DuPont™ Tedlar®:
A Non-PFAS Fluoropolymer

Abstract

Per- and polyfluoroalkyl substances (PFAS) are a class of chemicals that are subject to increasing regulatory pressure. To be considered a PFAS, a substance must meet regulatory definitions based on structure.[1-4] While many fluoropolymers have been classified as PFAS, polyvinyl fluoride (PVF) does not meet the definition of a PFAS due to the lack of full fluorination and the presence of hydrogen on each carbon on the backbone. The presence of hydrogen makes PVF susceptible to attack by free radicals and oxidation, resulting in breakdown in the environment and mineralization during incineration. Accordingly, PVF has been identified by scientific and regulatory bodies as not posing the same environmental persistence concerns associated with PFAS.

Background: Per- and Polyfluoroalkyl Substances (PFAS)

Per- and polyfluoroalkyl substances (PFAS) are a group of synthetic chemicals that have been in use since the 1940s and can be found in a wide range of industrial and consumer products. These substances have been widely used because of the unique properties imparted by fluorination; they are highly inert, chemically and stain resistant, water and oil repellant, and have extreme thermal, hydrolytic, and UV light stability.

The definitions of PFAS encompass thousands of fluorinated substances and varies from one regulation to another. These regulatory definitions were designed to encompass substances that do not degrade under normal environmental conditions and are therefore persistent, or those that have potential to degrade into other substances that may persist in nature.

Although there is not one universal definition of PFAS, current regulatory definitions uniquely include the requirement of at least one fully fluorinated carbon. This simple structural requirement aligns with the scientific understanding of fluoropolymer degradation and aims to address via regulation the concern for persistence of PFAS polymers and their concern for substances formed during degradation. Saturation with fluorine prevents free radical attack or oxidation of the backbone, leading to environmental persistence.

Defining and Regulating PFAS

The Organisation for Economic Co-operation and Development (OECD) is an international organization that works to promote policies and serves as a forum for governments to collaborate and develop best practices for policy development. Many individual government regulations closely follow the definition of PFAS from OECD. Its current definition is:[1,9]

> "PFAS are defined as fluorinated substances that contain at least one fully fluorinated methyl or methylene carbon atom (without any H/Cl/Br/I atom attached to it), i.e., with a few noted exceptions, any chemical with at least a perfluorinated methyl group (–CF_3) or a perfluorinated methylene group (–CF_2–) is a PFAS."

Subsequent OECD work further clarified the life cycle behavior of fluoropolymers, reinforcing the structural basis of the PFAS definition.[2,9]

This definition was recently endorsed by a substantial group of prominent environmental scientists with expertise in per- and polyfluoroalkyl substances as being the most comprehensive definition of PFAS.[5]

The definition of PFAS used by the European Chemicals Agency (ECHA), which is responsible for managing the chemicals legislation in the European Union including the REACH regulation, closely follows the definition from OECD within their restriction proposal.[2]

> "Per- and polyfluoroalkyl substances (PFASs) defined as: Any substance that contains at least one fully fluorinated methyl (CF_3–) or methylene (–CF_2–) carbon atom (without any H/Cl/Br/I attached to it)."

The Environmental Protection Agency of the United States (EPA) has also implemented a reporting recordkeeping requirement for PFAS, which adopted a similar definition:[3]

> "PFAS is defined as including at least one of these three structures:
> - R– (CF_2) –CF(R')R", where both the CF2 and CF moieties are saturated carbons;
> - R–CF_2OCF_2-R', where R and R' can either be F, O, or saturated carbons; and
> - $CF_3C(CF_3)$R'R", where R' and R" can either be F or saturated carbons."

Individual states within the United States have also adopted their own definitions. Notably, the state of Maine uses perhaps the broadest definition:[4]

> ""Perfluoroalkyl and polyfluoroalkyl substances" or "PFAS" means substances that include any member of the class of fluorinated organic chemicals containing at least one fully fluorinated carbon atom."

Again, these definitions all require at least one fully fluorinated carbon to be present in the molecule for the material to be considered a PFAS.

Polyvinyl Fluoride is a non-PFAS Fluoropolymer

Polyvinyl fluoride does not have a fully fluorinated carbon and therefore is outside of all current regulatory definitions of PFAS. The structure, shown in Figure 1, includes a hydrogen atom on each carbon on the polymer backbone. This important structural distinction means that the polymer can degrade.

In fact, polyvinyl fluoride was used as an example of a non-PFAS material in the OECD publication defining PFAS,[1] and was specifically cited as a non-PFAS material and a viable alternative to PFAS in the ECHA restriction report.[6]

> "Polyvinyl fluoride (PVF) is a partial fluorinated fluoropolymer and therefore not a PFAS, which could be an alternative fluoropolymer to polymeric PFAS such as PVDF and PTFE for certain applications in transport, electronics, and the energy sector."

In addition to PVF not being a PFAS, there are no other raw materials, surfactants, or other ingredients that meet the definition of PFAS in PVF made by DuPont™ Tedlar®. As such, PVF and its supply chain do not meet current regulatory definitions of PFAS and are not subject to PFAS-specific restrictions.

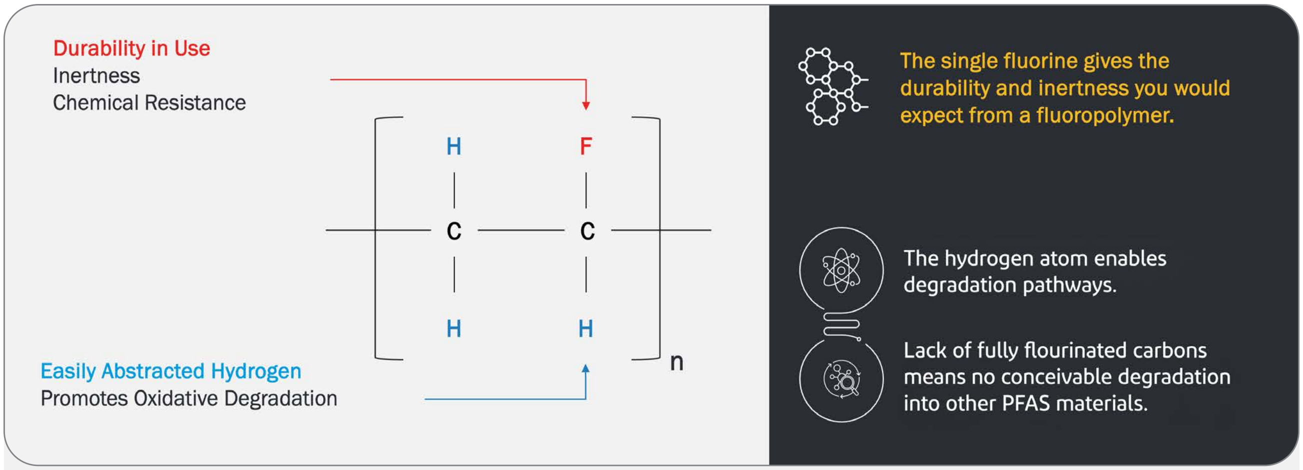

Figure 1: The structure of PVF does not include any fully fluorinated carbons. The hydrogens can be abstracted, enabling oxidative degradation of the carbon backbone.

Degradation Products of Polyvinyl Fluoride

The structure of polyvinyl fluoride, illustrated in Figure 1, does not include any carbons that are fully saturated with fluorine. This leaves the backbone of the polymer susceptible to free radical attack and oxidative degradation. Previous studies have shown that hydrogen is abstracted from the backbone, leaving a free radical that is susceptible to oxidation and formation of a peroxide radical. This radical further degrades by breaking the backbone carbon chain, splitting the polymer into two shorter segments. The terminal groups of these polymer segments are carboxylic acids. The shorter chains thus formed are similar to the original chain, and therefore also subject to further oxidation and chain length reduction. This mechanism, illustrated in Figure 2, would continue until the chain is fully consumed, and the polymer has been converted into carbon oxides, water, and fluoride ions.[7]

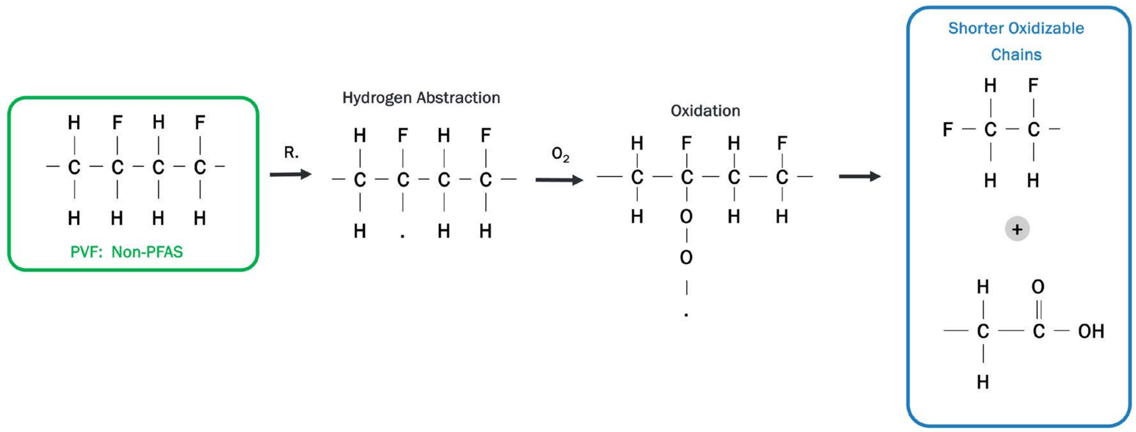

Figure 2: PVF degrades through hydrogen abstraction, oxygen insertion in the backbone, and chain scission. This process produces increasingly shorter segments, terminating in carbon oxides, water, and fluoride ion. No degradation products meeting current PFAS definitions are produced.[7]

The theoretical degradation mechanism is confirmed experimentally. The resulting thermal oxidation products of PVF are primarily carbon oxides, water, and HF. Some additional products are detected which result from the incomplete oxidation, which appear as shorter chain hydrocarbons and some of their mono-fluorinated analogs. However, none of these fluorinated species have more than a single fluorine attached to a carbon and therefore would be susceptible to further oxidation and degradation in the environment, again resulting in carbon oxides, water, and fluoride ions as the terminal products.[8] These results are summarized in Figure 3.

Oxidation Products	Mol %
CO	32
CO_2	0.6
H_2O	43
HF	21
Other	3.4

Note : Chatfield, D. The Pyrolysis and Nonflaming Oxidative Degradation of Poly(vinylfluoride), J. Poly. Sci, 21, 1681-1691 (1983)

Oxidation of PVF is well-studied both theoretically and experimentally.

All fluorinated products have pathway to further degradation. End result is mineralization.

Detected Products (Non-Fluorinated)			
Methane	Butene	Styrene	C_6H_{10}
Ethane	1,2-Butadiene	N-Propylbenzene	C_7H_{14}
Ethylene	1,3-Butadiene	Iso-Propylbenzene	$C_{10}H_{10}$
Acetylene	Cyclopentadiene	C_6H_5-C_3H_5	$C_{10}H_{12}$
Propene	Benzene	Indene	$C_{12}H_{12}$
Butane	Toluene	Napthalene	$C_{12}H_{14}$

Detected Products (Fluorinated)	
Fluoroethylene	Fluoronapthalene
C_3H_5F	C_6H_9F
C_4H_5F	C_8H_7F
Fluorobenzene	C_9H_7F
$(CH_3)C_6H_4F$	

Figure 3: Oxidative degradation of PVF results primarily in carbon oxides, water, and fluoride ions. Other products of incomplete oxidation are non-fluorinated hydrocarbons and mono-fluorinated analogs which can be further oxidized to result in carbon oxides, water, and fluoride ions.

The safe degradation profile positions PVF as a sustainable and high-performance alternative to traditional fluoropolymers. The single fluorine still provides enough stability to the polymer to enable the outstanding weatherability, hydrolytic and UV stability, and chemical resistance that defines fluoropolymers, adding tremendous value to a wide range of applications in a variety of industries. This durability in harsh environments comes without compromising on environmental sustainability.

Summary

PFAS regulations are written to restrict the use of fluorinated substances that are environmentally persistent, or those that produce degradation products that are environmentally persistent. These regulations have specifically excluded PVF due to its lack of a fully fluorinated carbon, which enables it to degrade. Experiments demonstrate that the degradation of PVF also does not produce PFAS byproducts. Because PFAS regulations are grounded in structural and persistence criteria, the non-PFAS status of PVF is expected to remain robust as regulatory frameworks continue to evolve. PVF therefore represents an alternative choice for industries seeking high-performance fluoropolymers.

For further information, please *contact your DuPont representative*. For more information in DuPont Sustainability initiatives, please visit: ***https://www.dupont.com/about/sustainability.html***.

References

[1] OECD, Reconciling Terminology of the Universe of Per- and Polyfluoroalkyl Substances: Recommendations and Practical Guidance, OECD Series on Risk Management, 2021, 61

[2] ECHA, Annex XV Restriction Report, Version 2, 2023

[3] Environmental Protection Agency, Toxic Substances Control Act Reporting and Recordkeeping Requirements for Perfluoroalkyl and Polyfluoroalkyl Substances, Federal Register 88, 195, 2023

[4] State of Maine, An Act to Amend the Laws Relating to the Prevention of Perfluoroalkyl and Polyfluoroalkyl Substances Pollution, Public Law 2023, c. 630

[5] Sigmund, G. et al, Environmental Science and Technology Letters, 2025, Article ASAP, DOI: 10.1021/acs.estlett.5c00478

[6] ECHA, Annex XV Restriction Report Annex A, Version 2, 2023

[7] Farneth, WE et al, Degradation Mechanisms of Poly(vinyl fluoride) Films, Macromolecules, 1993, 26, 4765-4769

[8] Chatfield, DA, The Pyrolysis and Nonflaming Oxidative Degradation of Poly(vinylfluoride), Journal of Polymer Science: Polymer Chemistry Edition, 1983, 21, 1681-1691

[9] OECD (2025), Synthesis report on understanding fluoropolymers and their life cycle, OECD Series on Risk Management of Chemicals, OECD Publishing, Paris, https://doi.org/10.1787/35b035df-en

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