Verband der Automobilindustrie

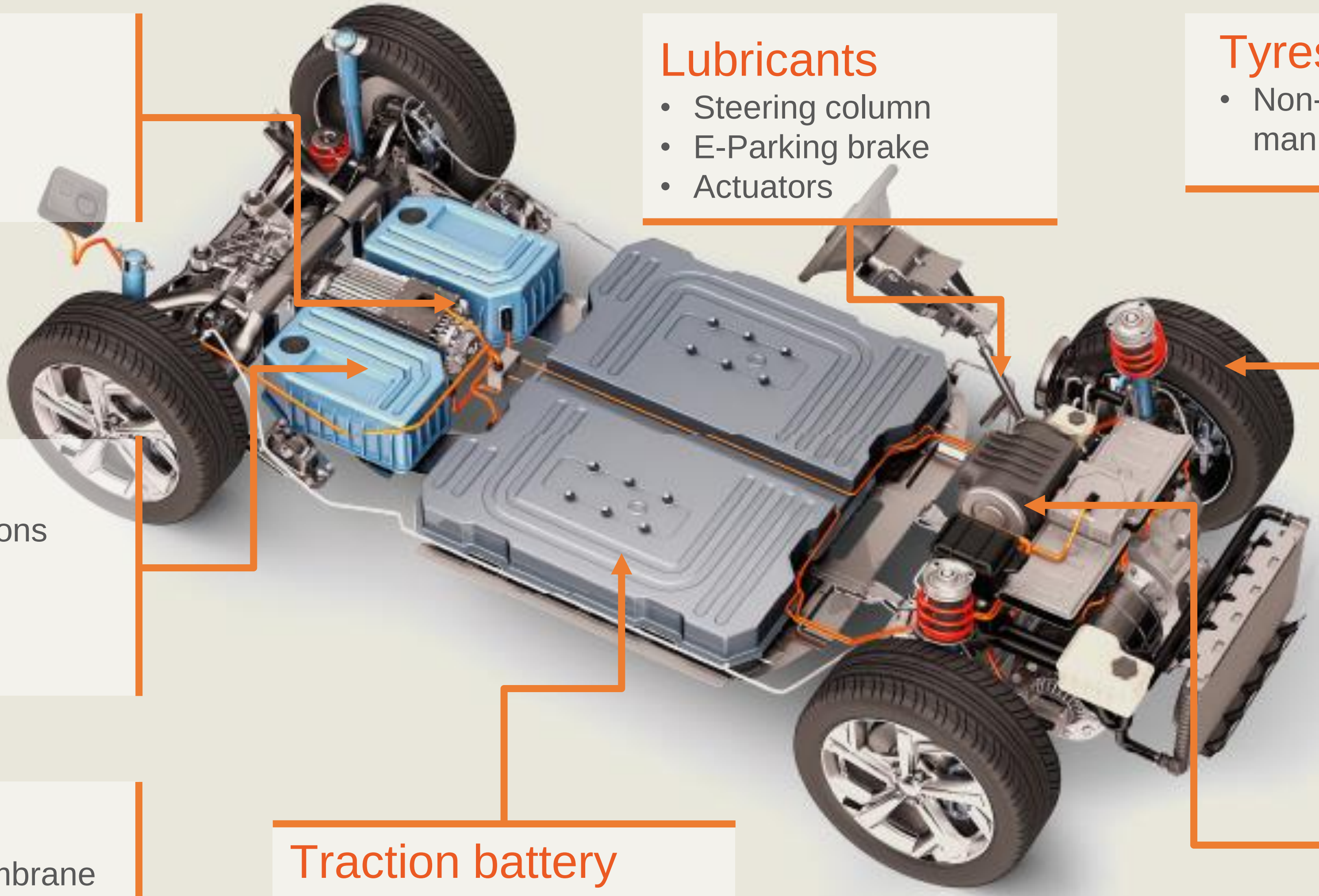
PFAS in the Automotive Industry

PFAS containing technologies for the EU path to a climate neutral society based on the European Green Deal

Juli 2023

Examples for PFAS Applications in Vehicles

VDA



Elastomers
- Seals
- Hoses
- Diaphragm

Lubricants
- Steering column
- E-Parking brake
- Actuators

Tyres
- Non-stick coating in manufacturing process

Electronics
- High-voltage applications
- Sensors
- Controllers
- Semiconductors

Fuel cell
- Proton exchange membrane
- Electrodes
- Gas diffusion layer

Traction battery
- Binder
- Adhesive layer

Air condition
- Refrigerant

Source: VDA

Hydrogen

Fuel Cell & Electrolysis

- PEM stacks are the centerpiece of fuel cells and electrolyzers. Stacks consist of hundreds of identical cells, the core component of which is the membrane electrode assembly (MEA).
- PFAS polymers (PFSA and PTFE) in MEAs are essential for the function and durability of the cells.
- PEM fuel cells and PEM electrolysis cannot be realized without PFSA and PTFE at present or in the foreseeable future.
- A closed return/recycling system is already ensured due to the platinum and iridium content of the PEM.
- Emissions in the utilization phase are at or below the detection limit according to current knowledge.
- Any almost equivalent PFAS-free substitute will in turn be persistent.
- The automotive industry is planning significant investments in PEM fuel cells and electrolysis with R&D and production largely in Germany.
- PFAS restrictions without exemptions jeopardize investments in Germany and the EU as well as the ramp-up of the hydrogen economy as a pillar of the EU Green Deal.

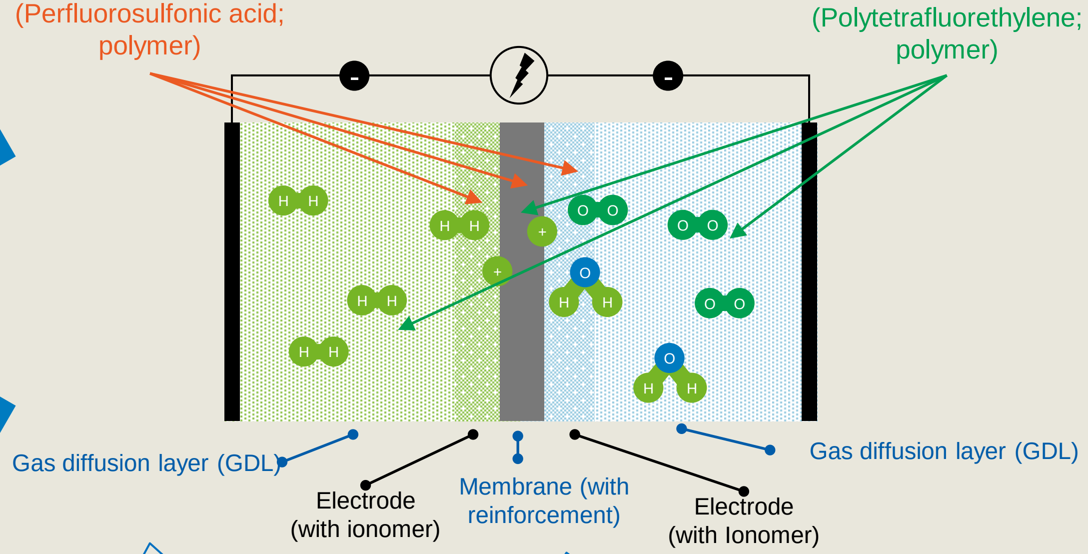
Products

PEM fuel cell stack

PEM electrolysis stack

Membrane Electrode Assembly (MEA)

schematic



Known Alternatives

PTFE-free GDL:
- × Performance approx.. -50%

PTFE & PFSA-free membrane:
- × Performance approx. -30%
- × Service Life ↓↓

PFSA-free electrode:
- × Performance approx. -60%
- × Maximum TRL3

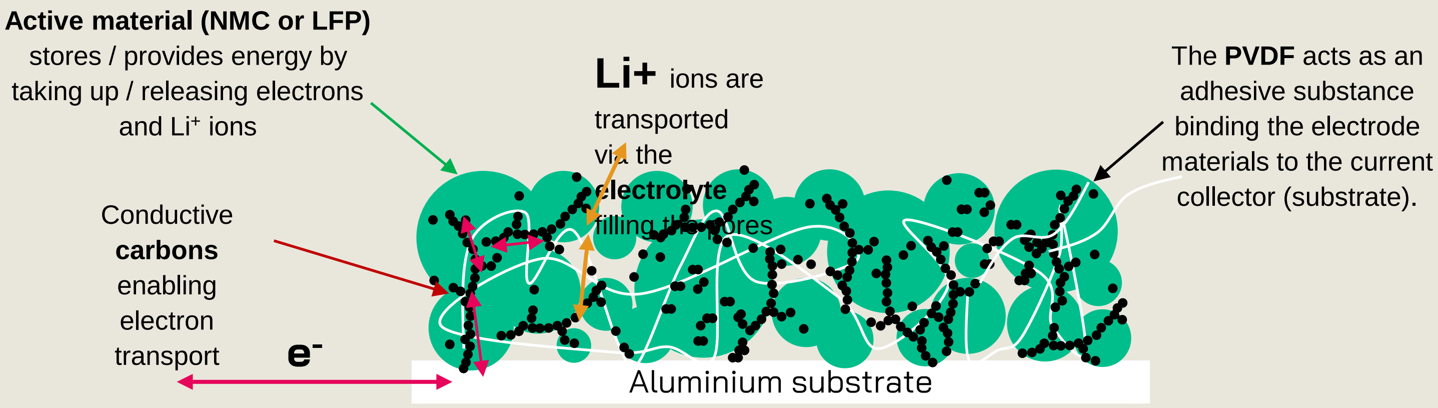
Material	Characteristics	Alternatives
PFSA	• Proton conduction • Minor swelling due to water • Chemical stability	• Elektrodes (Ionomer): no PFSA free commercially available
PTFE	• Mechanical stability • Chemical stability • Hydrophobicity	• GDL & membrane: Alternatives uneconomical due to performance and service life disadvantages and low maturity

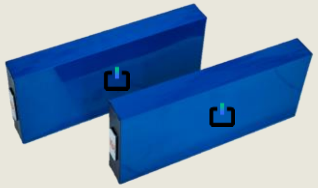
PEM: Proton Exchange Membrane; GDL: Gas Diffusion Layer; MEA: Membrane Electrode Assembly

E-Mobility

Lithium-Ion Battery

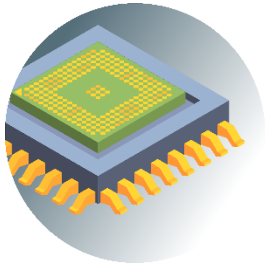
- The automotive industry is currently investing heavily in the production and R&D of batteries in Germany and Europe in order to reduce dependencies, particularly from Asia.
- The cathode of a battery cell is produced with a metal powder (NMC, LFP) using a binder. All binders used in series production today are made of the fluoropolymer PVDF.
- PVDF is also used as an adhesive layer to bond the separator and the electrodes.
- Future dry coating processes for electrodes without the solvent NMP will also require fluoropolymers (e.g. PTFE).
- Li-ion batteries (NMC or LFP) without fluoropolymers cannot be produced in the near future. This also applies to solid-state batteries available in the future.
- A ban on fluoropolymers for the production of Li-ion batteries prevents the successful introduction of electromobility and thus the achievement of the EU Green Deal targets.
- The fluoropolymers used are not dangerous (low concern according to OECD) and no relevant emissions occur during the production, utilisation and disposal phases of the traction battery.





Standard NMC or LFP cells contain between 15 - 50 g PVDF per kWh

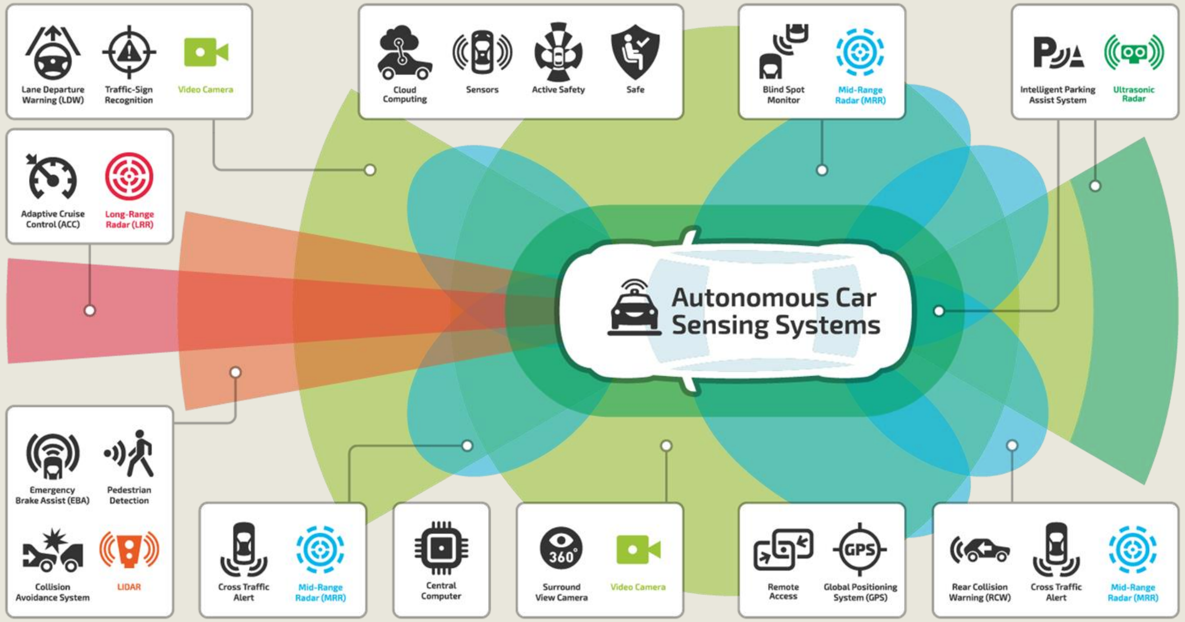
Utilisation	Use of PFAS	Current Substitution Possibility
Binder for producing the cathode and adhesion layer for connecting the separator and electrodes	• PVDF	• Currently no PFAS-free binders available. Dry coating and solid batteries also require PFAS. • Acrylic adhesives may be used for adhesion layers in the future.
Dry coating of electrodes in order to dispense with the solvent NMP, which is toxic to reproduction	• PTFE	• Development stage • No PFAS-free alternative known
Conducting salt for polymer electrolytes in solid-state batteries, potentially higher performance and safety	• LiTFSI	• Research and development stage • No PFAS-free alternative known



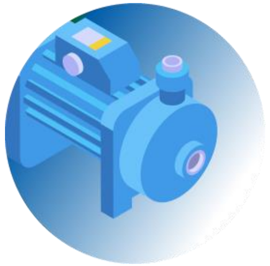
Electronics

- Future trends such as e-mobility, autonomous driving, connectivity and multimedia applications cannot be realised without reliable and powerful electronics.
- Digitalisation & more efficient networking can save up to60,000 tonnes of CO_2 in Germany every year.
- A modern car is a complex network on wheels (control units, sensors, actuators, communication devices, wiring harness) and automotive electronics are ultimately indispensable for a wide range of functions (safety, control, assistance, comfort, communication, etc.).
- In contrast to consumer electronics, the demands placed on automotive electronics are significantly higher due to high safety requirements and loads.
- According to the current state of technology and science, only PFAS and fluoropolymers can fulfil these stringent requirements for electronic components.
- In order to ensure competitiveness, the European automotive industry has made and is making enormous investments in the construction of wafer fabs specialising in automotive semiconductors (e.g. Bosch in Dresden, ZF etc.).
- A ban on PFAS and fluoropolymers would have incalculable socio-economic and environmentally damaging effects. The goals of the GREEN DEAL, the EUROPEAN CHIPS ACT and the transformation of the automotive industry would not be achievable.

Applications of Automotive Sensors



Material	Application in	Alternatives
PTFE	• High-frequency radio and radar applications: PTFE cores in printed circuit boards • Aluminium electrolytic capacitor encapsulation • Film capacitors • Coils • SMD connectors (insulator) • Diodes • Switches (foil) • Wiring harness	No alternatives possible according to the current state of technology, research and development. The development of alternatives (if feasible at all) is expected to take between 13.5 and 25 years (worst case for semiconductors).
ETFE, FEP	• Thermistors (protect pipes and connecting wires)	
Non-polymeric PFAS	• Semiconductors (essential for production/wet chemistry, photolithography, machines and production facilities, coolants, etc.)	

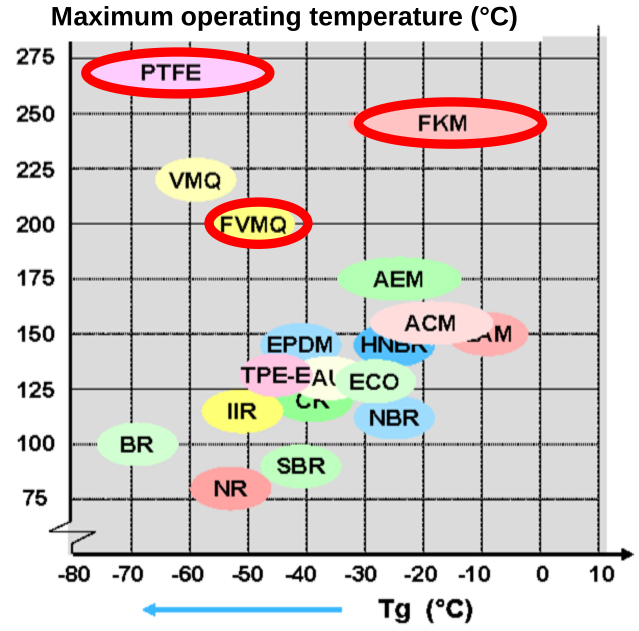


Hoses & Seals

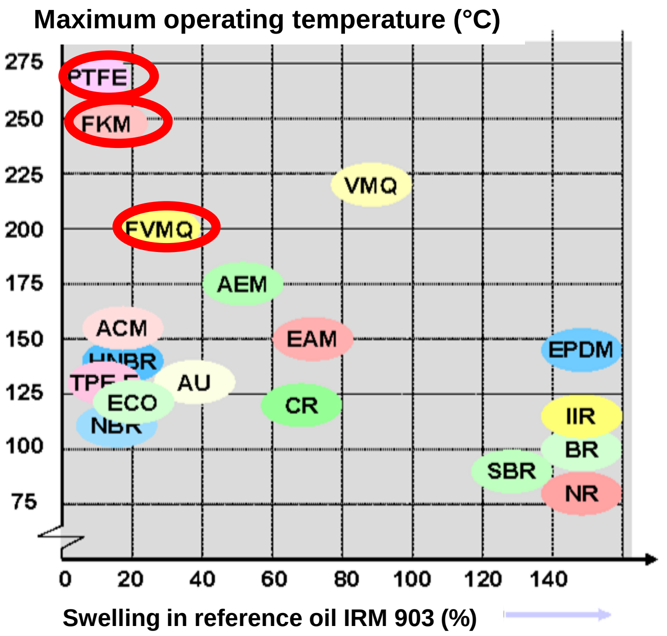
- Fluoroelastomers and PTFE are used in demanding sealing and hose applications because other materials are not resistant to high temperatures and contact with aggressive media.
- Replacement with other polymer classes is therefore always accompanied by a loss of performance and a significant reduction in the service life of the respective component.
- Premature component failure leads to leakage and associated emissions of the respective fluids into the environment → up to serious safety losses.
- If a seal or hose fails, there is often a high risk of serious damage to the engine, transmission or fuel system → up to total loss of the vehicle.
- Some applications will disappear with the combustion engine - others are also needed in alternative drive technologies or are currently being developed for them.

→ Safe, reliable and low-emission mobility is not possible without fluoroelastomers and PTFE.

What Makes Fluoroelastomers and PTFE Special?



Relative heat and cold resistance of elastomers



Relative heat and oil resistance of elastomers

Product Examples

Radial Shaft Seal

Temperature stable
Resistant to high-performance lubricants and acids
Wear-resistant
Low friction, durable

O-Ring

Temperature stable
Highly media- resistant
Durable
Corrosion resistant
Permeation-tight

Fuel Hose

Resistant to fuels
Durable
Permeation-tight (low-emission)

Automotive Applications of Fluoropolymers*

VDA Proposal on the Restriction Text

VDA Verband der Automobilindustrie

Future Developments

5.ff. product and process oriented research and development
5.ff PFAS that represent new technologies with significant benefits if it can be demonstrated that no substitute is available and that the risk to human health and the environment is manageable NEW

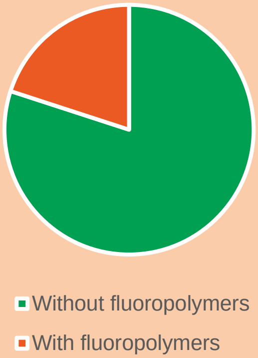
Development Phase

in accordance with the requirements for the authorisation of substances. This exemption shall be reviewed and assessed by the Commission no later than 13.5 years after EiF

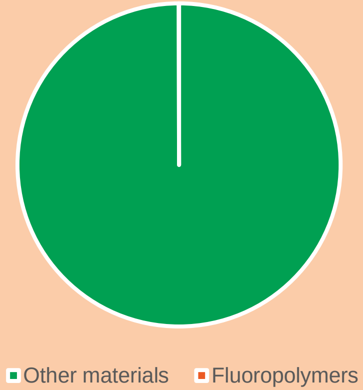
→ Review see next slide

Current Production

Proportion of components with fluoropolymers in the vehicle



Fluoropolymers by weight in vehicles

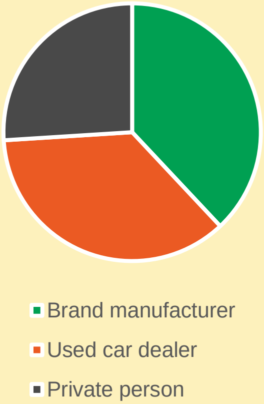


Production Phase

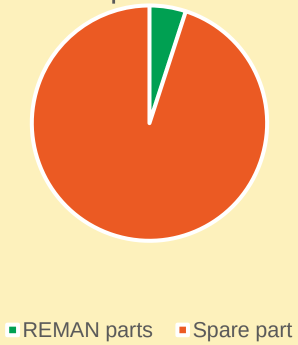
6.o. applications affecting the proper functioning **or** safety of transport vehicles, **or** affecting the safety of operators, passengers, or goods**. This exemption shall apply perpetually but maybe reviewed and reassessed by the Commission no later than** 13.5 years after EiF. ADJUSTED

Vehicles in Stock

Share of distribution of used vehicles



Share of remanufactured components for spare parts



Parts supply phase

5.xy. transport vehicles already placed on the market for the first time NEW

5.xy. spare parts and remanufactured parts, whenever placed on the market, for use in the maintenance and repair of transport vehicles already placed on the market for the first time NEW

Also relevant for all production systems

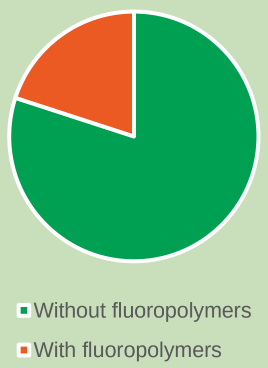
* Data from the VDA submission to the public consultation on the PFAS restriction proposal 8/2023

If no General Exemption of Fluoropolymers, then a Review Process is Necessary

VDA Verband der Automobilindustrie

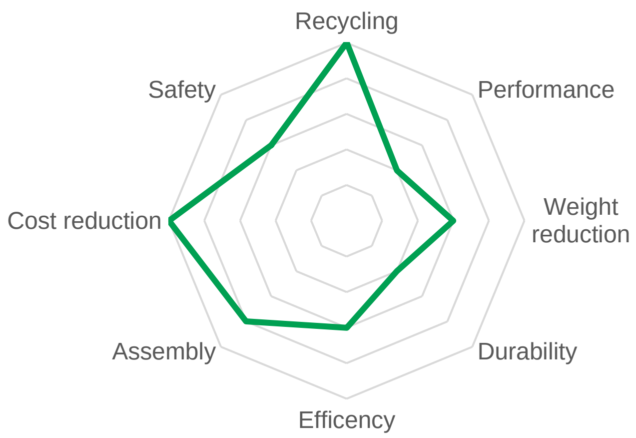
Initial Situation

Proportion of components with fluoropolymers in the vehicle



15-20% of all car components with a low proportion of fluoropolymers, some with specific functions

Product Development



In addition to legal requirements, there are also requirements for quality, comfort, durability, functionality and much more

Replacement of the materials without loss of performance and durability is time-consuming or impossible, as no suitable materials are available on the market to date

Review Process

Review of the exemptions after 13.5 years (based on COM/2021/219 final) together with the automotive industry

The following applications are to be subject to a review process (instead of a fixed phase-out date):

- Lithium ion battery
- Fuel cell
- Electrical and electronic components
- Technical textiles
- Seals and hoses
- Lubricants
- Automotive valves based on PTFE membranes
- Manufacturing

Example: Entry 68 PFCA, point 11 REACH Annex XVII

„(…) The Commission shall review this derogation no later than 25 August 2024.“

Summary

The automotive industry is in favour of a responsible and risk-based approach to PFAS and proposes the following five steps as a step-by-step procedure:

1. **Phase-out-Roadmap**: PFAS, which pose potentially high risks to humans and the environment and for which substitutes with comparable properties are available today, can and should be continuously substituted. This is already current practice. Lead times for redesigns and new developments should be taken into account.
2. **Review process**: PFAS that cannot yet be replaced because no adequate state of the art or technology is yet available should be regularly reviewed as part of a procedure defined by the legislator. This is successfully carried out, for example, within the framework of the End-of-Life Vehicles Directive with heavy metals such as lead.
3. **Exception for fluoropolymers**: Fluoropolymers that are categorised as "low-concern" according to the OECD should be completely exempt from the restriction. These are necessary for the fulfilment of the European Green Deal (e.g. in lithium-ion batteries, fuel cells and the electrical and electronics industry) or are used in existing drive technologies..
4. **Exception for spare parts and remanufactured parts:** An exemption for spare parts according to the „repair as produced“ principle, which is widely accepted in the European Union, and the possibility of remarketing used vehicles, machinery and their parts is crucial with regard to the European waste hierarchy.
5. **Openness to innovation**: Within a defined process, the use of PFAS in future technologies and applications should be made possible if it is essential for society and risks can be adequately controlled.