

REACH Restriction Process on PFAS

More complex than just 'forever chemicals'

Fluoropolymers, the cornerstone of modern societies

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Chemours:

Chemours' business segments include two segments that are potentially affected by the PFAS restriction: Advanced Performed Materials (APM, including fluoropolymers with brand names Teflon™ fluoropolymer, -Viton™ fluoroelastomers, Nafion™ membranes & Krytox™ lubricants) and Thermal & Specialised Solutions (TSS, including F-gases with the brand name Opteon™ refrigerants and propellants used for insulation).

Chemours, as a forward-looking different kind of company, put in place a very ambitious Corporate Responsibility Commitment (the 'CRC') in 2018, just three years after becoming an independent company. The CRC set serious targets for 2030 (60% greenhouse gas emissions reductions) with the objective to reach net-zero operations greenhouse gas emissions by 2050 to contribute to the Paris Climate Agreement goals.

As part of its CRC goals, air and water process emissions of fluorinated organic chemicals are to be reduced by 99% or more compared to the 2018 emission levels by 2030. The company's Dordrecht Works (NL) site anticipates that 80% of this target will be met by 2024 while the Belgian blending plant in Mechelen is has already achieved this target. The emissions of HFPO-DA (GenX Technology polymerization aid platform) were reduced substantially by 2021. Permits for total emission to air and water took implemented abatement measures into account and were around 35 kgs in 2021 vs 8 tons in 2013).

Chemours is clearly leading the industry towards a major reduction of the emission of fluorinated organic chemicals and global warming emissions within the next 7-8 years.

Only a handful of sites, most of them located in Netherlands, France, Belgium, Germany, and Italy, are producing Fluoropolymers in Europe. Chemours has 3 plants (Netherlands, France, and Belgium) in the EU. The manufacturing of Fluoropolymers is limited to the site in the Netherlands and can therefore be regulated with regular controls by the national authorities on emissions and the application of BAT abatement technologies.

REACH Process at a glance

The competent authorities of the five countries (Germany, the Netherlands, Norway, Sweden & Denmark) have agreed to prepare a joint REACH restriction proposal on the manufacture and use of a wide range of PFAS. On 11 May 2020, these countries launched a call for evidence on a broad PFAS restriction to restrict the manufacture, the placing on the market and the use of all per- and polyfluoroalkyl substances (PFAS) in the common market. These 5 countries concluded that the very

high persistence of these chemicals in the environment and the potential contamination of ground, surface and drinking water is problematic. In conclusion, a call for evidence was launched.

The registration of intention to propose a restriction was launched in July 2021, requiring the dossier submitters to present the Restriction proposal within one year. A second call for evidence took place and closed on 17 October 2021. The countries are currently working on the proposal, the submission of which is expected by 13 January 2023 (originally planned for 15 July 2022). After the proposal is presented, checked for conformity, a six-month Stakeholder Consultation will take place.

Next steps will include the Risk Assessment Committee (RAC) of ECHA to draw conclusions by the first trimester of 2023, taking into account information submitted by stakeholders. Then the Socio-Economic Committee (SEAC) will publish its Draft opinion which will be open to an additional 60-day stakeholder consultation. SEAC is expected to finalize its opinion by the summer of 2023. The Commission should then finalise its proposal by the end of 2023 with a vote at the REACH committee in 2024. However, with the delayed submission of the dossier, this timeline might be delayed by six months or more.

Given the importance of fluoropolymers in today's economy and in key innovations (hydrogen, semiconductors, automobile, 5G, medical equipment, aerospace, defence), the decision by the European Commission will need to balance the real risks posed by an exposure to the societal benefits.

PFAS: all equals?

Per- and polyfluoroalkyl substances (PFAS) are a large group of chemicals with widely different physical, chemical and biological properties. The general category PFAS is not based on the physiochemical or biological properties of the substances. Their **only** common denominator is that they include at least 1 perfluorinated methyl (-CF₃-) or methylene (-CF₂-) group.

Fluoropolymers a distinct class of low concern

Fluoropolymers ('Fluoropolymers') are a sub-category of PFAS. They appear mostly as solid in a granular or powder form but are also distributed as aqueous dispersions and films. Granulates are mainly used for moulding while powders are used for paste extrusion (2nd level in the value chain). While Fluoropolymers may be deemed to match the definition(s) of PFAS based on the common structural denominator, they have different environmental and toxicological properties when compared to other members of the PFAS group, and, for this reason, they should be considered separately from any regulatory initiative on PFAS. **Fluoropolymers do not pose a significant risk to human health or the environment in their intended use because of their unique characteristics.**

Fluoropolymers, high molecular weight polymers, have unique properties that constitute a distinct class within the PFAS group. Fluoropolymers have thermal, chemical, photochemical, hydrolytic, oxidative, and biological stability and they have negligible residual monomer and oligomer content and low to no leachables.

Fluoropolymers are practically insoluble in water and not subject to long-range transport and, with a molecular weight well over 100 000 Da, fluoropolymers cannot cross the cell membrane.

Fluoropolymers do not dissolve or contaminate water and cannot enter or accumulate in a person's bloodstream given their high molecular weight¹. They are biologically stable and chemically inert in presence of virtually any chemical, non-bioavailable, non-bioaccumulative and non-toxic. Due to their unique chemical characteristics, they are used in specific applications where durability, mechanical strength, inertness, thermal stability and resistance to chemical, biological and physical degradation are required.

Fluoropolymers satisfy widely accepted assessment criteria to be considered as “polymers of low concern” (OECD-PLC). *In vitro* and *in vivo* studies demonstrate that Fluoropolymers like PTFE are biologically inert and not degraded by microorganisms under oxygenated (aerobic) or anoxic (anaerobic conditions)².

Fluoropolymers in Chemours's portfolio present very low levels of residual (fluorinated) monomers, oligomers or other leachable thanks to the sensitivity of the polymerization reaction to contamination and the post-polymerization processing steps implemented to remove residuals and drive off volatile monomers. This is due to great investments in R&D.

Indeed, the 4 key Fluoropolymers (PTFE, ETFE, FEP, and PFA) that have been demonstrated to meet the OECD criteria of PLC, represent approximately about 75% of the world Fluoropolymers consumption in 2015³. Additional information is being compiled by the industry this year to increase the percentage to 85%.

While Fluoropolymers are regarded as being persistent in the environment, persistence alone does not imply that there is a present or future risk to human health or the environment. The main concerns related to Fluoropolymers are not linked to the polymer as such, but to other chemicals used in or derived from the manufacturing process (e.g., PFAS polymerization aids) as well as to potential impurities of the FP products. In general, polymerization reactions rarely proceed to 100% completion, leading to a low to negligible presence of unreacted residual monomers and oligomers. However, even with a potential presence of residues, exposure from fluoropolymers would be limited, as they are not mobile and cannot bioaccumulate as mentioned.

The use of modern Polymerisation Aids in responsible manufacturing

It may happen that during the manufacture, use and end-of-life treatment of Fluoropolymers, that there are situations that need to be monitored and controlled to avoid any risk for human health or the environment. Indeed, emissions from the use of certain PFAS (as mentioned above: monomers,

¹ Henry et al. *A Critical Review of the Application of Polymer of Low Concern and Regulatory Criteria to Fluoropolymers in Integrated Environmental Assessment and Management — Volume 14, Number 3—pp. 316–334, 2018.* <http://dx.doi.org/10.1002/ieam.4035> and https://fluoropolymers.plasticseurope.org/application/files/5116/3671/1909/Fluoropolymers_Safe_Hand_EN_2021.pdf

² Henry et al. 20218

³ Henry et al. 20218

oligomers & polymerisation aids) during the manufacturing process are not entirely excluded and need to be addressed properly as being done by Chemours.

Polymerisation Aids are used, in extremely low concentrations, to support the polymerization process. After the polymerization process is completed, steps are taken to remove remaining traces from the final polymer and the recovered polymerisation aid (such as HFPO-DA) can then either be recycled or safely destroyed.

It must be clear that individual members of the industry progressed highly in terms of innovation as they transitioned from longer-chained polymerization aids to shorter ones. One new key polymerization aid, (HFPO-DA Ammonium Salt/ FRD 902/ C3 Dimer salt or sometimes referred to by the trade name GenX) is not comparable to the previous processing aids (much less toxic & not bio accumulative as a short-chain PFAS). Indeed, HFPO-DA is eliminated from the body in a matter of days as compared to 3-5 years for PFOA (80 hours for half of the HFPO-DA in the blood to be eliminated).

HFPO-DA is imported into the EU, being manufactured in the US. The Dordrecht plant imports around 50 Tons per year, well within the range of the REACH category of imports between 10-100 Tons. The emission of HFPO-DA can be very well addressed through technical measures. The total permitted emission to air and water was around 8 Tons / year at the introduction of the GenX technology with actual emissions always well within the permitted amounts. Chemours continued to reduce emissions and announced a further reduction of total emission to air and water by 99 % versus the 2017 baseline of 3 Tons to air and water. The permitted amounts were also reduced over time. The total release of HFPO-DA to air and water was below 30 kgs/year in 2021, meeting the 99 % commitment. The specific permit requirements for HFPO-DA in 2023 are:

- 2 kg / year HFPO-DA in wastewater discharged to the municipal wastewater treatment plant (indirect emission into the river). Actual reported emissions have been below 0,2 kg in recent years.
- 5 kg / year HFPO-DA by direct discharges into the river, combination of rainwater and treated groundwater where traces HFPO-DA are detected due to atmospheric deposition. Actual reported emissions have been around 1 kg in recent years.
- 3.5 kg / year HFPO-DA by air emissions. The permit level has been further tightened in recent years and actual reported emissions have been within these limits.

As regards the classification of GenX, only a self-classification does exist and GenX is not classified as a Carcinogenic, Mutagenic or Toxic for Reproduction (CMR) substance nor an Endocrine Disruptor. This self-classification was never challenged by an authority whether ECHA or a Member State⁴. A study by the Dutch National Institute for Public Health and Environment concluded that there is “no

⁴ Authorities claimed some concern due to its properties which may cause probable serious effects to human health and the environment and it was included the candidate list of substances of very high concern for authorization. This decision was legally challenged.

*health risk is expected for people living in the vicinity of the Chemours Dordrecht plant due to exposure*⁵.

Grouping, a valid scientific approach?

The procedures to adopt a restriction under REACH, based on a grouping approach, are underpinned by the application of REACH principles such as "One Substance, One Registration", as well as general principles of EU law such as the proportionality, due process, precautionary, equal treatment, and legal certainty. Although the grouping of substances is only foreseen under REACH for purposes of fulfilling data requirements of registered substances, the current and future approach leans towards grouping for risk management purposes, including restriction processes. This appears to be driven mostly by reasons of efficiency, however, carries the risk that regulation would be too complex for enforcement authorities and thus not feasible⁶.

The grouping of substances for restriction purposes is legally questionable since it is based on the assessment of the *hazards* of the substance whereas the purpose of restrictions is to assess and address unacceptable *risks* of substances. This is notably reflected in the wording of Article 68 of REACH.

One could assume that Member States authorities have not demonstrated any unacceptable risk for all PFAS. This is the reason why the 5 Member States decided to work on a grouping approach, but this requires gathering a lot of data in one process. A recent study shows that only 256 PFAS are commercially relevant globally⁷. This study suggests that grouping and categorizing PFAS using fundamental classification criteria based on composition and structure can be used to identify appropriate groups of PFAS substances for risk assessment, thereby dispelling assertions that there are too many PFAS chemistries to conduct proper regulatory risk assessments for the commercially relevant substances.

The grouping of several thousands of substances has no scientific basis. Any restriction needs to take into account exposure as well as socio economic risks/benefits. In that respect, grouping all PFASs would ignore the risk/benefit analysis and would not reflect the actual risks, uses and related management measures for each substance. Again, of course, the complexity of the PFAS, the many substances with the high number of applications in many different sectors, make it almost impossible for any Member State to draw conclusions.

The clustering of categories of substances into groups may be justified for reasons of efficiency of the administrative procedure (avoid inappropriate substitutions, consistency, etc), provided this is

⁵ National Institute for Public Health and the Environment, Ministry of Health, Welfare and Sport, *Evaluation of substances used in the GenX technology by Chemours, Dordrecht, 2016*.

⁶ This position is also shared by [BDI](#) and Orgalim through their position paper on the restriction of PFAS

⁷ Robert C. Buck, Stephen H. Korzeniowski, Evan Laganis and Frank Adamsky, *Identification and classification of commercially relevant per- and poly-fluoroalkyl substances (PFAS), 2021* (<https://doi.org/10.1002/ieam.4450>)

scientifically substantiated. But, in these cases, clear, scientifically robust, and transparent criteria should be set out to identify the relevant groups, e.g., chemical structure and molecular weight, health and environmental hazards, relevant uses and exposure scenarios and an assessment of the risk management measures already in place.

In conclusion, a grouping approach for such a wide number of substances is not justified and unfair to the industry as it departs from a substance-by-substance assessment thereby running the risk of making generic conclusions rather than specific and scientifically based ones. Not all PFAS are the same, as just indicated in the foregoing. A statement like 'forever chemicals' should all be banned is, of course, easier to make than to identify specific substances but it is not supported by science.

Restriction principles: derogation, risk management option

Restrictions under REACH are used to limit or ban the manufacture, placing on the market (including imports) or use of a substance (on its own, in a mixture or in an article), and can also impose conditions, such as technical measures, specific labels, the obligation to provide training to workers or information to consumers.

Under Article 68(1) of REACH, for a restriction to be adopted, there needs to be: (a) an unacceptable risk to human health or to the environment; (b) a causal link between that risk and the manufacture, use or placing on the market of the substance concerned; and (c) that risk needs to be addressed on an EU-wide basis.

- The structure and extent of restrictions may vary significantly, i.e., from total prohibition of manufacturing, placing on the market and use to specific restrictions of certain uses or uses in certain processes.
- The default concentration limit is 0,1%, although this may vary depending on a case-by-case assessment.
- Conditional or unconditional derogations may be foreseen.
- Substances can be, and in practice have been, restricted as a group.

Given the profile of Fluoropolymers (no concern on toxicology and considered as polymers of low concern), **those should benefit from a derogation** for the manufacture and use as well as for the use of PFAS required as polymerization aids or monomers in the manufacturing process. The monomers are by technical function an intermediate⁸. On-site isolated intermediates are exempt from restriction procedures. Moreover, their use takes place in strictly controlled conditions (closed systems) given the high reactivity of those monomers. Potential emissions of monomers (and other) can be well addressed on-site.

The way forward given the essentiality of PFAS Fluoropolymers to the society is to review the existing EU legislation and to set Best Available Techniques (BAT), which have been proven to work on a

⁸ In contrast to other intermediates, monomers are a distinct category and are required to be registered and may be in scope if their residual content in the final article is significant.

commercial scale, for abatement or acceptable emission levels for certain PFAS during the life cycle of Fluoropolymers, while taking into account the fluctuating nature of the production. In fact, this option should have been considered by the authorities as a Risk Management Option, but it was not done. Chemours manufacturing plant in Dordrecht Works already has emissions to water and air well below the tightened environmental and most strict permit levels and would support a review of the wastewater treatment EU legislation (Directive 2008/98/EC) with ambitious objectives.

Moreover, the review of the EU industrial emissions Directive **would also allow to set ambitious goals ensuring adequate technical controls are put in place to minimize to the furthest possible extent any risk derived from the disposal of FP products and from articles containing Fluoropolymers.** All the EU FP manufacturing sites operate under environmental permits in accordance with national and regional legislations, transposing the European Directive 2010/75 on industrial emissions (integrated pollution prevention and control), that defines the environmental limits and conditions for the manufacture of FP products.

In conclusion and given the fact that the Restriction process shall last for 5 years, there is time to amend the above EU legislation to tighten any possible emissions while control of the manufacturing sites for fluoropolymers should not be an issue given their low number in the EU (about 10).

The development of a voluntary industry initiative is also an option supported by Chemours and the industry to establish and implement the technical actions to guarantee an adequate control of the risks derived from the manufacture and use of Fluoropolymers, or even to remove such risks wherever possible, with a strong emphasis on R&D for a continued improvement of the polymerisation process and abatement technology. In this sense, the Manufacturing players would engage with the value chain players such as the compounders and moulders.

Fluoropolymers: vital for modern societies

Fluoropolymers have a unique combination of properties that no other chemistry matches. Fluoropolymers are critical for a number of sectors and industries in the EU and across the globe. Their unique combination of properties makes them durable (less maintenance, lower manufacturing costs in corrosive environments), efficient, reliable, versatile, and ultimately fundamental to the products they enable. Their properties include fire resistance, weather resistance, temperature resistance (in the range of 260°), chemical resistance (other chemicals do not affect them), non-wetting (coatings also resist oil) and non-sticking properties, and high-performance dielectric properties. In other words, durability and stability is an essential quality that the various industries wish to secure.

Should Fluoropolymers and some PFAS be substituted, the alternative would need the same characteristics including durability and stability.

Key Fluoropolymers include PTFE, PFA, FEP, while the monomers needed to produce these include TFE, F22, HFP, vinyl Ethers (PPVE, PEVE).

Fluoropolymers contribute highly to the society without it being known sometimes by the downstream users (e.g., automobile sector) given the complexity of the value chain. It is therefore no surprise that decision-makers are not aware of the very high value of these specialty chemicals. The number of sectors which benefit from fluoropolymers are too numerous to list, reason why, we have to focus on the most critical ones to reflect the essentiality of Fluoropolymers. The ones selected are: Automotive, Semiconductors, 5G technology, Green Hydrogen economy, Chemical Industry, Medical, Defence & Aeronautic.

Other sectors include textile, construction, and food contact materials. Chemours key branded products are worldwide known as Teflon™ (e.g., resins used in wire coatings and custom molded parts) and Viton (FKM fluoroelastomers used in applications such as O-rings, seals, hoses, gaskets), Nafion (ion exchange membranes) and Krytox (high performance lubricants increasing life of equipment). Those are used in the below sectors with some being present in most sectors like Teflon™ branded products.

As regards textile, Fluoropolymer membranes help to keep us warm & dry (e.g., in personal protection equipment, etc.) and allow the body to breath properly in extreme conditions.

Finally, construction materials include Fluoropolymers to ensure weatherability (UV resistance), chemical Resistance (preventing corrosion), cleanliness (ease of cleaning), temperature resistance, translucency, etc. airports, domes and stadiums all rely on Fluoropolymers (lifetime of 30 years for roof stadiums based on Fluoropolymers coatings whether steel, concrete, glass, insulation cables).

1. Automotive

In the automotive sector, Fluoropolymers and Perfluoropolyethers (PFPEs) are essential and Chemours brands are well recognized (e.g. Fluoroplastics (Teflon™), PFPE lubricants (Krytox™) Fluoroelastomers (Viton™) and Ion exchange membranes (Nafion™)). They allow to reduce emissions, increase safety & energy efficiency.

The value chain is composed by the manufacturer (e.g., Chemours), the less-known compounders/molders, the equipment manufacturer and the car manufacturer.

- Automakers keep investing to improve comfort & safety, limitless connectivity and in lighter cars to improve efficiency (whether electric or not). As automotive technology evolves, so does the complexity of automobile electrical systems. The temperature under the hood increased substantially over the years thanks to more performing engines (turbocharged) requiring high performance chemicals such as Fluoropolymers. Fluoropolymers improve the efficiency and connectivity of wires, cables, and circuits that power the equipment upon which communication depends (connection to 5G to improve navigation, telecommunications).

Fluoroplastics: Coatings (cabling) and moulded parts based on PFA, FEP, and PTFE

Fluoropolymers (Teflon™ is Chemours brand) allow heated seats wire, ABS brake transmission wire, battery terminal wire, Xenon headlight wire, navigation transmission wire, coated hoses to reduce emissions, NOx sensors wires, EV charging stations, and other.

- **Fluoroelastomers:** transmission seals, flexible O-rings (seals between 2 components to prevent leakages), shaft valve seals (enable adequate lubrication of the valve), clutch seals, fuel sender

seals, filter neck hose, turbocharger hoses, cylinder head gaskets (those seal the cylinders and prevent gas and liquid leakages)

Heat and stress resistance are essential as temperature and pressure are constantly changing in the air injection system; failure would lead to higher emissions and lower fuel efficiency

Fluoroelastomers play an important role in cutting carbon emissions (Greenhouse emission controls) via lambda, NOx or oxygen sensors which contain multiple fluoropolymer applications: wires, form hose, grommet and filter which are all operating in hot engine exhaust gases to optimize engine combustion and surface resistivity.

In short, shafts in engines need seals made of Fluoropolymers to avoid leaking oil and lubricants. If leakages, the engine will suffer, and the car will have a much shorter lifespan.

- **Lubricants** (Perfluoropolyethers): electric mirror lubrication, bearing lubrication. Lubricants reduce component failure, extend vehicle life and the elimination of noise and vibration even under the broadest range of temperatures and harshest conditions.
- **Ion Membranes:** among fuel cells available today, proton exchange membranes (PEMs) that utilize fluoropolymer membranes have become an effective choice in energy generation, especially when used for transportation and material handling applications. A fuel cell is an electrochemical cell that converts the chemical energy of a fuel (hydrogen) and an oxidising agent into electricity (key for the development of electric cars).

In conclusion, the whole car is made of multiple parts including Fluoropolymers. It is impossible to assemble a car without all these parts based on the Fluoropolymers technology and which allow to reduce emissions, increase performance & improve the safety and comfort of the passenger.

2. Semiconductors

We rely on semiconductors more and more for modern transportation, lighting, internet connectivity, medical devices, home appliances and communications. Semiconductor manufacturing processes are extremely intolerant of particulate, chemical, and metal contamination which can, even in trace amounts, dramatically reduce yields. The semiconductor industry relies on fluoropolymers' unique combination of properties to perform as the material of construction for processing equipment, fluid transport systems, and wafer handling tools due to their purity and resistance to chemical attack.

The European Union has basically no semiconductor industry despite its essentiality to the EU economy and society. Political statements were made in the wake of the Covid crisis that the EU would need to develop semiconductor investments in the EU. Semiconductor companies such as Intel, Texas Instruments or AMD would be keen to invest in the EU, but should Fluoropolymers be banned, those will no longer be possible since the Fluoropolymers are a key part of the semiconductor and the manufacturing process (equipment).

The value chain of the semiconductor industry is complex. The value chain starts with the manufacturing of Fluoropolymers, before it is then further processed by Molders and equipment supplier before producers of semiconductors use them in their final article. In the Process chemistry, Fluoropolymers are used in the production of other chemicals needed for manufacturing

semiconductors, while in manufacturing & support equipment as well inside the facility itself, Fluoropolymers are widely used in distribution systems (e.g., filters, tubing, seals) and for water and waste management. The final product contains Fluoropolymers as well and can be found in wires and cables, circuit boards, batteries, capacitors and other. Put simply, chips cannot be manufactured without fluoropolymers.

In the last 20 years, the innovation in microchips generated about €2.7tr of additional value to global GDP without considering indirect economic effects. Many sectors depend entirely on the functionality provided by these electronic components. It is estimated that Fluoropolymers use in the semiconductor industry results in annual benefits to European semiconductor makers of €11bn. This does not include benefits of using semiconductors further downstream in the value chain.

By 2025, there will be 75 billion internet of things devices, all requiring semiconductors and therefore Fluoropolymers....

Typical parts of the semiconductor containing Fluoropolymers include pipes, pumps, tubes, wafers, filters, level indicators.

- **Fluoroplastics:** PFA resins used for pipes, pumps, etc. offering high resistance to temperature (usual for semiconductors), resistance to corrosion.
- **Fluoroelastomers:** O-rings, seals, gaskets
- **Lubricants** help to reduce contaminants and outgassing when used in vacuum pumps and cleanrooms, where electronics and semiconductors are fabricated. They protect the microchips from contamination.
- **Ion Membranes:** the ability to selectively transport cations in various electrochemical processes is leveraged by the semiconductor industry for the cost-effective production of ultrahigh purity compound

3. 5G technology

Fluoropolymers enable 5G data transfer speeds and digitalization. Again, their low flammability insulation in cables and wires, capacity to improve signal quality over a wide frequency range for critical data transmission and increased durability lead Fluoropolymers to be essential to the development of the 5G Technology in the EU. Since they resist to high temperature, the Fluoropolymers are essential to secure the high-speed internet and protect server rooms/data centres.

In other words, Fluoropolymers are present in all electronic systems whether in terms of infrastructure or because of the presence of semiconductors (cell phones, laptops, tablets). The future of 5G will require more cable, more antennas, and more data centres to process all the information. Our solutions will be integral to all aspects of this growth market.

4. Green Hydrogen economy

Ion exchange membranes (IEMs) have many uses that can positively impact our world's economy and environment. Their versatility enables growth in new applications and more sustainable business

practices across the globe. IEMs can help reduce carbon emissions and offer more efficient ways to manage worldly resources, such as hydrogen and electricity.

Fluoropolymers based ion exchange membranes (e.g., Nafion™) are critical components in the production of water electrolyzers that produce 100% sustainable or renewable hydrogen (Green Hydrogen) used as an energy source in fuel cells (as described above in the case of Electric cars, for instance).

Water electrolysis is a process that can produce hydrogen without any harmful emissions, so long as the power used comes from a renewable source. During the process, an electrolyser uses an ion exchange membrane to convert electricity and water into hydrogen and oxygen, which can be stored for later use. This stored hydrogen generated by water electrolysis helps stabilize electrical grids when they rely solely on intermittent renewable sources like wind turbines and solar cells. Renewables face a challenge of keeping energy production consistent and reliable, matching supply with demand. Solar power generation peaks at midday and ends at sunset—but sometimes cloud cover interferes.

Because peak energy consumption generally occurs between mid-afternoon to early evening—with variations based on region and sea-son—energy supply can drop, with little means to generate more. Hydrogen production, via electrolysis, can supplement these renewable energy gaps more sustainably. Fuel cells—which use hydrogen and oxygen to produce electricity—can also compensate for times of lower energy production from renewables. Utility and grid operators can use commercial-scale systems to convert and store excess renewable power as hydrogen to supplement higher demand.

Green Hydrogen is the future and a key priority for the European Commission as outlined in the Hydrogen Strategy. they will replace over time traditional Hydrogen solutions such as grey hydrogen generated via the combustion of fossil fuels such as natural gas and which is largely dominant on the market today, but which generates important carbon emissions.

For this transition to happen we need Ion Exchange Membranes made from Fluoropolymers and without them the Green Hydrogen energy production would never take off.

Other relevant examples:

- **Fluoropolymers Coatings:** provide optical transparency and electrical insulation to **PV panels**, as well as protecting them from wind, humidity, UV, extreme temperatures, and chemicals. This increases the efficiency and lifetime, minimising failures, maintenance stoppages and associated CS costs (allowed in major production costs drops)

Wind energy manufacturers seek to reduce energy costs and reduce blade manufacturing cycles by producing **wind blade structures** more efficiently. FP based release films enable efficiency gains in wind turbine production. PTFE mould linings for wind turbine blades increase the number of blade cycles before replacement 10-fold. Paints and coatings on the main towers and blades of wind power generators. Ice build-up on turbine blades can be substantially reduced thanks to Fluoropolymers.

Fluoropolymers also facilitate advanced **energy storage** and conversion technologies, such as lithium-ion batteries. In lithium-ion batteries, Fluoropolymers are used in both electrode binders

and separators and can with further innovation can help to improve not only the performance of LiB but also the sustainability of LiB production by eliminating toxic solvents

5. Medical devices

Fluoropolymers enable excellent performance and long lifetimes in medical equipment such as surgically implantable medical devices, breathing treatments, catheter guide wires, filters, and pumps. This reduces the risks of failure, replacements, cross-infections and clogging of medical equipment, contributing to the reduction/avoidance of medical complications and the associated pain and public cost

In addition, Fluoropolymers are used as critical parts, and polymeric perfluoropolyethers (PFPEs) as lubricants and filling liquids for vacuum pumps in oxygen management systems to enable safe use and operations of such systems in hospitals and in portable units where other materials of construction are not compatible and do not meet code of practice requirements for safe and reliable use with oxygen. Use of unapproved lubricants in oxygen-rich environments could present serious safety risk, including fire or explosion.

Using an alternative in critical medical operations requiring the lowest coefficient of friction material, like catheter guidewires, could increase risk during life-saving interventions (e.g., heart surgery and key-hole operations of any kind). Because of their unique properties, the use Fluoropolymers reduces the risks of failure, replacements, cross-infections, contributing to the reduction/avoidance of medical complications and the associated pain and public cost.

Fluoropolymers play an essential role in enabling medical imaging and analysis (via electronic chips and semiconductors in X-ray, MRI, CT scan and echography) as well as medical analysis (blood, tissue, urine analysis). Alternatives in applications requiring sterility (to keep cross-contamination to a minimum) will not perform under the harsh conditions and broad temperature ranges required for steam, dry heat, and ethylene oxide sterilization regiments for this industry

When looking at the **Covid Crisis** and potential future pandemics Fluoropolymers play a major role in addressing the needs of the medical industry including applications in treatment, testing and prevention:

- **Fluoroelastomers & PFPE Lubricants:** Ventilators manufacturers had to increase their production. Fluoroelastomer gaskets are used in the production of **ventilators** because of their ability to withstand harsh chemicals without degradation (unlike rubber alternatives). For the seal to be maintained, fluoroelastomers are essential. PFPE lubricants are required for performance in oxygen-rich environments when most other lubricants would outgas or vaporize.

COVID-19 test kits require PFPE Lubricants in test kit plunger seals because of their resistance to biological growth and their lack of migration, permitting the kits and test samples to remain contaminant-free.

Fluoropolymers are approved for use in **metered dose inhalers** (MDIs) because the stability and chemical inertness of the fluoropolymer coating provides excellent protection for the pharmaceutical active by preventing interaction with the aluminium substrate while ensuring uniform drug delivery by preventing build-up along the sidewall of the MDI. MDIs are critical for

treating patients infected by COVID-19 as an alternative to nebulizers, which introduce greater exposure risks for healthcare workers.

6. Defence & Aerospace

Fluoropolymers and PFPE lubricants play an essential role in both the Defence (vehicle, aircrafts, etc) and Aeronautic industries, where component failures would have serious consequences) and without society being aware of these implications. Krytox lubricants were first used back in 1965 with the Apollo space program and Fluoroelastomers were initially developed for aerospace applications where they were valued for their unique combination of thermal stability and tolerance of hydrocarbons.

- Fluoropolymers provide superior dielectric properties that electronic components in airplanes require, insulating the millions of feet of cable that run through aircraft. Fluoropolymers are used because of their:
 - superior resistance to aging, radiation, and fire
 - chemical resistance permitting the safe and durable flow of fuel and other aircraft fluids
- Beyond airplanes, high-performance fluoropolymers add durability, reliability and conductivity to spacecraft and satellites to address the challenges they face when unprotected by Earth's atmosphere. Fluoropolymers were used in the construction of the Mars Exploration Rover
- PFPE lubricants meet the extremely demanding lubrication requirements in aerospace applications with greater extremes in temperature and pressure and the need for extended performance life. High performance PFPE lubricants have demonstrated the broad applicability to replace hundreds of conventional oils and greases throughout the aerospace industry. PFPE lubricants are well-suited to aerospace applications because:
 - They will not burn or support combustion, even in fully liquid or gaseous oxygen.
 - The various grades cover a wide temperature range, from -75 °C to +360 °C continuous, with spikes to temperatures greater than 400 °C.
 - They do not degrade or break down in the presence of aggressive chemicals and offer a long lubricant life with no potential for carbonaceous deposits.
 - The high PFPE lubricant film thickness protects them under high loads and across a range of speeds.
 - They are compatible with most elastomers, polymers, and a wide range of metals, in addition to being non-hazardous, nontoxic, and completely chemically inert.

7. Chemical Industry

Fluoropolymers prolong the lifetime of plants and equipment and reduce exposure to workers and environment and increase the overall safety of a plant. Maintenance costs in the chemicals industry are typically around 5% of fixed capital costs. Yearly capital spending in the EU chemical industry has

been around €20bn per year over the last 20 years. Hence, current maintenance costs are estimated in the region of €1bn.

Fluoropolymers (Teflon™ Coatings) & PFPEs (Krytox™ lubricants) are most often used in the following industrial applications

- hoses, sealants, gaskets, and tubing for corrosive fluid handling,
- Lining for heat exchangers or incinerators to protect off-gas emission or to improve energy efficiency,
- transmissions, Conveyor belts, Wire and cable coatings for sensors, high-frequency data cable, and high mechanical strength cables
- Filters systems (filter housing, cartridge, woven filters, etc.) to purify chemicals or filter harsh substances from emission

Way Forward

It is not scientifically objective and even misleading to deal with all PFAS within one restriction process as a group. However, if the sole objective is to gather data from industry, given the complexity of the topic, and increase the knowledge on how and where PFAS are used, then it is reasonable to analyse PFAS as a group.

Fluoropolymers are a sub-set of the PFAS group. For all the reasons described above, these should be exempt from the restriction. They are considered, under the OECD criteria, as Polymers of Low concern and they do not degrade into problematic compounds. In this sense, the fact that they are inert represents no risk to the environment or human health.

The description of the various uses in some strategic sectors lead to no doubt that those **fluoropolymers are essential**. Their special characteristics are unique, and **durability is one of them and key to the functions they fulfil. Any other alternative would have to also be durable and therefore persistent.**

The substances needed for making fluoropolymers (i.e., the monomers) may have some toxicological profiles raising concerns. In fact, the high reactivity of those monomers is needed to make the polymer. Polymerisation aids are needed in the industrial process. HFPO-DA is one of the several Polymerisation aids that replaced PFOA and is not classified as a Carcinogenic, Mutagenic or Toxic for Reproduction (CMR) substance nor an Endocrine Disruptor.

This being, emissions have to be carefully and strictly monitored and reduced as much as possible, taking into account technical and economic feasibility. Chemours is fully committed to follow that path and that is the reason it developed very quickly after its launch, a programme to reduce the emissions of its fluorinated organics by 99% compared to 2017.

Lower emissions can be formalized under the review of the Industrial emissions Directive and Water Framework legislations. Amendments would not take longer than the 5 years needed for a restriction to enter into force.

In conclusion, fluoropolymers and PFPE lubricants are essential to the society, do not pose problem to human health and/or the environment and should be fully exempted from the process. Without fluoropolymers, there will be no green hydrogen, no reduction of carbon emissions by automobiles, no semiconductors in the EU & less innovation in sectors such as medical equipment or even textiles. Fluoropolymers are an indispensable asset for the Green Deal.