PFAS EDUCATION

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

The Cookware & Bakeware Alliance

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

PFAS Education Series

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

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

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

Lifecycle Assessment

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

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

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

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

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

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

End-of-Life

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

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

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

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

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

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

Conclusion

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

Alternatives to PTFE-coated cookware

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

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

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

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

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

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

Important points regarding PTFE-based nonstick coatings:

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

Conclusion

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

References:

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

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

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