THE COOKWARE & BAKEWARE ALLIANCE

Building industry excellence through engineering, engagement, education and expertise.

PFAS Advocacy & Education

A Statement from the Alliance

We are facing unique and challenging times in our industry as we work to understand and comply with enacted state legislations regarding PFAS chemicals. Knowledge is powerful. This is a key element in why The Cookware & Bakeware Alliance was formed back in 1922, to collect and share important information and create safe consumer products.

For years we have answered questions and shared resources on important topics facing our industry. Many times, only part of the answer, or one viewpoint is shared. Our Good Science (https://cookwareandbakeware.org/good-science/) site has been created to help provide resources and access to more information on important topics.

In an effort to help educate those who are either involved in deciding on PFAS legislation, or for consumers looking to purchase our products, we created an education series on PFAS. The series is shared on the Good Science site and helps explain key differences of fluorochemicals vs fluoropolymers, life cycle assessment, alternatives, and the science on the impact of fluoropolymers on human health.

Part 1: **Cookware & Bakeware, PFAS, and PTFE,** the definition of PFAS involving a large family of substances with significantly varied properties and uses, was discussed. PFAS was divided into two distinct groups: non-polymeric and polymeric. The polymeric PFAS (fluoropolymers) are neither water soluble, nor mobile, nor bioavailable, nor bio accumulative.

Part 2, **Fluoropolymers and Human Health** it was shown that fluoropolymers do not present an unacceptable risk to human health and are classified as polymers of low concern. PTFE coated cookware and bakeware are assessed by authorities in the US and Europe as safe for the user. In addition, the emissions of PFAS (of concern) into the environment during the production of PTFE coated cookware is negligible, and more importantly manageable.

Part 3: **A Closer Look at PFAS in Cookware & Bakeware:** other contested issues with fluoropolymers are discussed such as, Environmental Emissions of PFAS, End of Life of Nonstick Cookware, Feasibility of Alternatives to PTFE.

Highlights from the Series

In the series, you will read about and find links to resources that present information and evidence that:

- Fluoropolymers do not present an unacceptable risk to human health.
- Use of fluoropolymers in cookware and bakeware does not lead to negative health impacts.
- Fluoropolymers, including PTFE, are widely used in other applications, such as medical devices, with no evidence of negative health effects.

- Polymeric PFAS (fluoropolymers), such as PTFE, which are used in nonstick cookware and bakeware coatings, are not water soluble, and have documented safety profiles. They are thermally, biologically, and chemically stable. They are also nonmobile, non-bioavailable, non-bioaccumulative, nontoxic, and most importantly, they are not soluble in water. Although fluoropolymers fit the current PFAS structural definition, they have very different physical, chemical, environmental, and toxicological properties when compared with other PFAS of concern.

- PTFE is the most stable fluoropolymer and has a continuous use temperature of 500°F (260°C). (Plastics Safe Handling Guide 2018). This temperature is well above temperatures realized during normal cooking and baking activities when a nonstick housewares article is used per the manufacturers' use and care instructions.

- There is no scientific basis that PTFE-coated cookware and bakeware poses a hazard or risk to humans or the environment when used under normal conditions. Therefore, in our opinion it is safe to use and should not be restricted.

- There are negligible emissions of non-polymeric fluorochemicals in landfill due to PTFE-coated cookware.

- Using the best-available technology and appropriate temperatures, PTFE and other fluoropolymers are of no concern for emissions of PFAS into the environment.

- Important points regarding PTFE-based nonstick coatings:

    1. PTFE-based nonstick coatings will retain their nonstick properties for as long as the coating is present on the coated article. This is due to the inherent nonstick properties of PTFE, a fluoropolymer. Alternative nonstick coating technologies will lose the nonstick characteristics over time.

    2. PTFE-based nonstick coatings are unaffected by household dishwashers.

    3. PTFE-based nonstick coatings emit very low levels of volatile organic compounds (VOCs) during the coating application process.

    4. The risk of PTFE-based nonstick coatings releasing low molecular weight PFAS substances of concern or any other substance that might adulterate food during normal use is very low.

- Not enough is scientifically known about the full lifecycle of ceramic or sol-gel coated cookware to declare this a viable alternative to PTFE coated cookware and bakeware. The risk of a regrettable substitution is significant.

- PTFE-coated cookware and bakeware has throughout its full lifecycle a negligible risk for PFAS emissions into the environment and is safe to use for the consumer. Therefore, there is no foundation to restrict its manufacturing, usage, or recycling.

In the 100+ years of our Alliance, we have stood by good science to create the standards for all our products. We have been dedicated to consumer safety and will continue to do so now and into the future.

PFAS EDUCATION

PART 1: COOKWARE, PFAS, AND PTFE

The CBA is a not-for-profit trade association owned by its membership: manufacturers of cookware, bakeware and kitchenware with substantial operations and headquarters in the United States. The CBA began in the early 1920s as the Aluminum Wares Association, became the Metal Cookware Manufacturers Association in the 1960s, and in the 1970s changed its name to the Cookware Manufacturers Association in recognition of its representation of all types of cookware and bakeware materials. The CBA's mission is to inform and promote the industry to its members, their customers and to the general public.

The members of The Cookware & Bakeware Alliance (CBA) develop standards to promote the welfare of the cookware industry and improve its service to the public. The CBA Engineering Standards are continually updated to reflect changes in materials and technology and include test methods for nonstick finishes on cookware that when followed ensure coating performance and durability.

Nonstick cookware and bakeware manufactured according to CBA Standards use only US FDA food contact compliant materials for surfaces. CBA supports the responsible manufacturing and safe uses of PTFE and other fluoropolymers, and a science-based approach to regulations that benefit human health and the environment. CBA supports labeling provisions to alert consumers to the presence of PFAS, but based on current science, considers it unnecessary to prohibit sales and eliminate consumer choice.

Your cookware and bakeware industry resource.

Knowledge is powerful. This is a key element in why The Cookware & Bakeware Alliance was formed back in 1922, to collect and share important information and create safe consumer products.

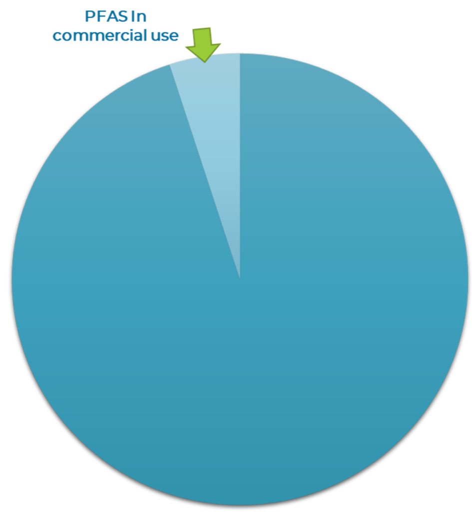
For years we have answered questions and shared resources on important topics facing our industry. Many times, only part of the answer is shared, or one viewpoint. The Good Science site has been created to help provide resources and access to more information on important topics. We now bring all of this information to our website to share and promote Good Science. [Visit the Good Science webpage to explore.]

For questions, please contact Fran Groesbeck, Managing Director (fran@cookware.org).

Thank you for your interest in Good Science!

DISCLAIMER: The Information compiled here Is not to be considered legal advice. This Information Is Intended to help understand Important Industry news and provide what the Alliance and/or affiliated experts understand of the situation. We recommend that all follow up on this or other Industry news be discussed with your legal teams.

PART 1: Cookware, PFAS, and PTFE



Per- and polyfluoroalkyl substances (PFAS) are a diverse group of chemistries that contain carbon-fluorine bonds, the strongest chemical bonds in organic chemistry. Due to their unique and useful properties, PFAS are widely used and critical to enabling numerous technologies.

The term PFAS encompasses in some instances as many as 12,000+ substances. However, it is estimated that roughly 5% of all PFAS substances are in commercial use today. Further, not all PFAS are the same. The chemistries currently in commercial use have very different physical and chemical properties, health, and environmental profiles, uses, and benefits.

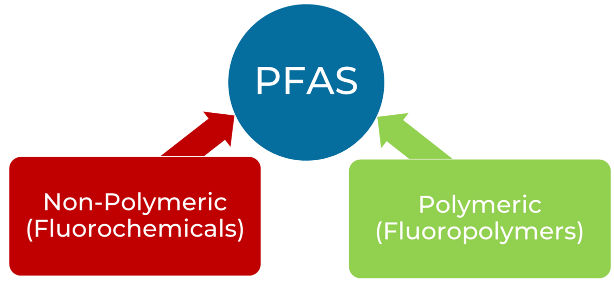
- Large family of substances
- Significantly varied properties
- Subgroups have unique and specific differences

They can be considered part of a universe of fluorinated organic substances with varying physical, chemical, and biological properties including polymers and non-polymers; solids, liquids, and gases.[1]

A subgroup of PFAS having specific characteristics and properties is called fluoropolymers. The discovery of the first fluoropolymer, polytetrafluoroethylene (PTFE), occurred in 1938 [2], and it led to its use in the most critical and demanding applications known. Aerospace and military applications were first to use fluoropolymers to insulate cables or create impermeable seals because it can withstand the harshest conditions and it replaces materials that have a high risk of failure due to a deterioration of properties. Uses in conditions where other materials fail due to corrosion and extreme temperature are the hallmark of fluoropolymers, often making them irreplaceable.

The first nonstick cookware appeared in the US in 1961.[3] Fluoropolymers are used in cookware, for their non-stick and barrier properties. To ensure food contact substances are safe for their intended use, the FDA conducts a rigorous scientific review before they are authorized for the market.[4]

PFAS can be divided into two distinct groups: non-polymeric and polymeric PFAS. Furthermore, the non-polymeric, ie fluorochemicals, are water soluble, versus the polymeric, ie fluoropolymers, are not.



The non-polymeric PFAS (fluorochemicals) are typically used for food contact materials (FCM), such as fast-food packaging and microwave popcorn bags, as well as a number of other applications and industries. The FCM examples referenced can indirectly contribute to dietary exposure through the migration of PFAS into food, which can be a food safety concern [5]. Because they are water soluble, consumers have the potential to be exposed through foods and/or drinking water.

Whereas the polymeric PFAS (fluoropolymers), such as PTFE, which are used in nonstick cookware and bakeware coatings, are not water soluble, and have documented safety profiles. They are thermally, biologically, and chemically stable. They are also nonmobile, non bioavailable, non bioaccumulative, nontoxic, and most importantly they are not soluble in water. Although fluoropolymers fit the current PFAS structural definition, they have very different physical, chemical, environmental, and toxicological properties when compared with other PFAS.[6]

Fluorochemicals	Characteristic	Fluoropolymer *(used in cookware)*
Yes	Water Soluble	No
Yes	PFAS of Concern	No
Yes	Transported in Air	No
Yes	Toxicity	No
Yes	Persistence/ Non-Degradable	Yes

[1] Identification and classification of commercially relevant per- and poly-fluoroalkyl substances (PFAS) Robert C. Buck,Stephen H. Korzeniowski,Evan Laganis,Frank Adamsky; First published: 14 May 2021 https://doi.org/10.1002/ieam.4450

[2] https://www.aps.org/publications/apsnews/202104/history.cfm

[3] ibid

[4] Authorized Uses of PFAS in Food Contact Applications https://www.fda.gov/food/chemical-contaminants-food/authorized-uses-pfas-food-contact-applications

[5] Schaider, L.A.; Balan, S.A.; Blum, A.; Andrews, D.Q.; Strynar, M.J.; Dickinson, M.E.; Lunderberg, D.M.; Lang, J.R.; Peaslee, G.F. Fluorinated Compounds in U.S. Fast Food Packaging. Environ. Sci. Technol. Lett. 2017. [CrossRef] [PubMed] https://www.mdpi.com/2304-8158/10/7/1443

[6] A critical review of the application of polymer of low concern regulatory criteria to fluoropolymers II: Fluoroplastics and Fluoroelastomers. Stephen H. Korzeniowski,Robert C. Buck,Robin M. Newkold,Ahmed El kassmi,Evan Laganis,Yasuhiko Matsuoka,Bertrand Dinelli,Severine Beauchet,Frank Adamsky

First published: 09 June 2022 https://doi.org/10.1002/ieam.4646

The Cookware & Bakeware Alliance
Supplying the Industry with Standards, Connections & Solutions.

PO Box 297 • Bradley Beach, NJ 07720
Cookware.org • info@cookware.org

PFAS EDUCATION

PART 2: FLUOROPOLYMERS AND HUMAN HEALTH

PFAS Education Series

PART 2: Fluoropolymers and Human Health

Definition of Fluoropolymers:

Fluoropolymers are defined according to Buck et a.l[1] as a distinct subset of fluorinated polymers, based on a carbon-only polymer backbone with fluorine atoms directly attached to it, e.g., polytetrafluoroethylene (PTFE), fluorinated ethylene propylene (FEP) and perfluoroalkoxy polymer (PFA). Many fluoropolymers have been approved for food contact applications by regulators, including the US FDA (21 CFR 175.1550), the European Union through Regulation (EU) 10/2011 and also through specific national regulations such as German BfR recommendation LI.

Fluoropolymers do not present an unacceptable risk to human health.

The current OECD definition of PFAS includes thousands of substances with wide ranges of properties, including classes such as fluoropolymers which have traditionally been differentiated from legacy non-polymeric PFAS (PFOA or PFOS). In 2021, the OECD wrote, "The term "PFASs" is a broad, general, non-specific term, which does not inform whether a compound is harmful or not, but only communicates that the compounds under this term share the same trait for having a fully fluorinated methyl or methylene carbon moiety".[2]

A typical restriction on a substance or material requires the demonstration of "unacceptable risk", and fluoropolymers do not meet this standard, as demonstrated by years of research:

- The OECD is a central source of definitions for global chemical regulation (including the definition of PFAS) and classifies polymers with "insignificant environmental and human health impacts" as polymers of low concern.[3]

- PTFE is not soluble in water (or any other common solvents) and is not mobile in the environment.[4]

- Fluoropolymers have been repeatedly found to meet all of the OECD characteristics of polymers of low concern,[5] based on their stability, lack of bioavailability, lack of bioaccumulation, and general absence of observed ill effects.

- In a scientific opinion published in 2016 relating to the risk analysis of chemical products in food, the scientific committee of the European Food Safety Authority (EFSA) specified that the risk analysis of polymers used in food additives must consider the molar mass of the polymer in question. For fluorinated polymers, EFSA proposed a threshold of 1,500 Daltons. Beyond this threshold, EFSA indicated that it is unlikely that the polymers will be absorbed through the gastrointestinal barrier and therefore considered that they do not present a health hazard.(6) By comparison, PTFE for food contact applications is characterized by sizes ranging from hundreds of thousands to several million Daltons. This recent opinion from EFSA shows that fluorinated polymers and in particular PTFE used for food contact materials like nonstick coated cookware do not pose a concern for health authorities.

Studies have consistently shown that fluoropolymers do not pose a risk to human health, largely due to their inertness, insolubility, and lack of reactive functional groups.

- A 2016 study by Naftalovich et al. shows that PTFE ingestion to increase satiety was both successful and safe. They also reviewed the biological safety of PTFE.(7)

- A 2022 study by Lee et al. shows that fluoropolymers such as PTFE are safe when ingested. For example, no toxic effects were observed from PTFE exposure in mice. No traces of PTFE were observed in the blood of mice even though they were exposed to very large amounts of PTFE.(8)

- The International Agency for Research on Cancer (IARC) has repeatedly investigated the carcinogenicity and toxicity of PTFE, finding it has no toxicological impact, and cannot be classified according to its carcinogenicity (IARC Group 3).(9)

Use of fluoropolymers in cookware and bakeware does not lead to negative health impacts.

The evidence does not indicate that use of fluoropolymer-coated cookware exposes users to non-polymeric PFAS.

- In a study on articles in the Korean market, Choi et al show that only a very limited number of articles (3 out of 139 fry pans) show migration of low molecular weight PFAS and only in the first migration experiment with no detection in later experiments. All detected quantities were significantly below the level of concern.(10)

- Studies of PTFE-coated cookware have detected no or for some products only traces of low molecular weight PFAS in the first migration experiment. The French consumer association 60 millions de consommateurs (n°579, April 2022), published a study on 9 non-stick coated articles. Despite detecting very low levels of low molecular weight PFAS, the author conceded that these substances “were probably not used in the manufacturing of the pans but could have been introduced in an accidental manner during manufacturing, packaging or transport”.[11]

- PTFE is known to start to deteriorate at an extremely slow rate above 260 °C (500°F). Above 360 °C (680°F), the degradation of PTFE starts to be measurable. However, according to the German Federal Office for Risk Assessment (BfR), the concentration of these emissions while normally using PTFE-coated cookware is so low that there is no health risk for the user.[12]

- It should be noted that degradation temperatures for fats and oils are typically lower than 200 °C (392°F), consequently at a much lower temperature than when fluoropolymers would begin to degrade. For instance, emission of volatiles, such as aldehydes, from coconut, safflower, canola, or extra virgin olive oil are measured by Katragada et al. from 180 °C (356°F).[13] This suggests that regular usage of fluoropolymer-coated cookware would not result in sufficient temperatures for fluoropolymer degradation.

Studies and expert reports consistently evaluate PTFE coated cookware as safe for users.

- The European Food Safety Authority (EFSA) published a 2020 report assessing the safety of PFAS in food contact materials, primarily focusing on non-polymeric legacy PFAS (PFOA and PFOS).[14] The study assessed the use of PTFE in cookware, saying it may contribute to human exposure on the scale of micrograms per kilogram, a level far below background exposure from eating fish, meat, eggs, and fruit (among the most common sources of exposure to PFAS).

- The American Cancer Society considers the use of fluoropolymer-coated cookware safe, saying “there are no proven risks to humans from using these products. While PFAS can be used in making some of these coatings, it is not present (or is present in extremely small amounts) in the final products”.[15]

Fluoropolymers, including PTFE, are widely used in other applications with no evidence of negative health effects.

PTFE is widely used in medical devices, including implanted devices, which are highly regulated and thoroughly studied for any negative health impacts. Evidence demonstrates the use of PTFE in these devices is safe, suggesting it does not pose a health risk for humans in other uses such as in cookware.

- The US-based independent research and innovation organization ECRI (Emergency Care Research Institute) was tasked by the US Food and Drug Administration (FDA) to carry out a review of the scientific literature and produce a report on the state of knowledge of the biocompatibility of PTFE-based (medical devices in terms of local and systemic host response. The analysis covered a total of 52 studies. The analysis found no local response to PTFE in implanted devices, and no exaggerated or fatal systemic responses.[16]

The general consensus of researchers is that PTFE and fluoropolymers do not present a health risk to humans.

- Their suitability for direct use in the human body is a central reason for their role in medical devices, and many researchers have argued that PTFE should be considered a polymer of low concern by meeting or exceeding all OECD criteria. This view is reinforced by regulatory agencies in the EU and the United States in multiple reviews and meta-analyses.

- The scientific literature on the health impacts of fluoropolymers, PTFE particularly as used in cookware, suggests that the use phase does not pose a risk to human health, as the fluoropolymers themselves are not absorbed by the body (not biologically available) and have no indicated harmful effects, and other non-polymeric PFAS are not present in meaningful quantities in the final products.

Beyond fluoropolymers, exposure to non-polymeric PFAS in other applications nonetheless presents a risk to health.

- According to the European Chemicals Agency (ECHA), the largest sources of PFAS contamination in the environment come from non-polymeric applications such as fluorinated refrigerants or waterproof coatings [e.g., treatments and finishes], which then raise concerns for exposure to humans through the food and water supply.[17] Regulatory solutions for PFAS exposure should be guided by the scientific consensus, while considering categories like fluoropolymers which have been consistently shown to be safe and result in minimal exposure.

Where or why does nonstick cookware come into all this?

PTFE, or polytetrafluoroethylene, is the PFAS material that makes nonstick coatings non-stick. As we discussed in Part 1 – PTFE is a fluoropolymer: it is non-water soluble, it is non-toxic, and it is not mobile or bio-accumulative. It has a certain level of persistence, but as with other fluoropolymers, it is this trait that makes it beneficial in so many applications.

Fluoropolymers do not fit any of the new classifications such as:

PBT : Persistent, Bioaccumulative, Toxic
vPvB : very Persistent, very Bioaccumulative
PMT : Persistent, Mobile, Toxic
vPvM : very Persistent, very Mobile

Looking at PTFE from a high level, it offers many benefits to the products that use it. It is an insulator, so it reduces heat transfer. It reduces friction, which is what allows it to aid products from cookware to cars. Also, we must remember this is one of the non-water soluble PFAS types, so water contamination is not possible.

Fluoropolymers, like PTFE, are stable under normal, foreseeable use conditions. Stability is resistance to physical, chemical, or biological breakdown. Fluoropolymers, in general, have very good chemical and thermal stability due to the strength of the Carbon to Fluorine bond. (Henry et al: 2018).[5]

PTFE is the most stable fluoropolymer and has a continuous use temperature of 500°F (260°C). (Plastics Safe Handling Guide 2018).[18] This temperature is well above temperatures realized during normal cooking and baking activities when a nonstick housewares article is used per the manufacturers' use and care instructions.

Consumer Nonstick Housewares Products

Fluoropolymers, mainly PTFE, are the principal ingredients in traditional nonstick coatings for housewares. In most cases, these coatings are water-based, liquid coatings. The PTFE has to be stable in this liquid mixture in order to be applied to a product like a piece of cookware. PTFE, as helpful as it is, is extremely stubborn when it comes to mixing with water. In order to get PTFE to be stable in a water mixture, a surfactant is needed as a dispersing aid. Historically, the surfactant used to make PTFE stable in water was a fluorinated surfactant (i.e. fluorochemical).

You don't need a lot of the fluorochemical to make this work. A good analogy is if you had an Olympic size swimming pool, you would need to add a thimble-sized amount of the fluorosurfactant to make the PTFE stable. To put this small amount into another perspective, it translates to just over a minute in a century, or 0.000000025%

Aqueous film forming foams (AFFF) used to fight petroleum-based fires can often contain as much as 3.0% of fluorochemicals which are PFAS of true concern. To contrast these amounts, it would require 2 million years of cookware production to equal the environmental exposure caused by 1 year's use of AFFF.[19]

There are PTFE manufacturers that are committed to the reduction of emissions from polymerization aid/surfactant technology used in the fluoropolymer manufacturing process, the adoption of state-of-the-art emission reduction technologies, and informing downstream users of fluoropolymers about their safe handling, use, and prevention of environmental release.[20]

Conclusion:

There is no scientific basis that PTFE-coated cookware and bakeware poses a hazard or risk to humans or the environment when used under normal conditions. Therefore, in our opinion it is safe to use and should not be restricted.

More from the PFAS Education Series

In the other parts in this series by CBA, we discussed several topics around PFAS and Cookware & Bakeware.

Part 1: Cookware, PFAS, and PTFE, the definition of PFAS involving a large family of substances with significantly varied properties and uses, was discussed. PFAS was divided into two distinct groups: non-polymeric and polymeric. The polymeric PFAS (fluoropolymers) are neither water soluble, nor mobile, nor bioavailable, nor bio accumulative.

Next in the series:

Part 3: A Closer Look at PFAS in Cookware & Bakeware: other contested issues with fluoropolymers were discussed such as, Environmental Emissions of PFAS, End of Life of Nonstick Cookware, Feasibility of Alternatives to PTFE.

Visit the Good Science webpage to explore.

The Cookware and Bakeware Alliance

The CBA is a not-for-profit trade association owned by its membership: manufacturers of cookware, bakeware and kitchenware with substantial operations and headquarters in the United States. The CBA began in the early 1920s as the Aluminum Wares Association, became the Metal Cookware Manufacturers Association in the 1960s, and in the 1970s changed its name to the Cookware Manufacturers Association in recognition of its representation of all types of cookware and bakeware materials. The CBA's mission is to inform and promote the industry to its members, their customers and to the general public.

The members of The Cookware & Bakeware Alliance (CBA) develop standards to promote the welfare of the cookware industry and improve its service to the public. The CBA Engineering Standards are continually updated to reflect changes in materials and technology and include test methods for nonstick finishes on cookware that when followed ensure coating performance and durability.

Nonstick cookware and bakeware manufactured according to CBA Standards use only US FDA food contact compliant materials for surfaces. CBA supports the responsible manufacturing and safe uses of PTFE and other fluoropolymers, and a science-based approach to regulations that benefit human health and the environment. CBA supports labeling provisions to alert consumers to the presence of PFAS, but based on current science, considers it unnecessary to prohibit sales and eliminate consumer choice.

Your cookware and bakeware industry resource.

Knowledge is powerful. This is a key element in why The Cookware & Bakeware Alliance was formed back in 1922, to collect and share important information and create safe consumer products.

For years we have answered questions and shared resources on important topics facing our industry. Many times, only part of the answer is shared, or one viewpoint. The Good Science site has been created to help provide resources and access to more information on important topics. We now bring all of this information to our website to share and promote Good Science. Visit the Good Science webpage to explore.

For questions, please contact Fran Groesbeck, Managing Director (fran@cookware.org)

References:

1 Buck, Robert C, James Franklin, Urs Berger, Jason M Conder, Ian T Cousins, Pim de Voogt, Allan Astrup Jensen, Kurunthachalam Kannan, Scott A Mabury, and Stefan PJ van Leeuwen. 2011. "Perfluoroalkyl and Polyfluoroalkyl Substances in the Environment: Terminology, Classification, and Origins." Integrated Environmental Assessment and Management 7 (4): 513–41. https://doi.org/10.1002/ieam.258

2"Reconciling Terminology of the Universe of Per- and Polyfluoroalkyl Substances: Recommendations and Practical Guidance"; OECD, 2021, https://www.oecd.org/chemicalsafety/portal-perfluorinated-chemicals/terminology-per-and-polyfluoroalkyl-substances.pdf

3 "Data Analysis Of The Identification Of Correlations Between Polymer Characteristics And Potential For Health Or Ecotoxicological Concern." OECD, 2009. https://www.oecd.org/env/ehs/risk-assessment/42081261.pdf

4 Korzeniowski, Stephen H., Robert C. Buck, Robin M. Newkold, Ahmed El kassmi, Evan Laganis, Yasuhiko Matsuoka, Bertrand Dinelli, et al. 2022. "A Critical Review of the Application of Polymer of Low Concern Regulatory Criteria to Fluoropolymers II: Fluoroplastics and Fluoroelastomers." Integrated Environmental Assessment and Management, August. https://doi.org/10.1002/ieam.4646.

5 Henry, Barbara J, Joseph P Carlin, Jon A Hammerschmidt, Robert C Buck, L William Buxton, Heidelore Fiedler, Jennifer Seed, and Oscar Hernandez. 2018. "A Critical Review of the Application of Polymer of Low Concern and Regulatory Criteria to Fluoropolymers." Integrated Environmental Assessment and Management 14 (3): 316–34. https://doi.org/10.1002/ieam.4035.

6 EFSA Panel on Food Contact Materials, Enzymes, Flavourings and Processing Aids (CEF), "Recent Developments in the Risk Assessment of Chemicals in Food and Their Potential Impact on the Safety Assessment of Substances Used in Food Contact Materials." 2016. EFSA Journal 14 (1): 4357. https://doi.org/10.2903/j.efsa.2016.4357

7 NEW Rotem Naftalovich, MD, MBA, Daniel Naftalovich, BS and Frank L. Greenway, MD: "Polytetrafluoroethylene Ingestion as a Way to Increase Food Volume and Hence Satiety Without Increasing Calorie Content". Journal of Diabetes Science and TechnologyVolume 10, Issue 4, July 2016, Pages 971-976
https://journals.sagepub.com/doi/epub/10.1177/1932296815626726

8 Lee, Sijoon, Kyung-Ku Kang, Soo-Eun Sung, Joo-Hee Choi, Minkyoung Sung, Keum-Yong Seong, Jian Lee, Subin Kang, Seong Yun Yang, Sunjong Lee, Kyeong-Ryoon Lee, Min-Soo Seo, and KilSoo Kim. 2022. "In Vivo Toxicity and Pharmacokinetics of Polytetrafluoroethylene Microplastics in ICR Mice" Polymers 14, no. 11: 2220.
https://doi.org/10.3390/polym14112220

9 International Agency for Research on Cancer. 1987. "IARC Monographs on the Evaluation of Carcinogenic Risks to Humans, Suppl 7, Overall Evaluations of Carcinogenicity: An Updating of IARC Monographs", Volumes 1 to 42.

10 Choi, Heeju, In-Ae Bae, Jae Chun Choi, Se-Jong Park, and MeeKyung Kim. 2018. "Perfluorinated Compounds in Food Simulants after Migration from Fluorocarbon Resin-Coated Frying Pans, Baking Utensils, and Non-Stick Baking Papers on the Korean Market." Food Additives & Contaminants: Part B 11 (4): 264–72.
https://doi.org/10.1080/19393210.2018.1499677

11 Consommateurs, 60 Millions de. 2022. "Poêles Antiadhésives : Nous Voulons Une Vraie Transparence." 60 Millions de Consommateurs. March 24, 2022. https://www.60millions-mag.com/2022/03/24/poeles- antiadhesives-nous-voulons-une-vraie-transparence-19857

12 Bundesinstitut für Risikobewertung. 2018. "Ausgewählte Fragen Und Antworten Zu Geschirr Mit Antihaftbeschichtung Aus PTFE Für Das Braten, Kochen Und Backen - BfR." www.bfr.bund.de. December 18, 2018. https://www.bfr.bund.de/cm/343/ausgewaehlte-fragen-und-antworten-zu-geschirr-mit-antihaftbeschichtung-aus-ptfe-fuer-das-braten-kochen-und-backen.pdf

13 Katragadda, Harinageswara Rao, Andrés Fullana, Sukh Sidhu, and Ángel A. Carbonell-Barrachina. 2010. "Emissions of Volatile Aldehydes from Heated Cooking Oils." Food Chemistry 120 (1): 59–65.
https://doi.org/10.1016/j.foodchem.2009.09.070

14 Schrenk, Dieter, Margherita Bignami, Laurent Bodin, James Kevin Chipman, Jesús del Mazo, Bettina Grasl-Kraupp, Christer Hogstrand, et al. 2020. "Risk to Human Health Related to the Presence of Perfluoroalkyl Substances in Food." EFSA Journal 18 (9).
https://doi.org/10.2903/j.efsa.2020.6223

15 American Cancer Society. 2023. "Perfluorooctanoic Acid (PFOA), Teflon, and Related Chemicals." March 21, 2023.
https://www.cancer.org/healthy/cancer-causes/chemicals/teflon-and-perfluorooctanoic-acid-pfoa.html.

16 Margerrison, Ed, Michael Argentieri, Dheerendra Kommala, and Scott Lucas. 2021. "Medical Device Material Performance Study PTFE Safety Profile ." https://www.fda.gov/media/158495/download.

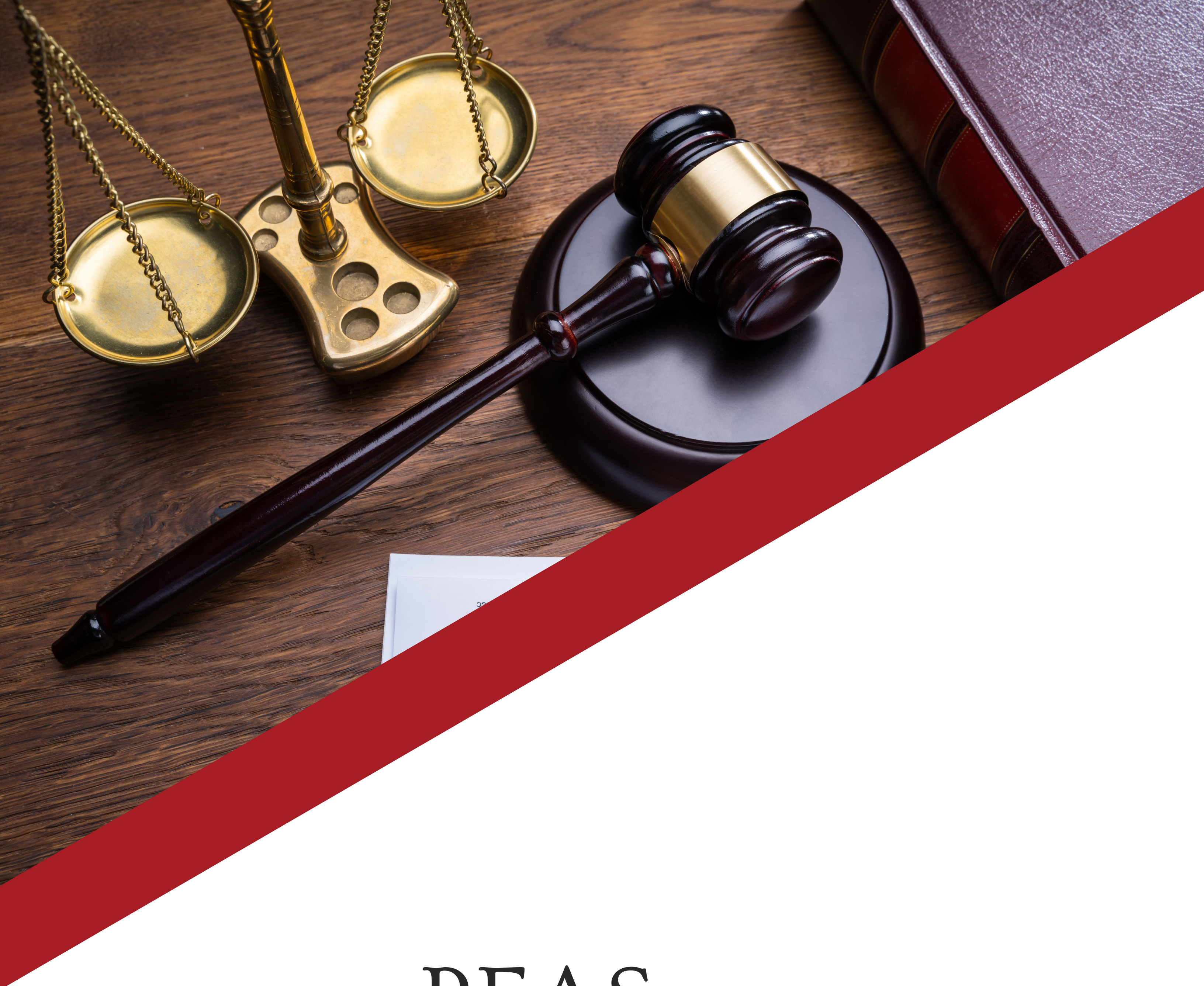
17 Webinar: Consultation on restriction proposal for per- and polyfluoroalkyl substances (PFAS) 5 April 2023
https://echa.europa.eu/documents/10162/21388210/2023_04_05_ECHA_UPFAS_infosession_all_presentations.p df/e4d9932e-4c6f-5950-601c-0cb8b5d8c441?t=1680595024744

18 FPG MANUFACTURING PROGRAMME FOR EUROPEAN MANUFACTURING SITES; FPG Newsletter September 2023:
https://fluoropolymers.eu/wp-content/uploads/2023/12/FPG_Newsletter_September2023.pdf

19 European Chemicals Agency (ECHA), Comments submitted to date on restriction report on PFAS Annex XV report Third Party Consultation; From 22/03/2023 to 25/09/2023. Part 22. Submission ID #4601, Federation of the European Cookware, Cutlery and Housewares Industries (FEC) "FEC's response to ECHA's consultation on the PFAS restriction proposal": https://echa.europa.eu/comments-submitted-to-date-on-restriction-report-on-pfas

20 European Chemicals Agency (ECHA) News Release, ECHA's committees: EU-wide PFAS ban in firefighting foams warranted; ECHA/NR/23/19 https://echa.europa.eu/-/echa-s-committees-eu-wide-pfas-ban-in-firefighting-foams-warranted#:~:text=ECHA's%20Committee%20for%20Socio%2DEconomic,200%20tonnes%20over%2030%20years.

21 Plastics Industry Association; Guide To The Safe Handling of Fluoropolymer Resins, 5th Ed.https://www.plasticsindustry.org/data-report/guide-to-the-safe-handling-of-fluoropolymer-resins-5th-ed/



PFAS EDUCATION

PART 3:
A CLOSER LOOK AT PFAS AND COOKWARE & BAKEWARE

PFAS Education Series

PART 3: A Closer Look at PFAS and Cookware & Bakeware

In previous parts of this series by CBA, we discussed several topics around PFAS and Cookware & Bakeware.

1. In Part 1 the large group of PFAS was divided into **non-polymeric fluorochemicals** and **polymeric fluoropolymers**. Fluoropolymers such as PTFE, which is used in nonstick coatings of cookware and bakeware, have very different properties compared to fluorochemicals. Existing legal restrictions of legacy fluorochemicals such as PFOA or PFOS should not be extended to fluoropolymers without scientific justification.
2. In Part 2, it was shown that fluoropolymers do not present an unacceptable risk to human health and are classified as polymers of low concern. PTFE coated cookware and bakeware are assessed by authorities in the US and Europe as safe for the user. In addition, the emissions of PFAS into the environment during the production of PTFE coated cookware is negligible.
3. In Part 3 we will have a closer look at the complete lifecycle of PTFE coated cookware and bakeware and current alternatives.

Lifecycle Assessment

Any lifecycle of consumer goods can be separated into four different sections: 1. Manufacturing of raw materials, 2. manufacturing of the product, 3. use of the product and 4. end-of-life.

It is important to point out that in the case of PTFE coated cookware phases 1, 2 and 4 are carried out by professionals with clear and elaborate OSHA safety and EPA environmental regulations.

Only phase 3 is carried out by non-professional consumers.

In Part 2 it was shown that PTFE coated cookware is of no or negligible concern during phases 2 and 3. Using existing best-available technologies emissions of these PTFE coated products are insignificant and will even be reduced in the coming years.

In phase 1 chemical manufacturers produce fluorinated monomers such as TFE (tetrafluoroethylene) and transform them into fluoropolymers using both fluorinated and non-fluorinated polymerization aids. There are technical and scientific indications that either of these production steps can be done without any non-polymeric PFAS emissions to the environment. A fluoropolymer industry-led initiative includes a platform to promote the adoption of commercially available state of the art technologies to minimize non-polymeric PFAS emissions during manufacturing.[1]

It can be summarized that based on phases 1 – 3 of the full lifecycle PTFE-coated cookware should not be restricted.

End-of-Life

Landfill, incineration or recycling are viable options for PTFE-coated cookware and bakeware used by consumers or professionals at the end-of-life.

A RIVM (Dutch National Institute for Public Health and the Environment) incineration review states that PTFE is stable at 260 °C without loss of mass. A PTFE coated article in **landfill** would therefore not decompose at the temperatures found in this environment (https://rivm.openrepository.com/handle/10029/625409). In addition, fluoropolymers such as PTFE are not soluble in water, not mobile, stable to most chemicals (https://setac.onlinelibrary.wiley.com/doi/10.1002/etc.5182) and UV radiation.

Therefore, it can be expected that there are negligible emissions of non-polymeric fluorochemicals in landfill due to PTFE-coated cookware.

Incineration and recycling can be discussed together because in both cases the fluoropolymer is thermally treated. Several studies have shown that it is possible to destroy or mineralize the fluoropolymers including undesired decomposition products such as problematic fluorochemicals (Utah 2023 https://www.wastedive.com/news/clean-harbors-incinerator-pfas-forever-chemicals/640829/, Dutch RIVM https://rivm.openrepository.com/handle/10029/625409, Karlsruhe Institute of Technology 2019 and 2023 https://doi.org/10.1016/j.chemosphere.2019.03.191).

Therefore, using the best-available technology and appropriate temperatures, PTFE and other fluoropolymers are of no concern for emissions of PFAS into the environment.

Due to the significant reduction of carbon footprint using recycled aluminum and stainless steel compared to their primary materials, it is strongly recommended to use an existing collection scheme or to implement a new scheme for PTFE-coated cookware at its end-of-life. Based on a rough estimate by FEC (European Federation for Cookware, Cutlery and Houseware Industry) more than 100 Mio. pieces of coated cookware is sold in Europa annually. The recycling of PTFE-coated aluminum cookware at end-of-life would reduce the carbon footprint by more than 250’000 tons $CO_{2\,eq.}$ per year.

Conclusion

PTFE-coated cookware and bakeware has throughout its full lifecycle a negligible risk for PFAS emissions into the environment and is safe-to-use for the consumer. Therefore, **in our opinion,** there is no foundation to restrict the manufacture, usage or recycling of products made with fluoropolymers.

Alternatives to PTFE-coated cookware

There are alternatives to PTFE-coated cookware and bakeware. The options can be split into two sub-groups: with and without nonstick coating. According to the 2023 Consumer Outlook Report, published by HomePage News, 72% of consumers indicated that they have a preference for products with nonstick coatings[2]. Therefore, stainless steel, cast iron or enameled cookware are not an equivalent alternative because they possess no nonstick property.

Nonstick is not only a function that simplifies the life of the user, it also reduces the risk of burning food with undesirable by-products that might be unhealthy. In turn, this also reduces the potential of food waste. It is an obvious feature of nonstick cookware that the cleaning is easier, and less cleaning agents and water is needed. Overall, nonstick cookware has a lower environmental footprint during its usage compared to alternatives without this property.

An example of nonstick alternatives are silicone-based coatings which are mainly used for bakeware. They are a low performance alternative to fluoropolymer systems, both in terms of temperature and damage resistance and nonstick performance. To avoid deterioration of silicones, temperatures of 230°C/446°F should not be exceeded during use [BfR recommendation, https://www.bfr.bund.de/cm/349/LI-Temperature-Resistant-Polymer-Coating-Systems-for-Frying--Cooking-and-Baking-Utensils.pdf].

The best-known nonstick alternative to PTFE based nonstick coatings are ceramic or sol-gel coatings. Ceramic refers to the material from which the coating is made of and sol-gel to the production technique being used. Today, there are two points in assessing this alternative:

- PTFE is a 100% defined material (polytetrafluoroethylene), but ceramic nonstick coatings can be made with a variety of materials. Thereby, the final ceramic coating and its composition varies from manufacturer to manufacturer.
- The ceramic coating itself has usually no nonstick performance and needs additional additives such as silicone oils.

To avoid any regretful substitution of PTFE-coated nonstick cookware, it is mandatory to carry out a study of the full lifecycle of ceramic coatings. To our best knowledge, no such analysis exists, and these coatings have been studied a lot less due to their limited applications compared to PTFE.

Important points regarding PTFE-based nonstick coatings:

1. PTFE-based nonstick coatings will retain their nonstick properties for as long as the coating is present on the coated article. This is due to the inherent nonstick properties of PTFE, a fluoropolymer. Alternative nonstick coating technologies will lose the nonstick characteristics over time.
2. PTFE-based nonstick coatings are unaffected by household dishwashers.
3. PTFE-based nonstick coatings emit very low levels of volatile organic compounds (VOCs) during the coating application process.
4. The risk of PTFE-based nonstick coatings releasing low molecular weight PFAS substances of concern or any other substance that might adulterate food during normal use is very low.[3]

Conclusion

Not enough is scientifically known about the full lifecycle of ceramic or sol-gel coated cookware to declare this a valuable alternative to PTFE coated cookware and bakeware. The risk of a regretful substitution is significant.

References:

1 Fluoropolymer Product Group Manufacturing Programme: https://fluoropolymers.eu/fluoropolymers/

2 HomePage News 2023 Consumer Outlook Report https://www.homepagenews.com/outlook23/?category=cookware

3 BfR German Federal Institute for Risk Assessment, FAQ of 18 December 2018: “Selected questions and answers on cookware, ovenware and frying pans with a non-stick coating made of PTFE https://www.bfr.bund.de/en/selected_questions_and_answers_on_cookware__ovenware_and_frying_pans_with_a_non_stick_coating_made_of_ptfe-60855.html], and Choi, Heeju, In-Ae Bae, Jae Chun Choi, Se-Jong Park, and MeeKyung Kim. 2018. “Perfluorinated Compounds in Food Simulants after Migration from Fluorocarbon Resin-Coated Frying Pans, Baking Utensils, and Non-Stick Baking Papers on the Korean Market.” Food Additives & Contaminants: Part B 11 (4): 264–72. https://doi.org/10.1080/19393210.2018.1499677