

FEC's response to ECHA's consultation on the PFAS restriction proposal

Founded in 1952, FEC, the Federation of the European Cookware, Cutlery and Housewares Industries, represents European companies dealing with cutlery, cookware and other nonelectrical household products used for preparing and serving food as well as for dining. We are a strong network of international companies, major national associations, and key suppliers of our industry. Our mission is to promote cooperation between members and to give fundamental help and support on economic and technical topics. We work to the definition of European regulations and officially represent the common interests of our members before the international authorities and particularly the European Commission in Brussels.

FEC represent 40 members spread over Europe: Belgium, Croatia, France, Germany, Italy, Spain, Switzerland, the Netherlands, the United Kingdom, etc. Our membership consists of companies, national associations, and suppliers for our industry.

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Executive summary

The members of FEC recognize the adverse effects on the environment and human health caused by certain chemicals within the PFAS family but are concerned by an approach which universally restricts all PFAS without any distinction between the many different types, properties, and risk levels and without considering the greater impacts on European competitiveness and strategic autonomy.

1) There are critical differences between polymerized and non-polymerized PFAS, something already accounted for by the restriction dossier. Fluoropolymers have been thoroughly studied for decades and are among the most well-understood groups of substances classified as PFAS by the OECD. Unlike non-polymeric PFAS, which are mobile, can bioaccumulate, and can have toxicity concerns, fluoropolymers have not been demonstrated to have negative health concerns and are a material of choice for sensitive applications such as medical devices, demonstrating strong confidence in their safety. (Section 1)

2) The production of fluoropolymer-coated cookware does not result in significant PFAS emissions into the environment due to limited content of non-polymeric PFAS in raw materials and effective environmental management measures. Additionally, non-fluorinated polymerisation aid technologies have the potential to greatly reduce the use of non-polymeric PFAS in the production process. (Section 2)

3) Fluoropolymers from food contact applications are unlikely to result in significant environmental emissions during the end-of-life phase. Landfilling, which represents a shrinking share of total EU waste management, is an unlikely source of PFAS emissions from fluoropolymers, due to the stability of the substances and lack of high ambient temperatures in landfilling conditions. Recycling and incineration, using adapted BATs (Best Available Techniques) that take into account PFAS control, result in full mineralisation of fluoropolymers, thereby preventing any degradation into non-polymeric PFAS. (Section 3)

The Restriction Proposal should therefore take into consideration the difference in risk and exposure between polymeric and non-polymeric PFAS and the absence of environmental risk from the cookware and bakeware sectors during production and end of life phase. Based on these grounds, we recommend excluding the use of fluoropolymers for cookware and bakeware from the scope of restriction.

4) The cookware and bakeware industries widely use fluoropolymers due to their unique combination of properties (e.g. non-stick, high temperature resistance, durability, heat conductivity, and resistance to abrasion). Ceramic cookware, the only tentative non-stick alternative, has lower non-stick durability and performance, requiring more frequent replacement with an increased environmental impact and price inflation for European consumers. There is no guarantee that, even with R&D investment and sufficient transition timing, alternatives can be found without compromising the high performance, durability, and functionality which are essential to maintain European competitiveness over Asia. (Section 4)

5) Any fluoropolymer restriction for the cookware and bakeware industries would have consequences on European strategic autonomy, competitiveness, and employment. The PFAS restriction proposal, as it is currently framed, would lead some parts of the industry to abandon their European production (fluoropolymer-coated cookware production for export markets; most R&D centres).

Even if a delay of 12 years were to be granted (the minimum estimated by the sector to complete all the transformation steps), some parts of the industry will not be able to absorb reconstruction costs, resulting in the collapse of major actors. European manufacturers that are able to bear the transformation costs and R&D costs will encounter a lack of competitiveness, due to investments to transform factories being comparatively lower in Asia. Finally, the significant investments will result in higher prices for consumers when purchasing cookware, and consumers may choose to buy cheaper imported products from outside Europe. (Section 5)

Conclusion: *With such a universal proposed restriction, the cookware and bakeware industries would be severely impacted, whereas fluoropolymers have not been demonstrated to have negative health concerns and their use by the cookware and bakeware industries is unlikely to result in significant environmental emissions during the manufacturing, use and end-of-life.*

Consequently, FEC requests the exclusion of fluoropolymers from the scope of restriction for use in cookware and bakeware.

Section 1 – Risk to Human Health

Fluoropolymers have been thoroughly studied for decades and are among the most well-understood groups of substances classified as PFAS by the OECD. Unlike non-polymeric PFAS, which are mobile, can bioaccumulate, and can have toxicity concerns, fluoropolymers have not been demonstrated to have negative health concerns. In fact, fluoropolymers are a material of choice for sensitive applications such as medical devices, demonstrating strong confidence in their safety. The demonstrated safety of fluoropolymers justifies that they should not be restricted in the same manner as non-polymeric PFAS. The lack of risks to human health from fluoropolymers imply that the restriction proposal is not proportional to the extremely minimal risk of the class.

Definition of Fluoropolymers:

Fluoropolymers are defined according to Buck *et al.*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 have been used for repeated-use food contact articles like cookware and bakeware since the mid-1950s.²

Research on the safety of fluoropolymers dates back to the 1960s and **has until now consistently found that they present no health risk to humans when used in food contact articles**. Unlike most non-polymeric PFAS, fluoropolymers have a very high molecular weight structure (>100,000 Dalton). Their structure makes them highly stable and durable and makes them unable to cross the gastrointestinal barrier and enter the organism.³

I. Fluoropolymers do not present an unacceptable risk to human health

- The 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*

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 US patent 30086018, 1955

³ 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>

*communicates that the compounds under this term share the same trait for having a fully fluorinated methyl or methylene carbon moiety”.*⁴

- A REACH restriction 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.⁵
 - **PTFE is not soluble in water** (and other common solvents) and is not mobile in the environment.⁶
 - Fluoropolymers have been repeatedly found to meet all of the OECD characteristics of polymers of low concern,⁷ based on their **stability, lack of bioavailability, lack of bioaccumulation, and general absence of observed ill effects**.
 - In a scientific opinion published in 2016 and relating to the risk analysis of chemical products in food, the scientific committee of the European Food Safety Authority (EFSA) specifies 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 the threshold size, EFSA indicates that it is unlikely that the polymers will be absorbed through the gastrointestinal barrier and **therefore considers that they do not present a health hazard**.⁸ By comparison, PTFE for food contact applications is characterised 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 do not pose a concern for health authorities.

⁴“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>

⁵ “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>

⁶ 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>.

⁷ 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>.

⁸ 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>

- 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 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.⁹
 - 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).¹⁰

II. 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.¹¹
 - 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*”.¹²
 - PTFE is known to start to deteriorate at an extremely slow rate above 260 °C. Above 360 °C, the degradation of PTFE starts to be measurable. However, according to the German

⁹ Lee, Sijoon, Kyung-Ku Kang, Soo-Eun Sung, Joo-Hee Choi, Minkyung 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>

¹⁰ 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.

¹¹ 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>

¹² 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>

Federal Office for Risk Assessment (BfR), the concentration of these emissions using PTFE-coated cookware is so low that there is no health risk for the user.¹³

- It should be noted that degradation temperatures for fat and oil are typically lower than 200 °C, 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.¹⁴ 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-treated 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).¹⁵ 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.”*¹⁶

III. 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

¹³ 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/de/ausgewaehlte_fragen_und_antworten_zu_geschirr_mit_antihaftbeschichtung_aus_ptfe_fuer_das_braten_kochen_und_backen-7012.html#topic_7018%20Quelle:%20https://pfannenhelden.de/teflonbeschichtung-giftig/

¹⁴ 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>

¹⁵ 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>

¹⁶ 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>.

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.¹⁷

- 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 and 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 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, which then raise concerns for exposure to humans through the food and water supply.¹⁸ Regulatory solutions for PFAS exposure should be guided by the scientific consensus, **while taking into account categories like fluoropolymers which have been consistently shown to be safe and result in minimal exposure.**
 - According to Evich *et al.* the global production volume of fluoropolymers is less than 10% of the overall PFAS production. Within the fluoropolymer industry, coatings for cookware and bakeware represent about 5% of the volume.^{19, 20} Therefore, the **fraction of fluoropolymer coatings for cookware and bakeware accounts for less than 0.5% of the total PFAS volume.**

¹⁷ 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>.

¹⁸ 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.pdf/e4d9932e-4c6f-5950-601c-0cb8b5d8c441?t=1680595024744

¹⁹ Fluoropolymer Product Group of PlasticsEurope. 2022, May. "Update of Market Data for the Socioeconomic Analysis (SEA) of the European Fluoropolymer Industry ." Plastics Europe. Accessed May 16, 2023. https://fluoropolymers.plasticseurope.org/application/files/1216/5485/3500/Fluoropolymers_Market_Data_Update_-_Final_report_-_May_2022.pdf.

²⁰ Evichet al., Science 2022, 375, 512 <https://www.science.org/doi/epdf/10.1126/science.abg9065>

- Whereas there are negative impacts on the environment and human health from some chemicals within the wide PFAS family, an approach to universally restrict all PFAS without any distinction between the many different types, which have varied properties and risk levels, would not be proportionate.
 - Anderson *et al* presented a review of approaches to grouping PFAS based on factors such as toxicity. Most of the experts in the panel agreed that not all PFAS should be grouped together, that persistence alone is not sufficient for grouping PFAS for the purposes of assessing human health risk, that subgroups are appropriate, and that the nature and definition of the subgroups can only be defined on a situation-dependent and case-by-case manner. No single grouping strategy was agreed on that would be sufficient for all regulatory or public health risk assessment purposes.²¹
 - Persistency alone is not a hazard criterion according to REACH and CLP.
 - The United Kingdom have also proposed Regulatory Management Options for PFAS and suggest a restriction excluding fluoropolymers: *“The restriction(s) set out above **need not apply to low hazard groups or low risk uses, for example; fluoroplastics or fluoroelastomers (low hazard groups) [...]. These could be highlighted as derogations to any restriction proposal**”*²².

Conclusion: There is no scientific basis that PTFE-coated cookware and bakeware poses a hazard or risk to humans or the environment. **Therefore, it is safe to use and should not be restricted.**

²¹ Anderson, J. K., R. W. Brecher, I. T. Cousins, J. DeWitt, H. Fiedler, K. Kannan, C. R. Kirman, *et al.* 2022. “Grouping of PFAS for Human Health Risk Assessment: Findings from an Independent Panel of Experts.” *Regulatory Toxicology and Pharmacology* 134 (October): 105226. <https://doi.org/10.1016/j.yrtph.2022.105226>

²² Health and Safety Executive. 2023. “Analysis of the most appropriate regulatory management options (RMOA)”. March 2023. <https://www.hse.gov.uk/reach/assets/docs/pfas-rmoa.pdf>

Section 2 – Environmental Emissions

The production of fluoropolymer-coated cookware does not result in significant PFAS emissions into the environment due to limited content of non-polymeric PFAS in raw materials (below 1 ppm) and effective environmental management measures. Considering the negligible environmental risk, any restriction for cookware and bakeware production would not be proportionate.

I. Description of the supply chain

The supply chain for fluoropolymer coated cookware and bakeware can be described in **three steps**. The following description gives a detailed view of this supply chain including the use of non-polymeric PFAS by the first operator of this supply chain.

a) Polymer Manufacturer

This first section covers chemical producers that are not members of FEC.

Fluoropolymer manufacturers transform fluorinated monomers such as TFE (tetrafluoroethylene) into polymers such as PTFE (polytetrafluoroethylene) using fluorinated or non-fluorinated polymerisation aids. For more than 10 years, the concentration of fluorinated polymerisation aids has been reduced to levels below 1ppm at the end of the process:^{23,24}

- Fluoropolymer manufacturers have mentioned in their Risk Management Option Analysis that abatement and recovery technologies are widely used in their industry leading to significant reduction in residual primary non-polymeric PFAS. The figure of 1 ppm residual is a commonly accepted figure in the sector, more details can be obtained directly from fluoropolymer manufacturers on a confidential basis.
- “The recovery/recycling techniques have been applied since the beginning of the 1990s and at the present time, they are installed in many FPs manufacturing facilities around the world and used for a variety of polymerisation aids. Recapture rate for fluorinated polymerisation aids of approximately 98% is achieved by some companies”.²⁵

²³ Dadalas, Michael C., Klaus Hintzer, Ludwig Mayer, Tilman C. Zipplies, and James Arthur McDonell. n.d. “Process for Removing Fluorinated Emulsifier from Fluoropolymer Dispersions Using an Anion-Exchange Resin and a Ph-Dependent Surfactant and Fluoropolymer Dispersions Containing a Ph-Dependent Surfactant.” Google Patents. Accessed May 16, 2023.

²⁴ Hoshikawa, Jun, Shinya Higuchi, and Yasuhiko Matsuoka. n.d. “Process for Producing Aqueous Dispersion of Purified Polytetrafluoroethylene.” Google Patents. Accessed May 16, 2023.
<https://patents.google.com/patent/US7238735?q=3M+dispersion+ion+exchange+resin>.

²⁵ Dieter Drohmann, Jaime Sales, Francisco Hernández Lara Dickens. 2021. “Regulatory management option analysis for fluoropolymers”. CHEMSERVICE. 4 November, 2021.
https://fluoropolymers.plasticseurope.org/application/files/5416/5104/8333/20211104_FP_RMOA_Final_3.pdf

Recently, new non-fluorinated polymerisation aids have been developed and patented, eliminating the need for fluorinated polymerisation aids completely.²⁶ More details can be found in Section IV.

Polymer manufacturers in Europe have issued recent statements highlighting their commitment to improve controls of PFAS emissions. “[All] FPG Members have committed voluntarily to responsible manufacturing principles in term of continuously improve and/or develop best available techniques in the manufacturing process, management of environmental emissions, development of R&D programs for the advancement of technologies allowing for the replacement of PFAS-based polymerisation aids, and/or the increase recyclability and reuse of its products in line with the objectives of circular economy.”²⁷

Fluoropolymers for food contact uses in Europe are mainly produced in:

- Germany (ex: 3M Dyneon)
- The United Kingdom (ex: AGC)
- The Netherlands (ex: Chemours)
- Italy (ex: Solvay, activity ceased in 2021)
- India (ex: GFL)
- USA (ex: Daikin, Chemours)
- Japan (ex: Daikin, AGC)
- China (ex: Daikin)

b) Coating Formulator

This section covers coating formulators, some of which are associated members of FEC.

The coating formulator creates mainly aqueous compositions including fluoropolymers, other non-fluorinated additives, binders and colorants to ensure application and performance of the final coating. As no non-polymer PFAS are intentionally added in this stage, the residual content of fluorinated polymerisation aids remains well below 1 ppm. As a safety measure against spill over of fluoropolymer-containing dispersions, the formulators use retention basins. This has been a general safety measure since the 1980s.

Coating manufacturers in Europe are mainly located in:

- Germany (ex: Weilburger)
- Switzerland (ex: Ilag)
- UK (ex: PPG)
- Italy (ex: PPG, Weilburger, Deco)

c) Article Manufacturer

Direct members of FEC are article manufacturers.

²⁶ Chauhan, Rajeev, Gaurav Kumar, P. s RAO, Navin Soni, B. s BHATTACHARYA, Anamika DUTTA, Akanksha SHUKLA, and Anand Mohan PATEL. n.d. “Process for Preparing Fluoropolymers and Fluoroelastomers in Presence of a Non Fluorinated Sulfonate Type Hydrocarbon Containing Surfactant Thereof.” Google Patents. Accessed May 16, 2023. <https://patents.google.com/patent/US20220372179A1/en?q=US20220372179A1>.

²⁷ Dieter Drohmann, Jaime Sales, Francisco Hernández Lara Dickens. 2021. “Regulatory management option analysis for fluoropolymers”. CHEMSERVICE. 4 November, 2021. https://fluoropolymers.plasticseurope.org/application/files/5416/5104/8333/20211104_FP_RMOA_Final_3.pdf

On the article manufacturer's site, the surface of the cookware or bakeware is cleaned using mechanical and chemical means without use of any PFAS. Afterwards, the liquid coating dispersion is applied to the surface of the cookware or bakeware article.

This can be done by spraying or a roller coating process. The first is carried out in a spray chamber on preformed articles, while in the latter the coating is rolled onto a sheet of metal. Depending on the number of coating layers, these process steps have to be repeated several times. In both cases the coating is cured after application at 400 to 420 °C. Roller coated materials will be formed into the final article shape at the end.

No non-polymer PFAS are intentionally added in this stage, and fluorinated polymerisation aids may be present in very small amounts²⁸, below the detection threshold, as residues in the dispersions. Possible sources for emissions of fluorinated polymerisation aids as well as fluoropolymer particles are treated by manufacturers with rigorous environmental management systems to control emissions:

Possible source of emissions	Environmental management systems
(a) Evaporation during spraying	The air from the spraying chambers is filtered and sent through the coating furnace or the thermal oxidising unit
(b) Evaporation in the roller coating process	The expected amounts of evaporating fluorinated polymerisation aids are so low that usually no specific measures are taken. Nevertheless, emissions of VOCs can occur as well. They are treated ²⁹ according to national emission control legislation, <i>e.g.</i> thermal oxidation, which also would destroy fluorinated polymerisation aids. (see section 3, part VI)
(c) Overspray in the spray process	Overspray is collected from the spray chambers and filtered for solid particles. The remaining (aqueous) liquid fraction is treated in the wastewater system of the plant.
(d) Spillage in the roller coating process	Same as (c)
(e) Evaporation during the curing process	All substances which evaporate during the curing process are treated in the exhaust system for example by thermal oxidation, ensuring that fluorinated polymerisation aids will be decomposed to HF. Because the amounts are far below the limit values in national emission control legislation, no further treatment is necessary.

²⁸ Polymer producers deliver dispersions with a level of fluorinated surfactants below 1 ppm with current state-of-the-art technology, which they confirm in their declaration of compliance.

²⁹ Official Journal of the European Union. 2012. "Directive 2012/18/Eu Of The European Parliament And Of The Council Of 4 July 2012 On The Control Of Major-Accident Hazards Involving Dangerous Substances, Amending And Subsequently Repealing Council Directive 96/82/EC." EUR-Lex. 2012. <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32012L0018>.

Possible source of emissions	Environmental management systems
(f) Leftovers in the dispersion containers	Containers which were used to supply the coating dispersion are cleaned with water, which is treated the same way (c) as the overspray from the spraying booths.
(g) Solid particles in the filters of the exhaust air and wastewater treatment	All filters are sent to a special waste treatment company, which burns the filters and destroys all fluorinated substances.

More information can be found in Section II. *Processes to prevent environmental emissions*. Cookware manufacturing in the EU is largely concentrated amongst the following producers and locations. Some examples are given in this non-exhaustive list.

- France
 - Cristel
 - De Buyer
 - Groupe SEB
- Germany
 - BAF Industrie
 - Fissler
 - Woll
- Italy
 - Aluflon
 - Ballarini
 - TVS
- Spain
 - Corr
 - Inoxbar
 - Valira
- Denmark
 - Scanpan
- Finland
 - Fiskars

II. Processes to prevent environmental emissions

Cookware manufacturers have strict rules which guide the use of PTFE and fluoropolymers in their manufacturing to minimize environmental risk. Industrial sites have highly modernized equipment and procedures to ensure efficient environmental management of production processes.

- There are strong measures at multiple levels which control raw materials coming from suppliers:
 - European regulations
 - The main example being the Industrial Emissions Directive (IED), 2010/75/EU. The controls in the IED are based on the Best Available Technique (BAT) principle

covering a [broad] range of industrial activities, and on the implementation of Emission Limit Values (ELV).³⁰

- National regulations
 - At national level, article manufacturing sites are subject to measures such as the Environmental Code in France and the definition of ICPEs (*Installation Classée pour la Protection de l'Environnement*). In Italy, national and local authorities issue Integrated Pollution Prevention and Control authorisations (IPPC) for instance. Furthermore, Italy imposes strict regulations for the disposal of wastewater.
- Company-specific procedures and processes
 - Regional and local environmental control authorities are typically in charge of the adaptation of European and national laws into environmental management measures for individual sites. Additionally, individual sites may be certified through ISO 14001, although more details on this can be obtained directly through FEC member contributions.

Manufacturers have implemented rigorous environmental management systems to control emissions related to the possible sources of emissions (see chapter I c).

- a) The air from the spraying chambers is filtered and sent through the coating furnace or thermal oxidising unit.
- b) The expected amounts of evaporating fluorinated polymerisation aids are so low that usually no specific measures are taken. Nevertheless, emissions of VOCs can occur as well. They are treated³¹ according to national emission control legislation, e.g. thermal oxidation, which also would destroy fluorinated polymerisation aids.
- c) Overspray is collected from the spray chambers and filtered for solid particles. The remaining (aqueous) liquid fraction is treated in the wastewater system of the plant.
- d) Spillage in the rolling pouring process: same as (c)
- e) All substances, which evaporate during the curing process are eliminated in the coating furnace and further treated by thermal oxidation in the exhaust system, ensuring that fluorinated polymerisation aids will be decomposed to HF. Because the amounts are far below the limit values in national emission control legislation, no further treatment is necessary.
- f) Containers, which were used to supply the coating dispersion are cleaned with water, which is treated the same way (c) as the overspray from the spraying booths.
- g) All filters are sent to a special waste treatment company, which burns the filters and destroys all fluorinated substances.

³⁰ <https://www.eea.europa.eu/themes/industry/intro>

³¹ Official Journal of the European Union. 2012. "Directive 2012/18/Eu Of The European Parliament And Of The Council Of 4 July 2012 On The Control Of Major-Accident Hazards Involving Dangerous Substances, Amending And Subsequently Repealing Council Directive 96/82/EC." EUR-Lex. 2012. <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32012L0018>.

III. Worker protection – Occupational exposure

Material safety data sheets from coating suppliers and fluoropolymer dispersion manufacturers give information about occupational hazards and protective equipment required.³²

IV. Introduction of fluoropolymer production using non-fluorinated polymerisation aid

The analysis in this section covers chemical producers that are not members of FEC.

Manufacturers of fluoropolymer coatings have been consistently iterating and improving their formulations, phasing out substances of concern, often voluntarily. These have included removing PFOA before it was restricted, as cadmium and lead for example.

Non-fluorinated polymerisation aid (NFPA) technologies to produce fluoropolymers without the use of fluorinated polymerisation aids have the potential to greatly reduce the use of non-polymeric PFAS in the production process, effectively addressing any concerns about the release of PFAS into the environment during the manufacturing stage.

- Typically, most fluoropolymer producers use 0.2 to 0.4 % of primary fluorinated polymerisation aid in their process. According to FPG,³³ in 2015, 3,500 tonnes of fluoropolymer were used in the manufacture of cookware in Europe. Switching to NFPA technologies in the supply chain would then ultimately lead to avoid the use of quantities between 7 and 14 tonnes of fluorinated polymerisation aid every year at fluoropolymer manufacturing sites.

Use of NFPA would also be beneficial for industry, reducing the complexity of the cookware supply chain by requiring fewer constraints on environmental management and product testing. Upstream manufacturing of NFPA dispersion requires stricter control of polymerisation, however, which could increase complexity to a degree. With the right incentives, industry could largely move from current polymerisation technologies to NFPA.

- A clear definition of processes that qualify as NFPA technologies is needed to ensure that industry does not engage in regrettable substitution. This could be addressed by specific legislation outside of REACH. EFSA could be tasked to approve such processes as it has done in the past when approving other polymerisation aids.

NFPA technology already exists, but to our best knowledge, only one supplier (Gujarat Fluorochemicals) is currently able to provide commercial grade product. Requirements to implement this technology on too short of a timeframe would induce concerns of sufficient supply, as well as potentially giving this company a monopoly on the market.

³² 3M MSDS

https://multimedia.3m.com/mws/mediawebserver?mwsId=SSSSSuUn_zu8l00xM8tSNxm1Nv70k17zHvu9lxtD7SSSSSS--

³³

https://fluoropolymers.plasticseurope.org/application/files/7816/1167/4026/Final_SEA_Fluoropolymers_summary2017_3.pdf

We anticipate that other manufacturers will require up to 5 years to be able to offer commercial grade NFPA. This would already be a substantially shorter phaseout than similar cases such as that of PFOA in the United States, which began in 2006 and ended in 2015. The actual timeline will depend on each fluoropolymer manufacturer's R&D strategy.

V. Consumer use phase

There are two statements from EFSA confirming that fluorinated polymerisation aids are successfully removed from the coating during the curing process.

- a) In its 2011 scientific opinion regarding the use of the fluorinated polymerisation aid 3H-perfluoro-3-[(3-methoxy-propoxy)propanoic acid], ammonium salt (ADONA, CAS 958445-44-8)³⁴, the European Food Safety Authority notes that : *"It is (...) expected that the decomposition products as well as the substance itself are efficiently removed from the polymer during thermal processing (high temperature extrusion, baking or sintering) into a final article."* The authority also reported content analyses on four different materials and noted that *"in all [four] cases the substance was not detectable in the final sintered perfluoropolymer materials at a detection limit of 0.02 mg/kg."*
- b) Similarly for the substance perfluoro[(2-ethyloxy-ethoxy)acetic acid], ammonium salt (CAS 908020-52-0), EFSA noted that *"it can (...) be expected that any post-polymerisation residual content of the substance is efficiently removed during thermal processing (high temperature extrusion, baking or sintering) into a final article. This was supported by an analytical screening experiment on a finished food contact PTFE polymer."* Following a set of migration testing, they also conclude that *"the data indicate that final PTFE food contact polymers do not contain the substance at concentrations which cause measurable migration into foods."*³⁵

Therefore, there are no emissions of fluorinated polymerisation aids during intended and foreseeable use.

³⁴ European Food Safety Authority. 2011. "Scientific Opinion on the Safety Evaluation of the Substance, 3H-Perfluoro-3-[(3-Methoxy-Propoxy)Propanoic Acid], Ammonium Salt, CAS No. 958445-44-8, for Use in Food Contact Materials." *EFSA Journal* 9 (6): 2182. <https://doi.org/10.2903/j.efsa.2011.2182>.

³⁵ European Food Safety Authority. 2011. "Scientific Opinion on the safety evaluation of the substance, Perfluoro[(2-ethyloxy-ethoxy)acetic acid], ammonium salt, CAS No. 908020-52-0, for use in food contact materials." *EFSA Journal* 9 (6): 2183. <https://efsa.onlinelibrary.wiley.com/doi/pdf/10.2903/j.efsa.2011.2183>.

Section 3 – End of Life

Fluoropolymer coated cookware and bakeware can be handled properly at their end of life, with minimal risk of environmental emissions of non-polymeric PFAS. Incineration, recycling and landfilling all adequately address the possibility of PFAS emissions, and consequently fluoropolymer-coated food contact items are unlikely to represent a risk to human health or the environment. Therefore, restricting the use of fluoropolymers for cookware and bakeware is disproportionate considering the lack of environmental and health risks and the existing risk management solutions.

I. The aims of the Circular Economy Action Plan and the European Green Deal

The aim of the European Green Deal is to support the transition to climate neutrality by 2050 for Europe to become the first climate-neutral continent. **The recycling of metal coated cookware and bakeware will contribute to this effort:**

- Recycling of aluminium reduces the carbon footprint by 95% compared to primary aluminium. According to European Aluminium³⁶, 51% or 4.3 Mt of aluminium produced annually in Europe comes from recycled sources, reducing the carbon footprint by 27.8 Mt CO₂ eq..³⁷ Therefore, fluoropolymer coated aluminium cookware should not be excluded from recycling.
- For stainless steel, another metal that is frequently coated with fluoropolymer-based materials, recycling reduces the carbon footprint by 70%.³⁸

FEC are in the process of collecting data on consumer behaviour in terms of recycling and article collection at the end of life stage of cookware and bakeware, and will report more detailed data on this later in this consultation process.

II. Sectoral initiatives

Collection schemes, initiatives from distributors

Some distributors have already taken some local initiatives to improve the collection of cookware and bakeware articles, making use of existing recycling schemes for metals.³⁹ Some local authorities also relay the message that coated cookware should be brought to recycling centres.⁴⁰

³⁶ European Aluminium. 2021. "Environmental profile report for the aluminium refining industry. Life Cycle Inventory data (2017-2019) for the production of cast alloys from scrap and waste. November 2021. https://european-aluminium.eu/wp-content/uploads/2022/08/2021-11-16_european-aluminium_environmental-profile-report-for-the-aluminium-refining-industry-1.pdf

³⁷ European Aluminium. n.d. "A Low Carbon Footprint." Accessed May 16, 2023. <https://european-aluminium.eu/projets/a-low-carbon-footprint/>

³⁸ Johnson, Jeremiah, B.K. Reck, T. Wang, and T.E. Graedel. 2008. "The Energy Benefit of Stainless Steel Recycling." *Energy Policy* 36 (1): 181–92. <https://doi.org/10.1016/j.enpol.2007.08.028>.

³⁹ Terracycle. n.d. "Le Kiosque de Recyclage Gratuit Carrefour." TerraCycle. Accessed May 16, 2023. <https://www.terracycle.com/fr-FR/brigades/carrefour-fr#@46.43945823018682:2.0516999531444124zoom:5>.

⁴⁰ Recycle for Greater Manchester. n.d. "Pots, Pans and Saucepans." Recycle for Greater Manchester. Accessed May 16, 2023. <https://recycleforgreatermanchester.com/what-do-i-do-with/pots-pans-saucepans/>.

Improving the collection and intake of metal for recycling of cookware and bakeware will play a role in reaching the sustainability and circular economy objectives of the European Green Deal and Circular Economy Action Plan.

Critically, fluoropolymers are distinct from non-polymeric PFAS when it comes to recycling. Metal recycling processes can adequately address the presence of fluoropolymers in waste articles, preventing the release of non-polymeric PFAS into the environment, and therefore eliminating potential sources of human exposure. Existing regulations (BAT, Best Available Techniques) should take into account the presence of fluoropolymers and the method by which they need to be treated and managed properly by metal foundries.

Separation of waste

General metal recycling schemes are already in place in Europe. FEC estimates that about 1% of aluminium and 0.1% of steel produced annually is used for the cookware and bakeware sector. Therefore, no specific EPR (Extended Producer Responsibility) schemes for fluoropolymer coated cookware and bakeware are needed, as the volumes would be too small to support such initiatives.

FEC supports regulatory efforts to improve recycling rates and sectoral efforts to inform and train the final consumer to make use of the metal recycling stream for their products at the end of life. Metal recycling must be a priority in the waste and recycling policy of the European Commission.

III. Fate of products at their end of life

Recycling and incineration rates vary widely between EU Member States. A maximum landfill target rate of 10% rate has been established for 2035, and many Member States have already achieved or exceeded this target.

Table 1 illustrates the varying levels of waste treatment across the EU.

FEC will demonstrate in the following section that none of the following end of life scenarios pose an environmental risk (landfill, incineration metal recycling), provided proper BATs are established for metal foundries and incinerators.

Germany⁴¹

Germany provides a strong case study demonstrating that strict regulatory regimes and investment in waste and recycling infrastructure can result in a minimum of waste ending up in landfill.

Only 0.4% of municipal (household) waste goes to landfill. There are existing waste collection systems for paper, glass, biodegradable waste, electronic equipment and packaging materials. In most areas metal waste can be brought to recycling sites. It is likely that bigger items like cookware and bakeware are separated from the municipal waste stream. Thus, the majority of cookware and bakeware items go into metal recycling or incineration.

⁴¹ Umwelt Bundesamt. 2013. "Ablagerungsquoten Der Hauptabfallströme." Umweltbundesamt. August 7, 2013. <https://www.umweltbundesamt.de/daten/ressourcen-abfall/ablagerungsquoten-der-hauptabfallstroeme#ablagerungsquoten>.

FEC will provide more data at a later date on consumer behaviour when disposing of cookware and bakeware articles at the end of life.

TABLE 1 – Waste fate by EU Member State

Rates of recovery and disposal of the total waste treated in the EU27, years 2017-2019⁴²

Countries / Group	Disposal						Recovery								
	Incineration (D10)			Landfilling and other operations (D1-D7, D12)			Material recycling			Recovery composting and aerobic/anaerobic digestion			Energy recovery (R1)		
	2017	2018	2019	2017	2018	2019	2017	2018	2019	2017	2018	2019	2017	2018	2019
EU27	1%	1%	1%	25%	25%	24%	30%	31%	31%	17%	17%	18%	27%	27%	27%
Austria	0%	0%	0%	2%	2%	2%	26%	26%	26%	32%	33%	33%	39%	39%	39%
Belgium	1%	1%	1%	1%	1%	1%	34%	34%	34%	20%	20%	21%	42%	42%	42%
Bulgaria	0%	0%	na	62%	61%	na	27%	30%	na	8%	2%	na	3%	7%	na
Croatia	0%	0%	0%	75%	72%	66%	22%	25%	30%	2%	3%	4%	0%	0%	0%
Cyprus	0%	0%	0%	83%	80%	81%	15%	17%	16%	2%	2%	2%	0%	1%	1%
Czech Republic	0%	0%	0%	48%	48%	48%	23%	23%	23%	11%	11%	12%	18%	17%	17%
Denmark	0%	0%	0%	1%	1%	1%	29%	32%	34%	19%	18%	18%	51%	49%	48%
Estonia	0%	0%	0%	20%	23%	19%	26%	26%	30%	4%	4%	3%	44%	44%	48%
Finland	0%	0%	0%	1%	1%	1%	27%	29%	29%	13%	13%	14%	59%	57%	56%
France	0%	0%	0%	21%	20%	20%	24%	25%	26%	20%	20%	20%	34%	34%	34%
Germany	1%	1%	1%	1%	1%	1%	49%	49%	48%	18%	18%	19%	31%	31%	32%
Greece	0%	0%	0%	80%	78%	78%	15%	15%	16%	4%	5%	5%	1%	2%	1%
Hungary	0%	0%	0%	49%	49%	51%	27%	29%	27%	8%	8%	9%	16%	13%	14%
Ireland	0%	0%	na	23%	15%	na	32%	30%	na	9%	9%	na	32%	43%	na
Italy	1%	1%	1%	26%	24%	23%	30%	32%	33%	22%	23%	23%	20%	20%	21%
Latvia	0%	0%	0%	70%	68%	56%	19%	22%	35%	8%	7%	5%	3%	2%	3%
Lithuania	0%	0%	0%	33%	27%	25%	24%	27%	31%	24%	32%	25%	19%	14%	17%
Luxembourg	0%	0%	0%	4%	4%	4%	30%	30%	30%	19%	19%	19%	47%	47%	47%
Malta	0%	0%	0%	88%	89%	91%	12%	11%	9%	0%	0%	0%	0%	0%	0%
The Netherlands	1%	1%	1%	1%	1%	1%	26%	27%	28%	28%	29%	29%	43%	42%	41%
Poland	2%	2%	1%	42%	42%	43%	27%	26%	25%	7%	8%	9%	23%	23%	22%
Portugal	0%	0%	0%	49%	51%	50%	13%	13%	13%	18%	18%	18%	21%	19%	20%
Romania	0%	0%	0%	81%	83%	82%	7%	8%	8%	7%	4%	5%	4%	5%	5%
Slovakia	0%	1%	4%	61%	55%	52%	21%	27%	27%	9%	10%	12%	10%	7%	5%
Slovenia	5%	1%	0%	13%	12%	12%	53%	54%	52%	20%	21%	20%	10%	12%	16%
Spain	0%	0%	0%	51%	54%	54%	18%	18%	18%	18%	17%	17%	13%	12%	11%
Sweden	0%	0%	0%	0%	1%	1%	31%	30%	32%	15%	16%	14%	53%	53%	53%

⁴² Istituto Superiore per la Protezione e la Ricerca Ambientale. 2021. “Rapporto Rifiuti Urbani”. 355/2021. December, 2021. https://www.isprambiente.gov.it/files2022/pubblicazioni/rapporti/rapportorifiutiurbani_ed-2021-n-355-conappendice_agg18_01_2022.pdf

Source: Istituto Superiore per la Protezione e la Ricerca Ambientale. 2021. “Rapporto Rifiuti Urbani”. 355/2021. December, 2021.

https://www.isprambiente.gov.it/files2022/pubblicazioni/rapporti/rapportorifiutiurbani_ed-2021-n-355-conappendice_agg18_01_2022.pdf

IV. Fate of fluoropolymers in landfill

Due to a number of factors, fluoropolymers are highly unlikely to degrade in landfill conditions. They have high UV resistance, are not subject to degradation by microbiological activity, and fluoropolymer decomposition temperatures are not reached in landfills. Their inertness to chemicals and insolubility in water and other solvents adds to their stability in landfills. No toxic emissions from fluoropolymers in landfills are expected.

“[Fluoropolymers have] particularly good UV resistance because of its very strong carbon- fluorine (C-F) bond [almost 30% higher than the carbon-hydrogen (C-H) bond], which is the common side bond that surrounds the carbon (C-C) backbone in a helix and protects it. Most fluoropolymers also do not have the light absorbing chromophore impurities in their structure that can act as an initiator for photo-oxidation.”⁴³

The Interstate Technology Regulatory Council (ITRC, a USA State led coalition) explains that “the type of PFAS (...) determines the relative environmental significance. Non-polymer PFAS (...) and some side-chain fluorinated polymer PFAS are likely to pose greater risks when released to the environment than certain fluoropolymer sources, such as the fluoropolymers PTFE (...). These fluoropolymers are considered to be polymers of low concern because they are relatively stable, insoluble in the environment, and not bioavailable”.⁴⁴

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 a landfill.⁴⁵

Guelfo *et al* also reiterate the inertness of PTFE and its lack of reactivity in the environment.⁴⁶

Due to the stability of fluoropolymers under the environmental conditions experienced in landfills, they are unlikely to degrade into non-polymeric PFAS, and therefore will not be a source of exposure to these

⁴³ Cole-Parmer. 2018. “UV Properties of Plastics: Transmission and Resistance .” Coleparmer.com. October 15, 2018. <https://www.coleparmer.com/tech-article/uv-properties-of-plastics> <https://www.coleparmer.com/tech-article/uv-properties-of-plastics>

⁴⁴ Interstate Technology Regulation Council. 2021. “2.1 Environmental Significance – PFAS — Per- and Polyfluoroalkyl Substances.” Pfas-1.itrcweb.org. August 2021. <https://pfas-1.itrcweb.org/2-1-environmental-significance/>.

⁴⁵ J. Bakker | B. Bokkers | M. Broekman, RIVM report 2021-0143 <https://rivm.openrepository.com/handle/10029/625409>

⁴⁶ Guelfo, Jennifer L., Stephen Korzeniowski, Marc A. Mills, Janet Anderson, Richard H. Anderson, Jennifer A. Arblaster, Jason M. Conder, *et al*. 2021. “Environmental Sources, Chemistry, Fate, and Transport of Per- and Polyfluoroalkyl Substances: State of the Science, Key Knowledge Gaps, and Recommendations Presented at the August 2019 SETAC Focus Topic Meeting.” *Environmental Toxicology and Chemistry* 40 (12): 3234–60. <https://doi.org/10.1002/etc.5182>.

substances. As Section 1 demonstrates, fluoropolymers themselves are not a health or environmental concern, and therefore their presence in landfills does not constitute a risk. Further, EU targets for minimizing landfilling to below 10% by 2035 will further reduce any possible presence of fluoropolymer-coated cookware and bakeware in landfills.

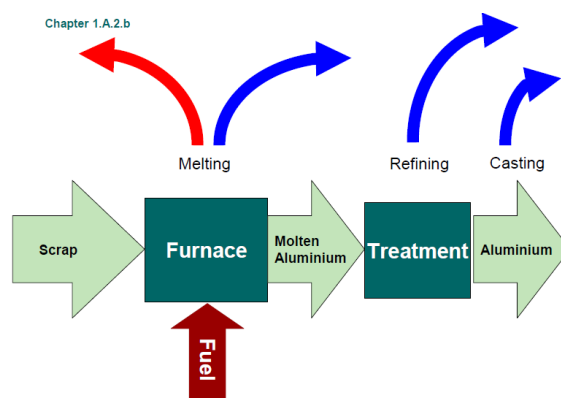
V. Fate of fluoropolymers in the metal recycling stream

The substrates used for fluoropolymer-based cookware and bakeware are recyclable. The majority of fluoropolymer based coated cookware is aluminium, with stainless and carbon steel representing a smaller portion of the overall category.

Aluminium recycling process:

“Coated scrap, like used beverage cans, is de-coated as an integrated part of the pre-treatment and melting process. The metal is refined either in the holding furnace or in an inline reactor to remove gases and other metals generally in the same way as for primary aluminium.”⁴⁷

Table 2 – Process scheme for secondary aluminium production.



Source: European Environment Agency. 2019. “EMEP/EEA Air Pollutant Emission Inventory Guidebook 2019.” European Environment Agency. 2019. <https://www.eea.europa.eu/publications/emep-eea-guidebook-2019>.

It is noteworthy that organic coatings on aluminium will not only be exposed to the temperature of the main furnace where the aluminium is melted, but also to higher temperatures in afterburners designed to mitigate emissions of VOCs and dioxins mainly.

“[An] important factor [in the control of aluminium recycling] is the combustion of organic coatings in the pre-treatment or melting furnace and the extraction and abatement systems can all be designed to cope

⁴⁷ European Environment Agency. 2019. “EMEP/EEA Air Pollutant Emission Inventory Guidebook 2019.” European Environment Agency. 2019. <https://www.eea.europa.eu/publications/emep-eea-guidebook-2019>.

with the treatment of these emissions. Fugitive emissions can be significant unless the fume collection systems are well designed. Afterburners are used generally to convert unburned VOC to CO₂ and H₂O.”

Table 3 – BAT-associated emission factors for source category 2.C.3 Aluminium production, secondary aluminium production

BAT compliant emission factors				
	Code	Name		
NFR Source Category	2.C.3	Aluminium production		
Fuel	N/A			
Other		Secondary aluminium, furnace processes, re-melting		
Pollutant	Value	Unit	95% confidence interval	
			Lower	Upper
Dust	2 - 5	mg/Nm ³		
SO _x	< 100	mg/Nm ³		
Chloride	≤ 0.1	mg/Nm ³		
Dioxins	≤ 0.1	ng TEQ/Nm ³		
HCl	≤ 5 - 10	mg/Nm ³		
VOC	10 - 30	mg/Nm ³		
HF	≤ 0.1	mg/Nm ³		

Source: European Environment Agency. 2019. “EMEP/EEA Air Pollutant Emission Inventory Guidebook 2019.” European Environment Agency. 2019. <https://www.eea.europa.eu/publications/emep-eea-guidebook-2019>.

Stainless steel recycling process

Steel mills melt both steel and stainless steel scrap, once cleaned, directly in an apparatus such as an electric arc furnace. After that, the melt passes to a steel converter to remove excess carbon and nitrogen. Once carried out, at a ladle station a final analysis process allows metallurgical adjustments to the materials chemistry. Once formed into ingots the material is stored for later ongoing production processes.⁴⁸

According to stainless steel manufacturers, the material is 100% recyclable and most stainless steels are comprised of 60% to 90% recycled material, which is actually limited by the availability of stainless steel scrap/ waste.⁴⁹

Temperatures in these furnaces are typically between 1 400 and 1 800 °C. As the following section demonstrates, the temperatures in recycling processes are sufficient to destroy fluoropolymers and ensure no non-polymeric PFAS are emitted into the environment.

⁴⁸ “Stainless Steel Recycling: How to Recycle Steel.” 2017. Montanstahl. July 10, 2017. <https://www.montanstahl.com/blog/recycling-stainless-steel>

⁴⁹ Ancon Building Products. n.d. “The Use of Stainless Steel.” Ancon (AU). <https://www.ancon.com.au/about-us/the-use-of-stainless-steel>.

VI. Review of incineration studies

According to the restriction dossier submitters, the assumed potential for emissions of non-polymeric PFAS from fluoropolymers is overwhelmingly accounted for in the end of life stage (shown in Figure B.69 in Annex XV report). Consequently, a demonstration that fluoropolymers from food contact applications can be adequately addressed in the waste stream would show that the category cannot be considered a significant source of human or environmental exposure. The following studies represent the state-of-the-art scientific knowledge on the question of fluoropolymer fate during incineration. The conditions in incineration and recycling can be met to ensure full mineralisation of fluoropolymers after incineration.

- Fluoropolymers, including PTFE, are completely destroyed under specific incinerator operating conditions.
 - Yamada *et al.*⁵⁰ studied textiles and paper treated with fluorotelomers at temperatures of 1,000 °C and residual times of 2 seconds. They found that they will be destroyed and will not be a source of PFOA in the environment.
 - According to a 2019 study from the Karlsruhe Institute of Technology, municipal incineration of PTFE did not result in significant generation of studied PFAS at temperatures between 870 and 1 020 °C. Instead, the PFAS degraded mainly into hydrofluoric acid and carbon dioxide.⁵¹
 - According to a 2021 report by the Dutch RIVM, PTFE is reduced to a fully mineralized state after 2 seconds of incineration at 850 °C. At incinerator bed temperatures, which generally range between 900 and 1 100 °C, PTFE and other fluorinated polymers are expected to fully degrade into small fluorocarbon molecules. For a high degree of thermal degradation, temperatures higher than 850 °C are required.⁵²
 - In 2023, an independent study of PFAS in hazardous waste incineration in Utah showed a thermal destruction of more than 99.9999 % at temperatures of 1 154 °C.⁵³
- In the JRC Science Report to the European Commission on the “Best Available Technology (BAT) Reference Document for the Non-Ferrous Metals Industries”, it is recommended to use

⁵⁰ Yamada, Takahiro, Philip H. Taylor, Robert C. Buck, Mary A. Kaiser, and Robert J. Giraud. 2005. “Thermal Degradation of Fluorotelomer Treated Articles and Related Materials.” *Chemosphere* 61 (7): 974–84.
<https://doi.org/10.1016/j.chemosphere.2005.03.025>

⁵¹ Aleksandrov, Krasimir, Hans-Joachim Gehrmann, Manuela Hauser, Hartmut Mätzing, Daniel Pigeon, Dieter Stapf, and Manuela Wexler. 2019. “Waste Incineration of Polytetrafluoroethylene (PTFE) to Evaluate Potential Formation of Per- and Poly-Fluorinated Alkyl Substances (PFAS) in Flue Gas.” *Chemosphere* 226 (July): 898–906.
<https://doi.org/10.1016/j.chemosphere.2019.03.191>.

⁵² Bakker, J., B. Bokkers, and M. Broekman. 2021. “Per- and Polyfluorinated Substances in Waste Incinerator Flue Gases.” Rijksinstituut voor Volksgezondheid en Milieu RIVM. December 8, 2021.
<https://rivm.openrepository.com/handle/10029/625409>.

⁵³ Quinn, Megan. 2023. “Clean Harbors Says It Can Destroy More than 99% of PFAS at Incinerator Facility.” Waste Dive. January 23, 2023. <https://www.wastedive.com/news/clean-harbors-incinerator-pfas-forever-chemicals/640829/>.

absorbents such as calcium hydroxide to remove gaseous components.⁵⁴ Fei Wang *et al.*⁵⁵ showed that the mineralisation ratio of polytetrafluoroethylene (PTFE) particles by calcium hydroxide could reach 80% or higher when the temperature was above 400 °C.

From this set of literature data, there seems to be a set of parameters that allow full mineralisation of fluoropolymers by using a combination of incinerators, filter systems and afterburners even in the municipal waste stream.

As the above referenced studies and analyses show, fluoropolymers from food contact applications are unlikely to result in significant environmental emissions during the end of life phase. Landfilling, which represents a shrinking share of total EU waste management, is an unlikely source of PFAS emissions from fluoropolymers, due to the stability of the substances and lack of high ambient temperatures. Recycling and incineration, using adapted BATs that take into account PFAS control, would result in full mineralisation of fluoropolymers, thereby preventing any degradation into non-polymeric PFAS. Due to these factors, the restriction of fluoropolymers for food contact uses would be disproportionate, as their use would not result in meaningful exposure for humans or the environment.

⁵⁴ Cusano, Gianluca, Miguel Rodrigo Gonzalo, Frank Farrell, Rainer Remus, Serge Roudier and Luis Delgado Sancho. 2017. "Best Available Techniques (BAT) Reference Document for the Non-Ferrous Metals Industries : Industrial Emissions Directive 2010/75/EU (Integrated Pollution Prevention and Control)". 2017. doi:10.2760/8224

⁵⁵ Wang, Fei, Xingwen Lu, Xiao-yan Li, and Kaimin Shih. 2015. "Effectiveness and Mechanisms of Defluorination of Perfluorinated Alkyl Substances by Calcium Compounds during Waste Thermal Treatment." *Environmental Science & Technology* 49 (9): 5672–80. <https://doi.org/10.1021/es506234b>.

Section 4 – Technical availability of alternatives

The cookware and bakeware industries widely use fluoropolymers due to their unique combination of properties (*e.g.* non-stick, high temperature resistance, durability, heat conductivity, and resistance to abrasion). Ceramic cookware, the only tentative non-stick alternative, has lower non-stick durability and performance, requiring more frequent replacement with an increased environmental impact and price inflation for European consumers.

There is no guarantee that, even with R&D investment and sufficient transition timing to complete all the transformation steps, alternatives can be found without compromising the high performance, durability, and functionality which are essential to maintain European competitiveness over Asia.

Based on this, a restriction is not justified, due to the fact that proposed alternatives are not of sufficient performance or durability.

I. Description and technical properties of main food contact articles for cookware and bakeware

The Annex XV restriction proposal elaborates a list of alleged alternatives to fluoropolymer based non-stick coatings for use in consumer and professional cookware. This list includes:

- Ceramic
- Silicone based coatings and silicone bakeware
- Stainless steel
- Hard anodized aluminium
- Enamel
- Pre-seasoned iron/steel

Production of materials and coatings used for cookware and bakeware

- **Fluoropolymer** based coatings are produced from an aqueous dispersion of small fluoropolymer particles.
There are two major application technologies: spray coating of already finally shaped bodies of cookware and roller coating of sheet material or discs, which are shaped into their final design after curing of the coating. Fluoropolymer based non-stick coatings have been improved since their introduction to the market 70 years ago and have reached a high level of technical maturity. Modern fluoropolymer-based coatings consist of 2 to 6 layers.
- What is known as **ceramic** non-stick coatings are produced using the sol-gel technique, comprised of silica-sol and silane. During the hydrolyzation of the silane, alcohols are formed resulting in a release of volatile organic compounds (VOC) during curing.
Today's coatings consist of one or two layers. The production of coatings with more layers is difficult because the non-stick properties hinder interlayer adhesion. Although the sol-gel technology was first developed in the 1800s, the first cookware coatings using it appeared on the market only around 2007. The performance of these coatings has improved continuously, but the technology has not reached a level of maturity equivalent to fluoropolymers yet.
Due to the hardness of the ceramic coating, it can be applied only on preformed shapes. So far, ceramic coated cookware and bakeware cannot be produced from roller coated sheets or discs.

- Especially bakeware, which is used at lower temperatures compared to frying pans is often coated with **silicone**. To create the coating, a silicone resin is applied on the surface. Side products, mainly alcohols, are created during this process. To avoid deterioration of silicones, temperatures of 230 °C⁵⁶ should not be exceeded during use.
- Due to its inherent chemical resistance, **stainless steel** is the only metal which can be used without protective coating even with salty or acidic food. However, the non-stick performance of stainless steel is poor and substantial amounts of oil or fat are required during the cooking/baking process to avoid sticking of food at temperatures above 140 °C.
- **Hard anodizing** is a process creating an aluminium oxide layer by an electrochemical process in acidic solution (e.g. sulfuric acid). The result is a surface layer, which increases the hardness and the chemical resistance, but it does not provide useful non-stick performance. Today it is largely used as surface modification prior to further coating.
- **Enamel** coatings in cookware are glass-like surface is very hard but provides only limited non-stick performance. In general, it is applied to cast iron and steel.
- **Silicon rubber** for bakeware is made of crosslinked silicone polymers. It is a soft material which use is typically restricted to pastry and backing.
- There are also **pre-seasoned** articles made from cast iron and forged carbon steel on the market. After shaping, waxes or oils are burned into the surface. This layer needs to be maintained by the consumer. It provides some mechanical and corrosion resistance and to a limited extent non-stick performance. The usage of fat or oil is recommended.

II. The key functions of fluoropolymer coatings

Fluoropolymer-coated, in particular PTFE-coated, cookware and bakeware have a range of properties which have made them the preferred choice for consumers. These properties are commonly selected in public consumer tests on cookware.

- Non-stick: Thanks to the C–F (carbon-fluorine) bond, presenting the highest bond energy in organic compounds, “PTFE exhibits superior self-lubrication and non-stick properties, and chemical and thermal resistance”.⁵⁷ Thereby, the fluoropolymer PTFE is intrinsically non-stick, providing:
 - Predictable cooking results by preserving food texture, avoiding risk of burning and reducing food waste
 - No/low fat use during cooking
 - Easy cleaning and lower use of detergent and water during the cleaning phase
- Chemical resistance: A scientific study⁵⁸ shows that PTFE-based systems are inert to chemical interactions, determined by the general inertness of fluoropolymers. While all PTFE-based systems in this study turned out to be completely inert to chemical interactions during dishwasher

⁵⁶ BfR recommendation LI, <https://www.bfr.bund.de/cm/349/LI-Temperature-Resistant-Polymer-Coating-Systems-for-Frying--Cooking-and-Baking-Utensils.pdf>

⁵⁷ Rossi, Stefano, Federico Valdrè, and Massimo Calovi. 2022. “Validation of Adhesion Characterization Methods for Antistick Coatings Applied in Cooking Systems.” *Journal of Coatings Technology and Research* 19 (4): 1287–1301. <https://doi.org/10.1007/s11998-022-00611-3>.

⁵⁸ Rossi, Stefano, Federico Valdrè, and Massimo Calovi. 2022. “Validation of Adhesion Characterization Methods for Antistick Coatings Applied in Cooking Systems.” *Journal of Coatings Technology and Research* 19 (4): 1287–1301. <https://doi.org/10.1007/s11998-022-00611-3>.

cycles, sol-gel coated ceramics exhibited inferior properties, *i.e.* they were more sensible to degradation and loss of performances after dishwasher cycles.

- Abrasion resistance: PTFE coatings have high abrasion resistance, due to the combination of the coating's ductility, adhesion, and low friction.
- Heat resistance: Pyrolysis of food starts at 180 °C, while PTFE is known to start to deteriorate at an extremely slow rate above 260 °C. Above 360 °C, the degradation of PTFE starts to be measurable. These temperatures ensure that PTFE-coated cookware has good heat resistance. According to the German Federal Office for Risk Assessment (BfR), even above 360 °C the concentration of decomposition gases resulting from PTFE-coated cookware is so low that there is no health risk for users.
- Corrosion resistance: PTFE coatings provide a functional barrier to aluminium corrosion.
- Overall durability: The resistance of PTFE to degradation and loss in performance makes the coating much more durable than ceramic, especially for long lasting non-stick properties. *"Sol-gel coatings, despite being proposed as valid alternatives to PTFE ones, do not achieve the same quality standards in terms of releasing properties, being in addition much more sensible to degradation and loss in performances."*⁵⁹
- Healthy cooking: *"Cooking dinner frequently at home is associated with consumption of a healthier diet ..."* according to Wolfson *et al.*⁶⁰. The easier the cooking process, the more people will cook at home. Thereby, the excellent non-stick performance of PTFE coated cookware facilitates and improves home cooking by consumers including the less experienced ones. Furthermore, cooking with less fat will bring additional health benefits.

Coatings are essential for the use of aluminium in cookware and bakeware, as they form a barrier preventing aluminium corrosion when the food contact article is used with acidic or salted food. Among them, fluoropolymer-based non-stick coatings are especially prevalent and have been used in cookware and bakeware since the mid-1950s.

Aluminium in cookware and bakeware is of particular interest because of the favourable thermal properties compared with stainless steel. *"Aluminium has a very high thermal conductivity of 205 W/(m/K) which explains its ability to heat up quickly and cook food evenly. Aluminium cookware is also affordable, relatively lightweight, and durable."*⁶¹

III. Criteria for Alternatives

Criteria used to assess alternatives must consider all aspects of the product performance including technical performance, economic viability, and consumer expectations and needs.

Several alternatives to fluoropolymer-coated cookware are described in the Annex XV proposal. The following criteria must be used to qualify alternatives to fluoropolymer-coated cookware:

⁵⁹ Rossi, Stefano, Federico Valdrè, and Massimo Calovi. 2022. "Validation of Adhesion Characterization Methods for Antistick Coatings Applied in Cooking Systems." *Journal of Coatings Technology and Research* 19 (4): 1287–1301. <https://doi.org/10.1007/s11998-022-00611-3>.

⁶⁰ Wolfson, Julia A, and Sara N Bleich. 2014. "Is Cooking at Home Associated with Better Diet Quality or Weight-Loss Intention?" *Public Health Nutrition* 18 (8): 1397–1406. <https://doi.org/10.1017/s1368980014001943>.

⁶¹ "The Impacts of Thermal Conductivity on Cooking Technique." 2021. Thermtest Inc. August 30, 2021. <https://thermtest.com/the-impacts-of-thermal-conductivity-on-cooking-technique>.

- Durable non-stick performance
- Chemical and mechanical resistance
- Stability at frying/baking temperatures

Stainless steel, enamel cookware, and anodized aluminium are not a credible alternative to fluoropolymer-coated cookware, as they are not non-stick, and are generally chosen for different applications in both consumer and professional settings. This leaves ceramic coatings to be considered as the only credible alternative in the rest of the document. Silicone could be an alternative limited to use in controlled temperature applications such as ovenware and bakeware.

IV. For consumers, PTFE cookware has better properties than ceramic in terms of non-stick performance, non-stick durability, and abrasion resistance, resulting in higher longevity.

- **At present, ceramic coatings have not achieved the same level of non-stick durability and performance as PTFE:**
 - According to a study by Rossi *et al*, the C–F bond in PTFE provides **superior self-lubrication and non-stick properties**, and chemical and thermal resistance compared to sol-gel ceramic coatings.⁶²
 - This study demonstrated also that the main concern with sol-gel non-stick coatings is their **reliability over long periods of usage** and when subjected to wear. Unlike PTFE coatings, ceramic coatings are not “*intrinsically non-stick, relying only on the action of the functionalized groups of the top-coat, which can be easily removed by everyday usage.*” This makes ceramic coatings **more susceptible to abrasion, degradation, and loss of performance, contributing to their inferior quality in terms of non-stick durability.**
 - “*Sol-gel coatings, despite being proposed as valid alternatives to PTFE ones, do not achieve the same quality standards in terms of releasing properties, being in addition much more sensible to degradation and loss in performances.*”⁶³
 - Consumer evaluations of ceramic and PTFE-coated cookware show that **ceramic cookware requires replacement more often due to lower durability**, resulting in a potentially larger environmental impact and price inflation for European consumers.⁶⁴
- Confidential data on durability and consumer preference for fluoropolymers over ceramic would be shared by individual company contribution

⁶² Rossi, Stefano, Federico Valdrè, and Massimo Calovi. 2022. “Validation of Adhesion Characterization Methods for Antistick Coatings Applied in Cooking Systems.” *Journal of Coatings Technology and Research* 19 (4): 1287–1301. <https://doi.org/10.1007/s11998-022-00611-3>.

⁶³Rossi, Stefano, Federico Valdrè, and Massimo Calovi. 2022. “Validation of Adhesion Characterization Methods for Antistick Coatings Applied in Cooking Systems.” *Journal of Coatings Technology and Research* 19 (4): 1287–1301. <https://doi.org/10.1007/s11998-022-00611-3>.

⁶⁴ Palermo, Andrew. 2020. “How Long Do Non-Stick Pans Last? (When to Replace).” Prudent Reviews. September 24, 2020. <https://prudentreviews.com/how-long-do-non-stick-pans-last/>.

V. Other coated and uncoated products are not non-stick, and should not be considered as viable non-stick alternatives

- **Other uncoated products (stainless-steel, anodized aluminium, iron) as well as coated ones like enameled cast iron, are not non-stick, and therefore, should not be considered as viable non-stick alternatives.**
 - Stainless-steel, anodized aluminium, cast iron, iron and enamel coated products could not be considered as non-stick alternatives. The "non-stick" performance is rated using a normative test based on cooking a "fried egg". These tests are based on specific norms NF D21-511 and BS7069.
 - Non-stick properties are one of the key criteria for consumers, since they make cooking easier and faster, requiring less oil or butter, and are easier to clean, making them less prone to scratching or damage.
 - Documentation and studies on consumer preferences and purchasing behaviours will be available to ECHA through specific FEC member company submissions.
- **Adverse effects of other cookware categories:**
 - The added cost of pans without non-stick properties is in potential adverse health effects: potential for burning food during cooking process.
 - As non-PTFE options either do not possess non-stick capabilities at all, or they do not perform as well, the use of added fat is required when cooking. This presents an added health risk to consumers.
 - The cleaning of pans without non-stick properties requires more water and detergent, resulting in a further higher impact on the environment.⁶⁵

VI. Elements of Life Cycle Analysis

Alternatives to fluoropolymer based coated cookware and bakeware should be judged not only on their ability to respond to consumers' needs but also on a full evaluation of their life cycle. Here FEC presents some key elements of life cycle analysis demonstrating that ceramic sol-gel-based cookware is not an equivalent alternative to their fluoropolymer-based counterparts, but rather an additional choice for consumers to suit specific cooking behaviours.

- A notable difference between the sol-gel ceramic coating process and the equivalent fluoropolymer-based coating process is in the amount of volatile organic compounds involved. When using a trimethoxy-based silane precursor to produce a sol-gel ceramic coating, an equivalent of three moles of methanol are produced for one mole of precursor.
- Fluoropolymer-based coated cookware and bakeware has been used, researched, and improved for 70 years, while ceramic-coatings have been in use for 20 years. This also applies to continuous improvement of the manufacturing process of the cookware and the coating.
- The Cookware and Bakeware Alliance illustrated the difference between the life span of ceramic coated cookware versus fluoropolymer-based coated cookware: "Ceramics [coated cookware] rely on siloxane chemistry for non-stick properties, so the release characteristic may diminish over

⁶⁵ Dieter Drohmann, Jaime Sales, Francisco Hernández Lara Dickens. 2021. "Regulatory management option analysis for fluoropolymers". CHEMSERVICE. 4 November, 2021.
https://fluoropolymers.plasticseurope.org/application/files/5416/5104/8333/20211104_FP_RMOA_Final_3.pdf

time. (...). By comparison, conventional non-stick PTFE coatings provide very good release for a longer period of time.”⁶⁶

- Considering that the loss of non-stick properties is a key driver for replacing cooking utensils, ceramic coated cookware suffers from a shorter lifespan compared to fluoropolymer-based counterparts.
- Consumer evaluations of ceramic and PTFE-coated cookware agree that ceramic cookware requires replacement more often due to lower durability, resulting in a potentially larger environmental impact and price inflation for European consumers.⁶⁷

In summary, ceramic cookware is the only directly comparable alternative to fluoropolymer-coated cookware, due to its non-stick properties. This is reflected in strong consumer demand for non-stick cookware, compared to other proposed alternatives. Studies and consumer evaluations reliably demonstrate that ceramic cookware is an inferior alternative to fluoropolymer-coated cookware, largely based on its lower non-stick durability, requiring more frequent replacement, and thereby implying an increased environmental impact and price inflation for European consumers. Based on this, a restriction is not justified, due to ceramic (or other proposed alternatives) not being of sufficient performance or durability.

⁶⁶ “Guide to cookware and bakeware”. The Cookware & Bakeware Alliance. n.d.

<https://cookwareandbakeware.org/wp-content/uploads/2022/04/Guide-to-Cookware-Bakeware.pdf>

⁶⁷ Palermo, Andrew. 2020. “How Long Do Non-Stick Pans Last? (When to Replace).” Prudent Reviews. September 24, 2020. <https://prudentreviews.com/how-long-do-non-stick-pans-last/>.

Section 5 – Economic availability of alternatives and social impacts

The PFAS restriction proposal, as it is currently framed, would have significant economic and social impacts on the bakeware and cookware industry, leading to the potential cessation of important parts of the business:

- Ceramic coatings is considered as the only potential alternative to fluoropolymer based non-stick cookware and bakeware.
- European producers will have to face very important costs for R&D and production lines transformation
 - **Building of spray production lines: production of ceramic coatings is not compatible with roller coating technology**, covering at present a significant portion of European fluoropolymer-coated cookware production.
 - **Adaptation of spray production lines:** ceramic coating, the main alternative considered for cookware now, requires new line set ups, even when already using spray technology to produce fluoropolymer coated cookware.
 - **R&D costs:** to find performance and cost competitive alternatives to fluoropolymers, diversify product offering, prevent loss of competitiveness, revenue, and maintain brand reputations.
 - The transition will be difficult because of shortage in the supply chain
- Job losses in Europe will be permanent, as the loss of industrial structure and know-how would make any re-industrialization plan in Europe nearly impossible, particularly if market share is lost to cheaper non-EU producers.
 - **Some parts of the industry will have to cease automatically and irreversibly** their production (European production destined to export markets, which is a significant part of European cookware production, as well as most of R&D centres)
 - **Some companies, especially SMEs will not be able to absorb the costs of transition** (reconstruction of roller coating lines, not compatible with ceramic production)
 - **Other European manufacturers** will face high transformation costs and R&D costs, undermining their effort to stay competitive over Asian production

On this basis, the members of FEC Europe recommend the following:

- The **most realistic transition time estimated by the cookware and bakeware sector to complete all the transformation steps would be 12 years (cf table 4)**, but even in this case there are **substantial risks of major adverse economic impacts**.
 - **Transformation costs will be too high to be bearable for some European companies, particularly SMEs or smaller firms, resulting in the inability to continue business from these companies**
 - Transformation of lines and investments in R&D will eventually be absorbed by the most resilient companies, but costs will be significantly lower in Asia than in Europe, undermining the effort of European producers to stay competitive over Asia, and incentivising offshoring
 - There is no guarantee that suitable alternatives can be found without compromising crucial factors such as high performance, durability, and functionality. These qualities are

vital for European producers to maintain their competitive advantage and their industry presence in Europe

- **Given the high economic risks associated with the restriction**, even in the case of a transition time of 12 years, **the bakeware and cookware sectors request the exclusion of fluoropolymers from the scope of restriction for use in cookware and bakeware, because:**
 - Fluoropolymers have not been demonstrated to have negative health concerns and their use by the cookware and bakeware industries is unlikely to result in significant environmental emissions during the manufacturing, use and end-of-life phases (see sections 1-3).
 - The restriction is not proportional to the economic risks. Even if a 12-year derogation were granted, only the most resilient European producers will be able to continue manufacturing in Europe, while others will have to close their facilities or offshore them. With the minimal risks presented by fluoropolymer-coated cookware, the economic disruption is disproportionate to the gains in protection afforded to EU citizens.

Fluoropolymers should not be restricted because they are safe. The lack of risks from fluoropolymers imply that the restriction proposal is disproportionate regarding the huge economic impacts of the proposal.

Additional data on economic impacts

To provide concrete evidence on the impact of the proposed PFAS restrictions on the cookware and bakeware industry in Europe, FEC will complete its response as follows:

1: An independent economic impact assessment will be submitted by FEC in a second contribution before September 2023

An independent study is being carried out by the consultancy firm Ricardo. It aims to shed light on:

1. The potential economic impacts of the restriction proposal on the bakeware and cookware industries (manufacturing sites in Europe using fluoropolymers/PTFE, number of employees, investment costs needed to transition, elements of European production of fluoropolymer-coated cookware destined for export markets that will have to stop immediately after the transition period or be offshored outside of the EU) and the wider economy (missing state tax revenues, knock-on effects)
2. The potential social impacts of the restriction proposal (impacts on European employment)

2: Individual member contributions

At the same time, some FEC members will provide ECHA with their individual contributions. In doing so, they will be able to share with ECHA data covered by confidentiality, including figures highlighting the considerable economic impact of the proposal (confidential information on industrial transformation costs for companies; the expected cookware price inflation for the consumer; data on consumer preference for fluoropolymers over ceramic, among other topics)

All these documents will provide ECHA with quantified and sourced data on this proposal for the sector.

I. Impact of the proposal on research and development

If European manufacturers are compelled to cease using fluoropolymers in their production, time and investments in research and development will be required to develop equivalent coatings, improved technologies and adapted products to stay competitive, match the expectations of consumers and avoid industry failure.

The proposed restriction would require the following efforts from companies in research and development and adapted product design:

- Undertaking research and development to find effective and cost competitive alternatives to fluoropolymers and to develop sufficient diversity on the market could take between **3** (to adapt existing technology) **to 5 years** (for a breakthrough, to find a product as performant as fluoropolymers for the consumer), **with a high risk of failure in this research.**
 - **Status of the innovation:** The fluorine content gives fluoropolymers their exceptional non-stick performance and the carbon-fluorine bond gives its resistance to high temperatures. Researchers need sufficient time to create suitable innovations for alternatives, **even though research on the topic has been conducted for more than 15 years, so far without satisfactory outcomes.** Alternative coating technology available now needs to be improved to respond to the demand of the market (estimated 3 years). The extent to which high non-stick performance and durability can be achieved without fluoropolymers through research and development to satisfy all consumers is presently unclear, and could take up to 5 years, **with a very high risk of failure.**
 - **The challenge of conducting R&D:** Studies⁶⁸ and consumer evaluations reliably demonstrate that ceramic cookware is an inferior alternative to fluoropolymer-coated cookware, largely based on its lower non-stick durability, requiring more frequent replacement, and thereby implying an increased environmental impact and price inflation for European consumers. European manufacturers need to invest in advanced alternative technologies and diversify product offerings to prevent loss of competitiveness, revenue, and maintain their brand reputations.
- R&D is also needed for technological development, to use this innovation in a safe, cost- and quality-effective process, to deliver an economically viable solution (**3 to 5 years**). Technology development will need to find solutions that exclude fluoropolymers from the components of the machines themselves, which will add another level of R&D to create new production technologies.
- Development of an adapted product offer (**3 years**): this step requires the analysis of consumer expectations, the creation of ranges (range concepts, functional proposals, price, design, colour, choice of coverings), the validation of ranges and prototypes by quality and quantity consumer studies.
- Certification, approval time, market tests, local authorities' approval are needed for any innovation to be put on the market to fulfil the regulatory requirements as they exist today (**typically 1 year**).
- The conception of products must be adapted to markets (typically **2-3 years**) to ensure the product suitability in real cooking conditions in different geographies (recipes, kitchen tools, etc).

⁶⁸ Rossi, Stefano, Federico Valdrè, and Massimo Calovi. 2022. "Validation of Adhesion Characterization Methods for Antistick Coatings Applied in Cooking Systems." *Journal of Coatings Technology and Research* 19 (4): 1287–1301. <https://doi.org/10.1007/s11998-022-00611-3>.

The proposal will have the following economic impacts on R&D, product offer and market:

- In the absence of a transition period to facilitate research and development towards finding competitive alternatives to fluoropolymers for European markets, non-EU cookware producers will fill the consumer demand in the interim. Lack of R&D and technical differentiation means that competition with non-EU manufacturers will be solely on price.
- Export markets will be impacted as well as European manufacturers will lose the market share or will have to delocalise production to continue to service these markets.
- The time needed to transition will open the door for other cheaper, non-EU alternatives to increase their presence in the market, risking an enduring loss of market share for European manufacturers.
- This R&D-intensive transition will be limited by an overload in the R&D departments of coating manufacturers. All manufacturers would turn to them at the same time to find specific solutions.
- Raw material suppliers are shared with other high-volume industries risking important delays for R&D for cookware and bakeware articles and creating additional costs because of lower volumes or product prioritization.
- R&D on fluoropolymer-based coatings would have to move out of Europe to serve markets outside of the EU. Consequently, the work of the whole R&D and quality departments of the coating industry might move out of Europe with significant impact on jobs and knowhow for the industry.

Any transition would take considerably longer than expected in the restriction proposal. Any shorter transition period than 12 years would impose a higher burden on European producers, which are able to handle R&D and transformation costs.

Nevertheless, there is no guarantee that suitable innovation can be found without compromising crucial factors such as high performance, durability and functionality. These properties are essential for European producers to maintain their competitive advantage over Asian counterparts.

II. Impact of the proposal on manufacturing and the supply chain

The proposal will require companies to make the following efforts to **adapt and/or rebuild** production lines:

- The switch from cookware and bakeware coated with fluoropolymers to alternative coatings will require heavy investments to change production equipment in Europe.
 - **Adaptation of spray coating production lines:** ceramic coating, the main alternative considered for cookware now, requires new line set up even when already using spray technology. Any European transition to ceramic will therefore require heavy industrial transformation to adapt spray technology.
 - **Reconstruction of production lines: production of ceramic coatings is not compatible with roller coating technology,** covering at present a significant portion of European cookware production. The transformation of roller coating lines will result in write-offs of investments into these production lines.
- The cookware sector estimates industrial investments to be **four times less expensive and faster in China** compared to Europe if there is a need to transform a factory to meet European demand in ceramic cookware.

- This estimation is based on difference in raw material and labour costs but also on the difference in safety devices and lower regulatory constraints required in each region. It reinforces the risk of loss of competitiveness of European industry and the risk of delocalisation.
- Adaptation (from spray PTFE to spray ceramic) as replacement of lines (from roller coating to spray ceramic) takes 1 year per line but can only occur one line at a time to avoid stopping the production process (*i.e.* 5 years are needed if the company operates 5 lines)
- Staff training and safety measures will have to be undertaken by companies, taking at least 6 months.

The proposal will have the following economic impacts on the supply chain, the production, the industrial infrastructure and the European workforce:

- The massive investments in rebuilding and/or adapting lines will **increase the cost of the final cookware or bakeware articles for the consumer**. The alternative for the consumer would be to buy cheaper cookware and bakeware imported from outside of Europe.
- **A significant part of European production facilities will have to close permanently:**
 - Some companies, especially SMEs, will not be able to absorb the costs of transformation.
 - All European industrial structure for fluoropolymer-coated cookware destined to export markets, which is a significant part of European cookware production, will have to be closed and move out of Europe.
 - Consequently, job losses will be permanent, as the loss of industrial structure and know-how would make any re-industrialization plan in Europe nearly impossible, particularly if market share is lost to cheaper non-EU producers.
- **New investments in rebuilding or adapting production lines will be likely to encounter difficulty due to supply chain shortages.**
 - Restriction on fluoropolymers also has the potential to impact new machinery and spare parts of existing machinery in Europe. There are a significant uncertainty and potential bottlenecks in acquisition of new and repair of existing production equipment.
 - The demand in raw material and spare parts to build and adapt production lines will probably increase at the same time, with a risk of shortages.
 - The shorter lifespan of ceramic coating in comparison to PTFE coating as well as the lower productivity of spray (compared to roller coating), will generate uncertainty on European manufacturers capacity to adapt rapidly to the growing demand induced by the higher frequency of replacement of products with alternative coatings.

Table 4: Indicative transition timing and steps to move away from fluoropolymers evaluated at sectoral level in Europe

(a) R&D, coating development	3 years (to adapt the existing technology) to 5 years to get a breakthrough with a product as performant as fluoropolymers
(b) R&D, technology development	3-5 years to deliver and economically viable process
(c) Product offer	2-3 years
(d) Production line replacement (Ordering machinery; installation)	1-2 years but replacement one line at a time to avoid stopping the production process (<i>i.e.</i> 5 years if the company has 5 lines)

(e) Local authorities' approval	1 year
(f) Staff training and safety measures (in parallel)	6 months in parallel with production line replacement
(g) Commercial deployment in different markets (Product adaptation, product stock clearance, change merchandising)	2-3 years

*Some of these activities could be run in parallel. The sector estimates that **12 years** is needed for the sector to transition. **Below 12 years**, more activities need to be run in parallel with very high economic risk, risk of failure and risks for employment levels.*

Comments:

- Most companies would like to differentiate their product and adapt the existing technology, with heavy investments, and steps (a) to (g) will apply.
- Even for companies that are willing to use existing technology, steps (b) to (g) will apply, with heavy investments and long delays. This will be only possible for companies able to absorb the economic impacts of the transition.

III. Impact of the proposal on sales, exports and distribution

The proposal will require companies to make the following efforts to adapt their distribution processes:

- **Distribution:** Retailers will need to get rid of their stocks of fluoropolymer-based products in a short period of time, to replace it with alternatives.
- **Change merchandising:** Existing commercial brands might disappear, replaced by new ones with alternative products, causing important additional costs regarding merchandising in general.

The proposal will have the following economic impacts on the distribution process:

- **Export markets:** Without a sufficient transition timing, European manufacturers producing in Europe would immediately lose their export market shares of PTFE cookware and bakeware, unless they delocalise their production out of Europe, with consequences on European employment and know-how. Time and investments are required from European manufacturers to find innovative products to keep their market shares in export markets.
- **Competitiveness:** Asian factories will still be able to produce fluoropolymer-coated products that will allow them to absorb the extra cost of more expensive products. For a similar capacity, investments in Asia are notoriously lower. Additionally, one must consider the loss of productivity when moving from roller coating to spray coating applications. European brands image might suffer because of lower lifespan of alternative products, leading the consumer to move to cheaper alternatives manufactured outside Europe.
- **Imports/enforcement:** European authorities will have to strictly control imports to maintain a level playing field in Europe.

IV. Economic impact of the proposal for the end consumer: inflation, export markets, consumer warranty, need for renewal and risk of carbon leakage

- **Price inflation for the end consumer in Europe:** The cost of the transition to alternatives, especially on a short timeframe, would have considerable economic impacts on cookware and

bakeware companies. Those costs will increase in the end the pricing of products, which will have a direct impact on the end customer, due to:

- Investments required to transform production lines, factories, stock management systems and to train employees.
- The efficiency loss on production lines and global distribution chains.
- The scrapping of remaining fluoropolymer-coated products with destruction of stocks.
- European manufacturers produce under performant ecological and social regulations, whereas there is a notable lack of such regulations in Asia, and any transition in Asia is therefore faster and cheaper.
- Insufficient timing to transition would make these economic impacts even more acute for European cookware and bakeware producers and would open the door for other cheaper, non-EU alternatives to increase their presence in the market.
- Producers need time to invest and develop new solutions to stay competitive over Asia and offer affordable prices for European consumers.
- Higher frequency of replacement of products with alternative coatings.
- **Need for renewal:** The lifetime of ceramic non-stick products is shorter than PTFE coated products and consumers will replace them more often. This will be substantiated by FEC member contributions, as it is not possible to aggregate data at sectoral level for confidentiality reasons.
- **Risk of environmental contamination:** European manufacturers produce under high regulatory standards, with performant ecological and social regulations, whereas there is a notable lack of such regulations in Asia. With insufficient transition timing, European manufacturers will lose their European production for export markets to cheaper countries (where the rules on production are not mature enough in terms of environmental control) as well as parts of their part of their European production for the EU domestic market.
- **Consumer warranty:** Today, warranty periods protect customers with a two-year delay on the product; those warranties won't be respected without a reasonable delay. European Union regulation provides that manufacturers should provide replacement or repair solutions in this period. The actual transition period won't be sufficient to do so.

V. Recommendation of the cookware and bakeware sector

- **The most realistic transition time estimated by the cookware and bakeware sector would be 12 years to complete all the transformation steps**

Table 4: Indicative transition timing and steps to move away from fluoropolymers evaluated at sectoral level in Europe

(a) R&D, coating development	3 years (to adapt the existing technology) to 5 years to get a breakthrough with a product as performant as fluoropolymers
(b) R&D, technology development	3-5 years to deliver and economically viable process
(c) Product offer	2-3 years
(d) Production line replacement (Ordering machinery; installation)	1-2 years but replacement one line at a time to avoid stopping the production process (<i>i.e.</i> 5 years if the company has 5 lines)

(e) Local authorities' approval	1 year
(f) Staff training and safety measures (in parallel)	6 months in parallel with production line replacement
(g) Commercial deployment in different markets (Product adaptation, product stock clearance, change merchandising)	2-3 years

*Some of these activities could be run in parallel. The sector estimates that **12 years** is needed for the sector to transition. **Below 12 years**, more activities need to be run in parallel with very high economic risk, risk of failure and risks for employment levels.*

Comments:

- Most companies would like to differentiate their product and adapt the existing technology, with heavy investments, and steps (a) to (g) will apply.
 - Even for companies that are willing to use existing technology, steps (b) to (g) will apply, with heavy investments and long delays. This will be only possible for companies able to absorb the economic impacts of the transition.
- **Nonetheless, a 12-year derogation for the cookware sector would not eliminate heavy costs and very high economical risks:**
 - **transformation costs will be too high to be bearable for some European companies, among which the less resilient and some SMEs, resulting in the collapse of those actors**
 - transformation of lines and investments in R&D will be a shock eventually absorbed by the most resilient companies, but costs will be significantly lower in Asia than in Europe, undermining the effort of European producers to stay competitive over Asia, and incentivising offshoring
 - there is no guarantee that suitable alternatives can be found without compromising crucial factors such as high performance, durability, and functionality. These qualities are vital for European producers to maintain their competitive advantage and their industry in Europe
 - **Given the high economical risks, even in the case of a transition time of 12 years, the bakeware and cookware sectors request the exclusion of fluoropolymers from the scope of restriction for use in cookware and bakeware, because:**
 - fluoropolymers have not been demonstrated to have negative health concerns and their use by the cookware and bakeware industries is unlikely to result in significant environmental emissions during the manufacturing, use and end-of-life.
 - The restriction proposal is not proportional to the economic risks. In the case of a 12-year derogation, only the most resilient European producers, able to bear transformation cost will carry on the manufacturing in Europe, while others will have to close their facilities or move out of Europe.