ECHA comment

6 / Information on alternatives and socio economic impacts for missing uses and resulting emissions

Aircraft wires

Direct import of our products constitute approximately 10 Tons of fluoropolymers per year for this application. Such products are used by all aircraft and aerospace wire manufacturers globally. We are using fluoropolymers because they are required within the specifications of our customers and end-users (aircraft wire producers and aircraft manufacturers) An example of a part of the specification can be found here:

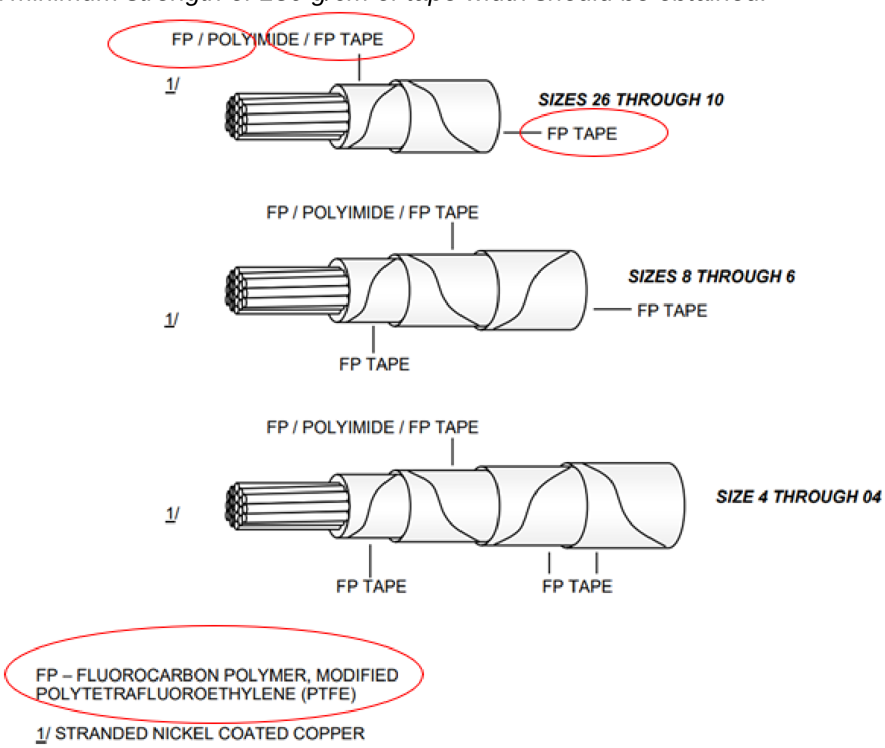
7.5. Adhérence du revêtement PFA sur le film polyimide / *PFA coating adhesion on polyimide film*

A sample is prepared by overlapping on an approximate length of 20 mm, 2 identical tapes and by welding the tapes under a pressure of 1.4 daN/ cm^2 at 350°C.

The test aperture should be maintained at these temperature and pressure during at least 20 seconds.

After cooling, minimum strength to separate the tapes measured under traction with a 300 mm/mn speed.

A minimum strength of 180 g/cm of tape width should be obtained.



From AS 22759/87 slant sheet specification

One of our specifications from wire manufacturers for aircraft wires (full) will be uploaded in the confidential section 5. Similar specifications obliging us to use some form of PFAS are available for more products from more customers and endusers.

According to our knowledge the fluoropolymers are needed for the aircraft wire quality and the aircraft's safety.
In order to assure the safety of air transportation those cables are strictly made under specifications like ASD-STAN (Aerospace standards in Europe including the specification to use FP or property norms like EN2275 and EN3475), SAE22759 specs, ASTM D5213,…. These norms cover e.g. following required properties for the cables:

- Temperature resistance from -55°C to + 260°C
- Light weight and thin to achieve weight and dimensional criteria
- Electrical resistance
- Accelerated ageing and thermal endurance (60.000 h at 260°C)
- Thermal shock
- Delamination at 310°C
- Bending at ambient temperature and cold temperature (-65°)
- Fire resistance
- Chemical resistance
- Cut through and scrape abrasion
- Torsion at 260°C and 310°C
- Cable to cable abrasion (2.800.000 cycles which need a low coefficient of friction)
- Flexural endurance
- Smoke density
- Toxicity
- Arc track resistance (both wet and dry)

Even when the polyimide gives several properties needed to achieve all necessary requirements, the fluoropolymers are needed for other properties. Due to the chemical nature and the properties of the fluoropolymers there are no known alternatives today. Below publication discusses the needs of PFAS in aircraft wires.

Quote : Cefic's FFP4EU published reasons regarding the importance of fluoropolymers for electrical aircraft wires. Link: [The importance of electrical cabling, and why this requires PFAS - FPP4EU]

The importance of electrical cabling, and why this requires PFAS

To transmit electric power or telecommunication signals from one place to another, electrical cables are needed. A typical modern aircraft may contain between 150 and 250 km of cables installed. These cables group together multiple conductors within a sheathing and are used in various industrial sectors.
When it comes to the aerospace industry, both air and spacecrafts need high performing electrical cabling under very demanding conditions. The electrical cables are often insulated with fluoropolymers, due to their small dimension.
PTFE (Polytetrafluoroethylene), FEP (Fluorinated ethylene propylene) and ETFE (Ethylene tetrafluoroethylene) have strong electrical and resistance properties, fire and flame retardancy, retention under a wide range of temperatures, and exposure to specialty fuels that may be chemically aggressive. Cables need to be flexible and resistant to high as well as low temperatures, which can go as low as -70°C.

If the flexibility requirements are not met, cables can turn rigid and there could be a breakdown risk that may result in a system failure, possibly compromising aircraft safety.
The exceptional dielectric properties provided by fluoropolymers allows for cables insulated with these materials to be very thin. Less weight improves the agility and speed of aircrafts and reduces the amount of fuel required. Moreover, fluoropolymers provide exceptional protection against the electric arc effect, which occurs when an electric field is created over normally nonconductive material, causing an electric breakdown of the material, increasing the conductivity in the medium. This is a serious fire threat which needs to be avoided when aircrafts are in operation.
Unquote.

There are even some serious doubts if alternatives are available. Enough articles can be found regarding the need and the advantages of fluoropolymers in the aircraft industry :

- https://fluoron.com/the-five-ways-fluoropolymers-can-benefit-a-passenger-aircraft/
- https://fluoron.com/the-benefits-of-fluoropolymers-in-aerospace-engineering/
- https://fluoropolymers.plasticseurope.org/application/files/4916/5286/4754/Fluoropolymers_Product_Group_Newsletter_April2022.pdf : The irreplaceable role of fluoropolymers in the aircraft industry (April 2022)
- https://thisisplastics.com/plastics-101/fluoropolymers-do-what-other-materials-cant/

For aircraft wires we use following properties of the fluoropolymers:
- Durability
- Temperature resistance
- Flexibility
- Low coefficient of friction for abrasion resistance
- Chemical resistance
- Low off-gassing (outgassing)
- Low dissipation factor and dielectric constant
- Arc track resistance
- Low weight
- Non-flammability
- Adhesion properties
- Etc.

Magnet wires for traction motors for trains

Direct import of our products constitute approximately 5 Tons of fluoropolymers per year for this application. The main reason to use polyimide with fluoropolymer adhesives is the continuous use temperature in locomotive motors reaching 200 to 260 C. Glass fibers, aramid papers, silicones, mica or pure polyimide without fluoropolymers can be used but the insulation will have to be much thicker and the motor design will be different due to the lack of an adhesive. Costs will increase due to more insulation needed, life time of the motors will decrease (more rebuilds leading to more waste), and efficiency of the motors will also decrease. All these changes will have to get approved which will take several years. Under such a scenario it is possible that the market will need to go back to DC motors which are heavier and larger, less powerful, less durable and more difficult to maintain. The design requirements for the AC motors of today specify a polyimide insulation with a fluoropolymer adhesive.

Another possible alternative would be to develop a thermoplastic polyimide adhesive which can replace the fluoropolymer. This would be a new technology and will have to be developed from the start to get an acceptable configuration for traction motors. It will double the cost of the insulation and will, including the long term testing of the motor, clearly take more than 5 years to implement.

A ban on fluoropolymers could lead to the disappearance of the train industry in Europe, eventually to the disappearance of trains since in the current production processes many fluoropolymers are used. In the best case scenario the European train industry will become non-competitive leading on the long term to a similar result.

Even for new developments for the train industry like the hydrogen powered trains or battery operated trains, the ban on fluoropolymers will set such developments back with several years.

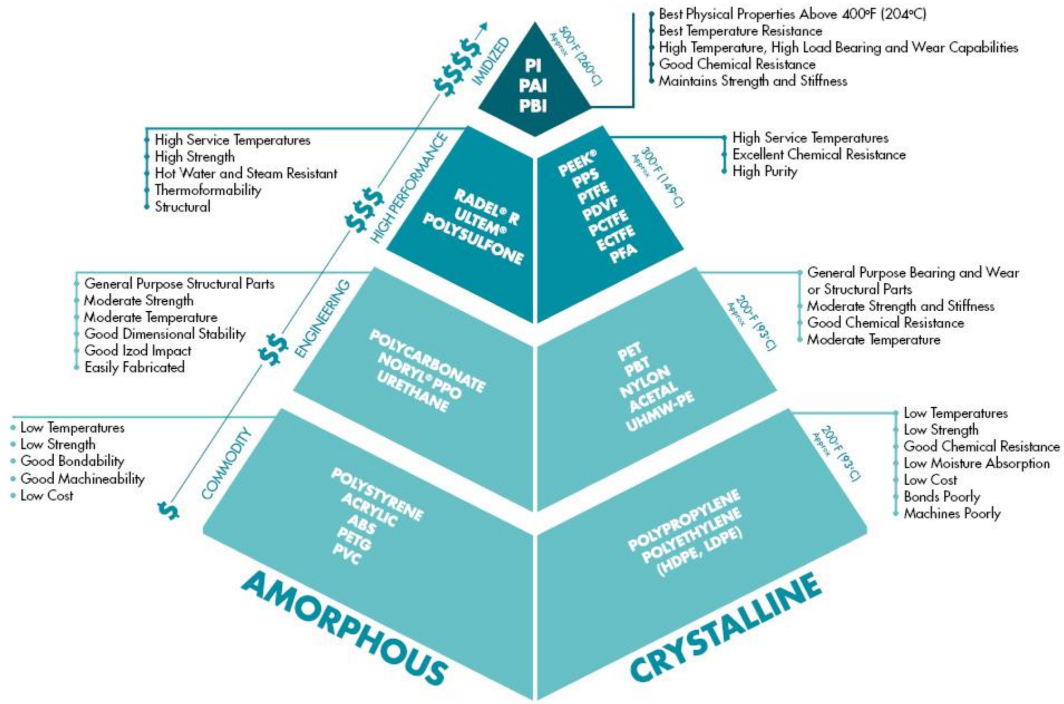
Other applications like EV

For all of these applications fluoropolymer / polyimide combinations give also here unique properties which cannot be found today compared to listed alternatives, such as thermal resistance, mechanical properties, good dielectric strength and light weight.

General

All these properties come from the very strong Carbon – Fluor bond. This is chemically the strongest bond possible which makes it difficult to replace these materials. Today, to our knowledge there are no alternatives available (difficult to prove something does not exist) and the development for such alternatives will take time. This development will be followed by another 7 years of approval and testing procedures. It is very doubtful that anyone find better alternatives (due to the chemical nature of the fluoropolymers with the C-F bond) in the short term. In order to develop more or less suitable alternatives it could take maybe 10 years followed by the testing and approval procedures.

It results in a unique place within the polymer pyramid.



Alternatives to replace the fluoropolymers as adhesives, show much lower overall characteristics, like e.g. life expectancy in the application. Some alternatives mentioned in the ECHA PFAS regulation are :

- Silicone materials : not usable for us due to a risk of contamination of other products. This would mean we have to build another factory to keep the products with and without silicones separate (see appendix 3). Additionally it is very doubtful that we can cover the full range of properties required for aircraft cables with the current available silicone resins. And there would still be a risk of contamination in further production steps down the supply chain up to the final application in the aircraft. Major studies will be needed and time for approvals would be very long. It would not solve the need to use extra layers of fluoropolymers (as per specification from the aircraft manufacturer), and may even require more layers than used today, increasing the total volume on aircraft wires needed for the arc track resistance.

  Below are reasons why silicones are a concern for contamination:

  Manufacturers are generally concerned about silicone contamination in production processes for several reasons:

  1. Adverse Effects on Product Quality: Silicone contamination can have a detrimental impact on the quality of manufactured products. Silicone is known for its low surface energy and nonstick properties, which can cause issues such as poor adhesion and compromised bonding between materials. In industries like automotive, electronics, aerospace and medical devices, where precise and reliable manufacturing is crucial, even the smallest amount of silicone contamination can lead to product failures or malfunctions.

  2. Difficult to Remove: Silicones are resistant to many solvents and cleaning agents, making it challenging to remove once it contaminates a production line. It can adhere strongly to surfaces, forming thin films or residues that are difficult to eliminate. The presence of silicone

contamination may require thorough cleaning through specialized treatments, or even replacement of affected components or equipment, leading to increased costs, production delays, and potential waste.

3. Cross-Contamination Risks: Silicone contamination can also lead to cross-contamination issues. If a manufacturing facility produces multiple products or components simultaneously, silicone residues can transfer from one product to another, compromising their intended properties. This can result in product failures.

4. Impact on Manufacturing Processes: Silicone contamination can disrupt various manufacturing processes. For example, in electronics assembly, silicone residues can interfere with soldering, impairing the reliability of electrical connections. Such process disruptions can lead to rework, scrap, or even production line shutdowns, impacting productivity and profitability. A silicone contamination could therefore also lead to poor connections between aircraft cables.

5. Regulatory Compliance: Many industries have strict regulations and standards regarding product quality, safety, and environmental concerns. Silicone contamination may violate these regulations and expose manufacturers to legal liabilities, fines, or damage to their reputation. Compliance with industry standards requires manufacturers to maintain clean and controlled production environments, minimizing the risk of silicone contamination.

6. Silicones can migrate very easily. Through human contact or even by air streams increasing the need for separated units to avoid cross contamination.

To mitigate these concerns, manufacturers implement stringent quality control measures, establish proper handling procedures for silicone-containing materials, enforce cleanliness protocols, and conduct regular testing and inspections to prevent and detect silicone contamination during the production process. Generally production lines using silicones are physically strictly separated from other production lines.

Literature:

- Edward M. Petrie, North Carolina State University, July 2013 : https://www.researchgate.net/publication/259092407_Addressing_Silicone_Contamination_Issues
- Edward M. Petrie, March 2013 : https://www.techsil.co.uk/media/wysiwyg/Blog-PDFs/White-Papers/Silicone_Contamination_white_paper.pdf

- PEEK : once above 143 C (glass transition point) the dielectric breakdown point reduces very quickly. The product is also too stiff to be used in its current form for aircraft wires. It would also require totally new production processes leading to the ban of existing factories and the need to invest in new technologies and production plants.
- Alkyl acrylates : not enough temperature resistance, fire resistance, etc.
- PU, acrylics and epoxy adhesives : not enough temperature resistance, fire resistance, arc resistance, etc.

There is a paragraph in the electronics chapter for wires and cables for the electronics industry for, e.g., heating cables. However the aircraft wires cannot be considered as pure electronic wires and no derogation is proposed regardless. The alternatives which are mentioned, such as PEEK, PC or even EPDM, cannot be used to fulfil the above mentioned requirements due to several requirements they cannot fulfil like e.g. temperature resistance, flexibility, thermal endurance, adhesion, arc tracking,… Additionally, aircraft wires should belong in the transportation sector since they are at the start of all aircraft manufacturing and aerospace applications.

All mentioned alternatives in the reports have one major advantage: they are generally a little to a lot cheaper than the polyimide with fluoropolymer films. But they would certainly jeopardize the lifetime expectancy which means that technical compromises would have to be made which would lead to a reduced useful life time and reduced safety of the aircrafts. Alternatives showing no or a minimum on property loss will increase the cost.

Therefore all of our products should continue to be treated as an article and not as a chemical.

The socio-economic impact

The socio-economic impact of a ban of the fluoropolymers in our products would be major. This despite there being evidence that the environmental impact of the polyimide with fluoropolymer films is very weak over the total life time of the application. It is clear that a total ban of such products would lead to downstream production stops for the whole supply chain and eventually the impossibility to have any aircraft built or left in Europe. A total ban could lead up to 130.000 direct losses of employment at the aircraft manufacturers with an additional 400.000 to 500.000 positions lost in the rest of the supply chain. Your own figures mention an industry loss of 130 billion Euro per year. Using some alternatives leading to technical compromises could lead to aircraft with higher fuel consumption, decreased lifetime of the aircraft (increasing the total waste balance), increased risk and reduced safety for passengers and the airline transport industry in general, and have a major impact on the daily life of people when aircraft and aerospace industry disappears.

Another huge impact would be in the train industry (both long and short distance trains). Even though it would likely be easier to identify alternatives there, there would still be a cost and/or quality degradation leading to a weaker position of the European rail industry, with a worse-case scenario of the total disappearance of trains since they all contain much more than 25 ppb of PFAS.

The global market for traction motors is around 11 billion US$ in 2022. Approximately 1/3 is for Europe. Several traction motor producers such as ABB, TSA, Bombardier, Alstom and Siemens would be impacted by the fluoropolymer ban. The following link gives more information regarding the traction motor market: https://www.factmr.com/report/railway-traction-motors-market

The socio-economic impact for the specialty cable area is relatively small but could have major repercussions if certain applications can no longer be made due to the missing cables. It is, however, too difficult to evaluate the economic impact in such a short time frame. Similarly the developments for the EV market not taking place could see a major delay in the development of better performing EV's.

The same reduction or socio-economic impact could actually happen if, due to a fluoropolymer ban, there no longer were enough fluoropolymers on the market (see announced stop of 3M). Alternatively, we and other manufacturers may have to abandon operations if we can no longer be profitable due to increased costs or loss of volumes to the European market. Additionally if our products (today considered articles) have to be registered under Reach this could have such a cost effect that we would be obliged to close our plants in the US, leading to the impossibility of supplying the aircraft wire manufacturers. Without enough quantities of aircraft insulation, there are no aircraft cables. Without aircraft cables, there are no aircraft. And that could be the case even where there is some type of time limited derogation.

Due to the uncertainty regarding our European business we decided to stop all investments regarding polyimides with fluoropolymers. This not only impacts our own factory, but has also negative effects on our customers through loss of deliveries and potential supply chain disruptions. Again, this regulation may oblige us to close our plant even in the case of a time limited derogation and/or Reach approval process.

The direct impact on our business would be in the range of 15 to 20 million USD/year, potentially up to 40 million USD in case of closure with a loss of around 60 employments.