Part 1: 3P activity with fluoropolymers

3P Performance Plastics Products is an innovating French group with an international focus. We are developing and manufacturing inventive solutions in high-performance plastics for the most critical applications of demanding industrial markets such as aerospace, automotive, energy, or chemistry.

With subsidiaries in Europe, Asia and in the USA, 3P is able to transform numerous plastics materials, mainly fluoropolymers and PTFE, to create technical components with unique specificities.

PTFE is a polymer of low concerns by the OECD standards that displays a unique combination of properties that cannot be found in other materials.

- Thermal stability
- Electrical insulation
- Low friction
- Self-flame retardant
- Biocompatible / non toxic
- Durable

Please find below the markets information that lead us, 3P, to request a full exemption of fluoropolymers, and especially PTFE, from the ongoing PFAS restriction study.

		Why are we currently using PTFE? PTFE properties						
		Chemical inertness	Thermal stability	Electrical insulation	Low friction	Self-flame retardant	Biocompatibility / non-toxicity	durability (over time)
Where are we using PTFE? Markets and applications	Aeronautics	X	X	X	X	X		X
	Automotive / Railway	X	X		X	X		X
	Energy	X	X	X	X	X		X
	Communication		X	X				X
	Chemical industry	X	X			X		X
	Foodstuff	X	X	X			X	X
	Healthcare	X			X		X	X

I) Aeronautics

In aeronautics, fluoropolymers are used as security parts, especially for electrical insulation applications for flight control commands (cable insulation). Replacing PTFE by alternatives would lead to a consequential reduction of flight safety.

Fluoropolymers are also used whenever sliding and durability properties are needed, for instance for the flap and slat technology of airplanes. This enables huge fuel consumption optimization during take-off, flight and landing procedures.

The chemical inertness properties of PTFE is usually exploited for fluid handling, especially for gas hoses. In addition to this, PTFE mechanical properties, heat resistance and flame-retardant make it a central material in handling safely critical fluid in planes.
PTFE low coefficient of friction also ensure high flow rates in new low consumption engines.

Potential alternative(s):

- **Electrical insulation:** Other materials are already being used to insulate electrical cables. Silicone, Polyethylene, PVC… However, they usually are either not performant enough (in terms of electrical insulation), or are not even PLC according to the OECD. For instance, the PE is not flame retardant.

  Additionally, these “potential” alternatives being considerably cheaper than PTFE, would already be used if they satisfied the safety requirement of modern aircrafts.

- **Gliding properties**: other polymers have gliding properties comparable to PTFE. It is the case of polyethylene. However, this polymer is not flame retardant, and could propagate flames. Moreover, polyethylene is much less resistant to UV light, especially when they are not filtered by the atmosphere, in high altitude.

  This does not rend this material totally not usable, but it would imply some additional maintenance, plastic wastes and energy consumption.

- **Fluid handling**: While existing polymers (silicones, polyurethanes) tubes could not be used for fuel hoses for safety reasons (flammability, chemical resistance…), the most immediate alternative to fluoropolymers in fuel hoses would be metal, which was the historical technical solution.
  Metallic tubes would mean heavier assembly and would increase the craft gas consumption.

II) Automotive

For automotive applications, PTFE is used to reduce friction and improve engines efficiency. Replacing PTFE would lead to more consuming engines (both gas and electric), due to frictions. Several PTFE parts are safety related, for instance motorbike brakes or in ESPs.

It is additionally impossible to design a battery for electric cars without fluoropolymer membranes (usually PVDF-HFP). The same goes for hydrogen fuel cells, where proton exchange membranes properties can exclusively be reached with fluoropolymers (usually FKM).

Potential alternative(s):

Polyethylene is often named as an alternative to PTFE for dynamic seals applications. Its good gliding properties and high stretchability would make it a suitable replacement of PTFE. However, its much lower thermal resistance would lead to more maintenance and part change (or oil and polluting fluid release in the environment when the part is worn out).

For applications above 100°C, like in the engine compartment, polyethylene would not even be suitable at all.

Other highly thermally resistant material could not be equivalent of PTFE, due to their high coefficient of friction (PI, polyphenylenes…). More friction would decrease the efficiency of the engine, and increase fuel consumption.

Other alternatives composed of polyolefins (High molecular weight polyethylene) could also be considered, but with lower durability, especially to temperature, and would need frequent maintenance and replacement.

III) Energy

PTFE and fluoropolymers also are integrant parts of alternative energy sources, coatings for solar panels, low friction coating of wind turbine blades…

Potential alternative(s):

To our knowledge, there are no alternative to PTFE for this application.

IV) Communication

PTFE as the lowest dielectric constant of all materials, except for air and vacuum. Dielectric constant, also known as relative permittivity, is the key characteristic for high frequency data transmission, and inevitable in 5G applications and IOT.

Potential alternative(s):

To our knowledge, there are no alternative to PTFE for this application.

V) Chemistry

PTFE is exclusively composed of carbon and fluorine atoms (the carbon-fluorine bond being the most energetic and strong bond in organic chemistry). Therefore it is extremely resistant to most chemicals, especially strong acids (nitric, sulfuric).

This is why PTFE is used to coat chemical tanks for aggressive chemicals.

Potential alternative(s):

Other materials exhibit high chemical and thermal resistance, such as ceramics and noble metals. In many cases, they are however not suited due to feasibility or safety reasons.

Glass coated tanks and chemical reactors already exist, but the temperature must remain relatively stable or cracks will appear in the glass coating (difference of coefficient of thermal expansion between glass and metal). PTFE has elastic properties that can withstand the metal deformation, while still protecting it from the corrosive chemicals.

Noble metal coating would rise other pollution concerns, since this process involves the cyanide salt of the metal.

VI) Foodstuff

PTFE and globally fluoropolymers are high purity polymers, from which there is no migration of chemicals even at high temperatures. Most of these polymers are compliant to food contact norms such as EU10/2011.

Potential alternatives:

Amongst alternatives for alimentary fluid transportation, the principal known alternatives are silicone and polyurethanes tubes.

Silicone could be used in some low requirement cases, considering they do not contain plasticizers or mobile small molecules. Polyurethanes are however well known for their terrible thermal and hydrolysis resistance. Using PU tubes in hot and / or watery applications would lead to a depolymerization of the tube, generating isocyanates (almost all known as carcinogenic and/or toxic to humans). These materials already are regulated by REACh Annex XVII, for instance entry 74**.**

VII) Healthcare

Due to their outstanding biocompatibility and non-toxicity, PTFE and fluoropolymers are widely used in healthcare applications. Most PTFE grades comply with medical contact norms, such as USP Class VI, or oxygen resistant applications (norm BAM). PTFE coated stents for arterial implants are recommended by the French national health comity (Haute Autorité de la santé)

https://www.has-sante.fr/upload/docs/application/pdf/2018-06/avis_du_15_mai_2018_endoprotheses_coronaires_couvertes__stents_couvertes_de_ptfe.pdf

Part 1 Conclusion

In all cases, the parts manufactured by 3P are used for their durability. The part lasts longer, therefore reducing maintenance.

Hence, the use of PTFE in these applications avoids using raw materials and energy to remake the worn out part, as well as the maintenance itself (especially for big remote parts, for instance offshore wind mill blades and components).

PTFE parts are wildly used in safety applications (Electrical insulation, flame retardant, brake systems…).

They are essential for future technologies (5G, IoT…) and renewable energies (Solar, wind…), in which 3P is actively involved.

It is also important to note that in all cases the substitution of PTFE should not even be considered, since PTFE is a safer and cleaner solution that its alternatives.

Part 2 : End of life :

Due to its extreme stability and durability, PTFE is difficult to recycle.

However, pure PTFE (without filler) can be grinded back into a processable powder called "reprocessed PTFE".

The recycling yield of 3P PTFE wastes is approximately 24%.

All plastics included, the average percentage of recycling of plastics is around 15%.

Considering the high price of PTFE (PTFE price ~15x polyethylene), recycling opportunities are developing very fast. For instance, several works are in progress to reuse incineration outgassing to regenerate close to 100% of PTFE wastes.

It has also been extensively proven that PTFE and fluoropolymers usual incineration methods do not break down the long polymer chains into small PFAS.

It is the case of the study *Waste incineration of Polytetrafluoroethylene (PTFE) to evaluate potential formation of per- and Poly-Fluorinated Alkyl Substances (PFAS) in flue gas*, Krasimir Aleksandrov and al., which final conclusion is "*municipal incineration of PTFE using BAT is not a significant source of studied PFAS and should be considered an acceptable form of waste treatment*".

Above 800°C, no PFAS are generated by PTFE incineration.

Because of its extremely large polymer chains, and their impossibility to degrade under normal temperature and pressure conditions landfills are completely safe way to dispose of PTFE.

Since the degradation of organic materials over temperature follow the exponential law of Arrhenius, the degradation of PTFE in air at + 50°C is basically inexistent. According this kinetic law, it would need 10^{22} years for 25ppb of the PTFE to degrade, thus potentially not conforming to the current Annex XVII of REACh.

Socio-economic impact

For society

Most of new technologies aiming for more efficient and more eco-friendly would be impaired in Europe (Hydrogen, semiconductors, electrifications, alterative power sources (wind/solar)).

This would nullify the billions of euros of subventions to these sectors, and be a setback of at least 50 years for society, without the insurance of finding alternatives.

In the light of the aforementioned information, we, 3P Company, ask for a complete exemption of fluoropolymers, and especially PTFE, from the PFAS restriction.