FACTSHEET – WHY FLUOROPOLYMERS ARE VITAL FOR DOWNSTREAM SECTORS

Introduction

The competent authorities for REACH of 5 countries, namely the Netherlands, Germany, Denmark, Sweden and Norway are currently preparing an analysis of EU REACH restriction options for PFAS (per- and polyfluoroalkyl) substances as a group.

As part of this work, they have published a call for evidence questionnaire (open until 31 July) to generate data and knowledge on PFAS and their uses in order to decide on which substances and uses should be covered as part of a restriction proposal. The call for evidence further aims at gathering information about whether chemical alternatives or technical replacements exist for PFAS, as well as any voluntary measures or substitution processes that may be ongoing. Following this exercise, it is expected that a REACH Annex XV Restriction dossier will be submitted in 2021.

The country authorities who will be reviewing submissions will be doing so through the lens of the EU Green Deal – reducing waste, reducing carbon emissions, etc.

To help with your input into this call for evidence, we have provided an overview of the multiple applications of fluoropolymers across a number of major industries, in many of which European companies are at the very forefront of innovation. For each industry we further outline the benefits and innovations made possible by fluoropolymers in their various applications.

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AEROSPACE

Europe is a major player in the aviation manufacturing market and a major source of global exports. There are several specialised and highly skilled civil and military aerospace activities in specific Member States. These include fuselage design and assembly/testing, wing design and manufacturing, engine manufacturing, landing gear, fuel systems, helicopters, carbon fibre reinforced plastic components, internal data and power supply systems.

Fluoropolymer Applications	Fluoropolymer Benefits	Innovations
▪ Fuel lines and hoses ▪ Hydraulic systems ▪ O-rings, gaskets ▪ Electronic systems ▪ Coating for a variety of purposes (cables, wires…) ▪ Tapes, wires and cables ▪ Satellites: PTFE can be used as a fuel for satellite propulsion systems (solid fuel instead of liquid fuel) ▪ Exterior surface coatings	▪ Enhance reliability ▪ Enhance safety ▪ Provides durable and effective protection against heat, UV, aggressive fuels, humidity, vibrations, and compression ▪ Weight reduction	▪ Aircraft release film: With its heat resistance, chemical resistance, optical transparency, and non-adhesiveness, release film used in various aircraft applications (composite noise panels, ...). ▪ In-flight connectivity (Electronics): Recent developments enable improved communication and internet access in aircraft with excellent telecommunications and positioning signals without increasing the size/weight of hardware required. This is achieved with cable-based antennas constructed with engineered fluoropolymers and light coaxial cable. Given the reduction in hardware capital costs, it is a cost-effective solution for improving in-flight entertainment.

ARCHITECTURE

The unique combination of properties of fluoropolymers makes them a product of choice for many challenging applications in architecture. Many landmark buildings of the last few decades have utilised these properties.

Specific coating systems can reduce building cooling costs and the associated energy use (by between 4%-22%, depending on colour, geographical location, climate conditions, and substrate type).

Architectural design plays an important role as part of the European "creative industry". Activities in this sector had a turnover of €36.2bn, with some 493,000 jobs (registered architects) in the EU as of 2012.

Fluoropolymer Applications	Fluoropolymer Benefits	Fluoropolymer Innovations
▪ Architectural films. Films from fluoropolymers such as ETFE are used as parts of the roofs in stadia, domes and other structures ▪ Fluoropolymer coated glass fabric roofs, and laminated coatings ▪ PTFE Woven Fabric ▪ Fluoropolymer-based paints ▪ Bridge and offshore bearing pads. Made from PTFE as it has the lowest friction coefficient of all plastics ▪ "Cool Roof" technology	▪ Combination of waterproofing, breathability and comfort (thin and light) ▪ Increased lifetime of the product or building component, even in extreme environments ▪ Reduced maintenance of building structures ▪ Novel architectural designs requiring flexibility and thin materials ▪ Weight reduction of building structures ▪ Improved fire safety - no flame propagation and low smoke generation ▪ Improved energy efficiency of buildings ▪ Non fouling and easy clean	▪ "Signature" buildings: O2 Dome in London, the Sony Centre in Berlin, Eden Project in Cornwall, UK. ▪ Novel design solutions: Wimbledon Centre Court retractable roof, Allianz Arena in Munich with changeable light facade, San Mamés stadium in Bilbao.

AUTOMOTIVE

The automotive industry is of strategic importance to the European socio-economic landscape. It accounts for 6.5% of EU GDP and directly employs around 12.2 million people in Europe. With more than €45 billion invested in R&D annually it is also a true innovator, producing cars that are recognised globally as the best in class for engine efficiency, emissions reduction and safety.

Thanks to the unique set of mechanical, temperature, chemical and dielectric properties of fluoropolymers they are the material of choice for crucial parts and coatings of a number of electronic and functional components used in various automotive applications

As a striking example, modern legal requirements related to road transport emission standards, such as “Euro 6” and “Euro 7” could not have been achieved without fluoropolymers. The Euro emission standards aim to reduce the significant health impacts from road transport emissions, which have been estimated to cause economic costs of about $364 billion in the EU-24 in 2010.

Fluoropolymer Applications

- Turbocharger hoses
- Multilayer fuel hoses
- Hydraulic hoses
- ABS break lines
- O-rings used as seals in fuel containment systems and fuel injectors.
- Shaft seals and valve stem seals
- Air intake manifold gaskets
- Cylinder head gaskets
- Automotive venting products
- Lambda oxygen sensors in exhaust systems
- Reliable Electronic systems
- Wires and cables

Fluoropolymer Benefits

- Lower fuel emissions
- Better fuel economy from weight saving
- Lower exhaust emissions (both carbon and NOx gasses)
- Increased lifetime and reliability of components
- Better engine performance
- Increased comfort (and noise reduction)
- Permits use of alternative fuels (like bio-diesel)
- Increased safety (e.g. through reliable performance of parts)
- Cleaner environment by avoiding leakage (e.g. oil or coolant leaks)

Fluoropolymer Innovations

- Electromobility will be critical tomorrow to fight global warming and resource depletion. Fluoropolymers are key components and enablers for the novel types of batteries and fuel cells that are currently being developed and tested to address this challenge. High performance cathode binders, battery gaskets, fuel cell membranes are just a few critical examples where fluoropolymers are critical.

CHEMICALS AND POWER

12 of the 30 largest chemical companies are based in Europe, registering more than €550 billion in sales in 2014. In addition, a turnover of €2.6 trillion was generated by the power industry. Fluoropolymer-enabled efficiency gains support both sectors.

The unique combination of properties of fluoropolymers are used in corrosion, leak and emission prevention and tight process controls in the chemical and power sectors. This combination of properties allows the European chemicals and power industries to be internationally competitive thanks to their high level of efficiency and environmentally safer operations in harsh environments.

In combined heat and power plants, fluoropolymers could contribute to €8 billion in energy savings annually, based on 2013 Eurostat data and €3 billion in CO_2 emission allowance reductions, based on 2016 prices.

In terms of corrosion prevention each percent of reduction is estimated to deliver €150 million in savings per year. Fluoropolymers play a major role in these savings.

Fluoropolymer Applications	Fluoropolymer Benefits	Fluoropolymer Innovations
▪ Tanks, vessels, pipes, tubing, column packing, heat exchangers, pumps, filters, seals and/or the lining of these components ▪ Power and data cable insulation ▪ Coal burning and waste incinerator heat exchangers and desulfurization units ▪ Battery binders ▪ Chloralkali processes ▪ Nuclear industry fluid handling, filtration and gas sampling	▪ Corrosion prevention ▪ Leak prevention ▪ Chemical emission reduction ▪ Higher uptime, lower maintenance cost and increased component lifetime ▪ Cleaner power plant flue gasses and reduced CO_2 emission ▪ Higher efficiency and production yield ▪ Improved quality and purity of products ▪ Waste reduction ▪ People and environmental safety	▪ Air filtration for gas turbines: highly efficient in capturing virtually all particles even in challenging wet and humid conditions over a long lifetime in comparison to other filter systems. ▪ Mercury Control System for coal-fired utilities: fixed sorbent system for capturing elemental and oxidised gas phase mercury from industrial flue gas containing SO_3. ▪ Fluoropolymer membranes in fuel cells and vanadium redox flow batteries.

COOKWARE

Fluoropolymers have been widely used for cookware and bakeware for half a century. Fluoropolymer-coated cookware provides easy-clean, non-stick properties, saving time, water and energy. This facilitates cooking with less added fat, contributing to a healthy diet.

Fluoropolymer Applications	Fluoropolymer Benefits	Fluoropolymer Innovations
▪ Non-stick cooking articles e.g. pots, pans ▪ Baking products e.g. baking trays, baguette trays ▪ Non-stick baking forms ▪ Baking sheets ▪ Sandwich and waffle makers, raclette, rice cookers	▪ Prevent corrosion because of low surface energy and chemical resistance → increased lifetime of products ▪ Non-stick cooking and avoiding burns →easier cleaning, saving time, water and energy ▪ Dishwasher safe ▪ Less oil needed → reduction of fat/oil usage in cooking ▪ Safe usage at high temperatures	▪ Heat indicator: built right into the non-stick coating of the pan, the heat indicator tells you when your pan has reached the optimum temperature. ▪ The non-stick coating technology is also used in various other household goods → broad improvement in this industry.

ELECTRONICS

Fluoropolymers are essential to the European electronics industry and irreplaceable in the manufacturing infrastructure of microprocessors used in personal, industrial and professional high-tech electronic devices. They help meet the needs of ever evolving design complexities and miniaturisation in semiconductors for a wide range of electronic devices and the data transfer between these devices.
For Europe the annual benefit to semiconductor makers was estimated at €10 billion in 2006 and has been growing ever since.

Fluoropolymer Applications

- Semiconductor and photovoltaic cell manufacturing infrastructure: pipes, vessels, valves, pumps, spinners, filters, seals, fluid storage containers and wafer baskets
- Printed Circuit Board and semiconductor part cushioning, packaging and release film
- Displays, touch screens, copier rolls and paper feeders
- Anti-drip, easy clean, non-adhesive additives for computers and other electronic devices
- Wires and cables used in a wide range of sectors, especially where reliability in aggressive environment and/or high volume data transmission is key**,** e.g**.** medical, data centres, automotive, wireless communication etc.

Fluoropolymer Benefits

- Improved functionality, reliability, affordability and complexity of ever smaller microprocessors for a multitude of electronic components thanks to superior chemical resistance and high purity of fluoropolymer-based manufacturing infrastructure
- Increased component lifetime and Manufacturing cost savings
- Reduced environmental risk
- Excellent dielectric properties up to medium voltage
- Improved performance of high-volume data transmission, better connectivity, hardwired and wireless
- Improved reliability of electronic systems that control a majority of safety critical operations in industrial use
- Improved fire safety

Fluoropolymer Innovations

- Internet of Things: Fluoropolymers have contributed to breakthroughs in microprocessor wafer size increases, node reductions and processing efficiencies that were needed for connecting billions of “things” to the internet.
- Fluoropolymer cable constructions with excellent dielectric properties comply with demanding high-volume data transfer and fire safety specifications of data centers, e.g. cloud centers.
- Mini and micro coax cables for a multitude of wireless communication solutions

FOOD & PHARMA

Fluoropolymers are useful for crucial components in food and pharmaceutical production as well as packaging to enable quick and flexible processing, safe storage and ensuring the highest purity and hygiene standards are met. In the European biopharmaceutical industry alone, €270 million was saved between 2008 and 2012 alone due to increased prevention of contamination and material failure in biopharmaceutical manufacturing.

Fluoropolymer Applications	Fluoropolymer Benefits	Fluoropolymer Innovations
▪ Lining of valves, piping, tubing, filters, seals, gaskets and other standard fluid handling components ▪ Lining of mixing vessels and tanks ▪ Coating on processing belts ▪ Labware ▪ Medicine Packaging ▪ Items that need sterilisation	▪ Increased lifetime of components ▪ Lower cleaning and maintenance costs ▪ Increased productivity by enabling production of multiple products with the same equipment, reducing failures and improving flow of process substances ▪ Higher production yields and quality from improved purity of process substances ▪ Health benefits from high purity and hygiene standards, lower health risks from cross contamination and avoiding over / under dosage of pharmaceuticals ▪ Lower levels and risk of exposure of workforce and environment to chemicals, including avoiding leaks ▪ Prolonged preservation of the product ▪ Combination of steam, heat, chemical and UV resistance enable efficient sterilisation	▪ Development of a new High Efficiency Dry Powder Inhaler - Coating the inhaler and capsule with PTFE significantly increased the emitted dose.

MEDICAL APPLICATIONS

Thanks to the unique combination of their properties fluoropolymers enable an excellent performance and long lifetimes in medical equipment such as surgically implantable medical devices, catheters, guide wires, filters and pumps.
They contribute to the reduction/avoidance of medical complications and additional or repeated medical care, hence contributing to pain avoidance and the public costs of medical care.

Fluoropolymer Applications	Fluoropolymer Benefits	Fluoropolymer Innovations
▪ Surgically implantable medical devices such as vascular grafts ▪ Heart patches ▪ Catheters ▪ Diaphragm pumps ▪ Membranes for filtering and venting purposes ▪ 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) ▪ Sterile container filters, needle retrieval systems, Tracheosto, catheter guide wire for laparoscopy, valves, fittings, pumps, tubing and medicine inhaler canister coatings	▪ Reduced risk of cross-infections and thus medical complications and the associated pain and public costs ▪ Increased lifetime of implants reducing risk of failure and risk of replacement ▪ Allows tissue attachment and cell adhesion without an adverse reaction due to the biocompatibility of Fluoropolymers ▪ Higher consistency of dosages, increasing effectiveness and safety of drugs ▪ Less frequent clogging and thus less frequent re-application/replacement for the patient ▪ Improved functionality of medical equipment (e.g. filtering and venting) ▪ Facilitates non-invasive surgical procedures with guidewires ▪ Facilitates miniaturisation for keyhole survey	▪ Membrane for heart defects: a permanent implant consisting of a wire frame covered with a thin ePTFE membrane. The wire frame is made of a platinum-filled nickel-titanium (Nitinol) alloy. ▪ Endoprosthesis for the functionality of damaged liver: The proprietary, reduced permeability ePTFE graft lining minimises transmural permeation of bile and mucin (which are common causes of patency loss) and minimises tissue ingrowth into the graft for ease of surgical dissection during liver transplantation

RENEWABLE ENERGY

Europe is at the forefront of the development and the use of renewable energy and has one of the most ambitious goals for the future in this respect. Europe is a leading market in photovoltaic as well as in wind energy. France and Germany are leading in geothermal energy.
Fluoropolymers combine properties that help to improve components of renewable energy.

Fluoropolymer Applications	Fluoropolymer Benefits	Fluoropolymer Innovations
▪ Photovoltaic: o Front sheets: protected by fluoropolymers, provide weather resistance, ultraviolet blocking, optical transparency, fire resistance o Back sheets: improve electrical insulation, protection from weathering and chemicals o Vents: fluoropolymers are used e.g. in junction boxes ▪ Wind turbines: o Control centers for offshore wind parks o Paints and coatings: long term protection against weathering to increase product life, extend maintenance cycles o Release film: support production of composite turbine blades esp. for offshore turbine PTFE bearings ▪ Fuel Cells and flow batteries: o Ionomer exchange membranes o Energy storage: used as a component e.g. binders which provide chemical, heat and oxidation resistance, and long-term storage of renewable energies and stationary energy storage	▪ Excellent chemical, corrosion and abrasion resistance; low and high temperature resistance → increased lifetime of components (fuel cells, batteries, photovoltaics etc.) ▪ Lower maintenance costs ▪ Increased efficiency in manufacturing processes ▪ Enabling sustainable energy and facilitating remote location of installations ▪ Design flexibility	▪ This is a dynamic area in a constant innovation mode with fluoropolymers a key enabler. Specific example would be high voltage batteries, flexible PV front sheet and high durability fuel cells.

TEXTILE

Fluoropolymers provide a combination of waterproofing, breathability as well as lightness and thinness to clothing and footwear.
Textiles and clothing are an important sector in Europe, some 174,000 companies were active in this sector in the EU in 2013 with a turnover of almost €170 billion and employing 1,700,000. Small and medium enterprises (SMEs) are the backbone of the European sector, over 90% of textile companies have fewer than 50 employees and producing almost 60% of the sector's value added.
Fluoropolymers also provide unique properties for the treatment of organic waste as well as for industrial filtration.

Fluoropolymer Applications

- Jackets, trousers, gloves and footwear for private and professional use with increased comfort and performance
- Aerospace suits
- Outdoor applications like awnings, umbrellas, furniture, boat covers and sails
- Fabrics with ePTFE membrane are a key component for a composting solution for the treatment of organic waste (green waste, food waste, source separated organics, biosolids or Municipal Solid Waste - MSW)
- Industrial filtration and gas sampling to prevent emissions in the chemical and power sectors
- ePTFE sewing thread, fibers and weaving yarn are used in demanding environments and high-performance ropes

Fluoropolymer Benefits

- Combination of waterproofing, breathability and comfort (thin and light)
- Increased lifetime of the product or building component, even in extreme environments
- Increased lifetime of the finished product
- Facilitates composting
- Non fouling and easy clean
- Chemical emission reduction

Fluoropolymer Innovations

- A lightweight, breathable and waterproof fabrics system using two ePTFE membranes that delivers high levels of thermal protection in firefighter gear while reducing the risk of burn injuries and heat stress in wet and dry conditions.
- Air filtration for gas turbines: highly efficient in capturing virtually all particles even in challenging wet and humid conditions over a long lifetime in comparison to other filter systems.