of-life requirements and is continuing to invest in research into the safest conditions for disposal of fluoropolymers.[12]

Based on a thorough review and assessment of fluoropolymer toxicity data, human clinical data, and physical, chemical, thermal, and biological data, research has concluded that—for these reasons—fluoropolymers are distinctly different from other polymeric and nonpolymeric PFAS and should be separated from them for hazard assessment or regulatory purposes.

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[10] A critical review of the application of polymer of low concern and regulatory criteria to fluoropolymers

[11] A critical review of the application of polymer of low concern regulatory criteria to fluoropolymers II: Fluoroplastics and fluoroelastomers

[12] A critical review of the application of polymer of low concern regulatory criteria to fluoropolymers II: Fluoroplastics and fluoroelastomers

## RESPONSIBLE MANUFACTURING

Guided by existing regulation, industry already employs robust responsible manufacturing practices, including control of gaseous, aqueous, and solid emissions throughout manufacturing and processing, stringent emissions abatement technology and waste disposal methods, and end of life management. Leading fluoropolymer manufacturers have invested in state-of-the-art emissions control facilities and have already demonstrated significant emission reduction, including fluorinated polymerization aid recovery for reuse, 99% reduction of air/water process emissions, and 99% plant emission reductions.[13]

As such, every stage of fluoropolymer manufacturing—from the earliest stages of raw materials and monomers to the creation of polymers—can be completed responsibly, with thorough management of raw materials, polymerization aids, and the resulting polymers that are used in various product applications. The vast majority of fluoropolymers are manufactured in a manner that enables them to meet the OECD's criteria for polymers of low concern.[14]

Moreover, numerous recycling, incineration, and landfill processes and methods are existing, well suited to address end-of-life concerns associated with fluoropolymers. Similarly, existing waste directives as well as recycling, incineration, and landfill standards and practices demonstrate that effective mitigation measures are already in place or can be amended to address potential risks associated with the end of life of applications containing fluoropolymers.

Along those lines, fluoropolymer manufacturers in Europe committed to the highest standards for manufacturing worldwide. The industry-led program includes a concrete commitment to minimize emissions of non-polymeric PFAS residues from polymerization aids, a platform to promote the adoption of commercially available state-of-the-art technologies to minimize non-polymeric PFAS emissions in manufacturing, as well as the commitment to inform downstream users of fluoropolymers on their safe handling and use in the Guide for the Safe Handling of Fluoropolymer Resins. In addition, R&D investments have increased recyclability and re-use, core to the goal of a circular economy. In other words, fluoropolymers can be manufactured and used safely and responsibly.

## THE PATH FORWARD: GOVERNMENT & INDUSTRY PARTNERSHIP TO ACHIEVE A SCIENCE-BASED REGULATORY OUTCOME

As demonstrated, attempting to regulate all PFAS in a broad and general way as currently proposed would discard decades of accepted regulatory assessment practice and drive unintended, adverse consequences resulting in a regulatory precedent that will stifle the European economy, make Europe more dependent on third countries for critical materials, and—above all—undermine EU's clean energy, technology, and economic goals. Moreover, fluoropolymers' safety profile (including designation as "polymers of low concern," existing regulatory approval, and aggressive goals with respect to responsible manufacturing), unique

[13] A critical review of the application of polymer of low concern regulatory criteria to fluoropolymers II: Fluoroplastics and fluoroelastomers

[14] A critical review of the application of polymer of low concern and regulatory criteria to fluoropolymers

combination of characteristics, and critical industry applications require this exemption. Grouping all PFAS together doesn't accurately reflect the actual risks, uses, and related management measures for each substance.

Instead, to regulate PFAS in a way that benefits regulators, industry, and modern society, it needs a time-unlimited derogation for manufacturing, sale, import, and use of fluoropolymers—underpinned by an unwavering commitment to responsible manufacturing of fluoropolymers and responsible life-cycle management.

It has been shown that risks associated with the use of fluorinated substances in the manufacture of fluoropolymers can be controlled and minimized applying the framework of strictly controlled conditions, including standard emission abatement technologies and very strict manufacturing standards. It has been further outlined that the use of fluorinated polymerization aids in the manufacture of fluoropolymers cannot be entirely substituted with non-fluorinated polymerization aids, and that the use of non-fluorinated polymerization aids generates comparatively higher amounts of unknown emissions, which themselves bear a risk to human health and the environment and limit performance. Hence, Chemours urges ECHA to consider:

- an exemption for the use of transported isolated intermediates in the manufacture of fluoropolymers and fluoropolyethers under strictly controlled conditions.
- an exemption for non-intermediate substances necessary for the manufacture of fluoropolymers and fluoropolyethers under strictly controlled conditions.
- an exemption for the use of fluorinated processing aids in the manufacture of fluoropolymers. If a phase-out is eventually considered by the Scientific opinions to be a more appropriate measure, then Chemours urges ECHA to consider a derogation of at least 12 years with a review period, which will be necessary to ensure that disproportionate socio-economic impacts can be avoided.

We remain committed to working with the appropriate competent authorities to help fill any data gaps or to provide additional information about the safety and socio-economic value of fluoropolymers. In line with this commitment, we participated in ECHA's public consultation and provided substantial data and knowledge on the manufacturing, uses, and end-of-life management of fluoropolymers. We will continue to constructively engage in the regulatory process, and we are confident that we can achieve a coherent, science-based regulatory approach that leads to the use of safer, better-performing chemicals in the EU, and enables the sustainability and success of the EU industrial value chain.