Poster (PO 1_10) presented at Fluoros 2023, An international symposium on PFAS
Idstein, Germany, August 31 – September 1, 2023

Screening and identification of polymeric PFAS in consumer products

Combustion ion chromatography (CIC)-based total fluorine (TF) determination together with pyrolysis-gas chromatography-mass spectrometry (Pyr-GC/MS) have successfully been used for quantification and identification of polymeric PFAS in a wide range of consumer products. Both methods allow direct analysis without sample preparation or extraction. In the broad PFAS restriction proposal, prepared by Sweden, Norway, Denmark, Germany and the Netherlands, a concentration limit of 50 ppm total fluorine is proposed to include polymeric PFAS (marked in the TF-plots below). We suggest this combination of analytical methods for quantification and verification of PFAS content in products for compliance with future regulations.

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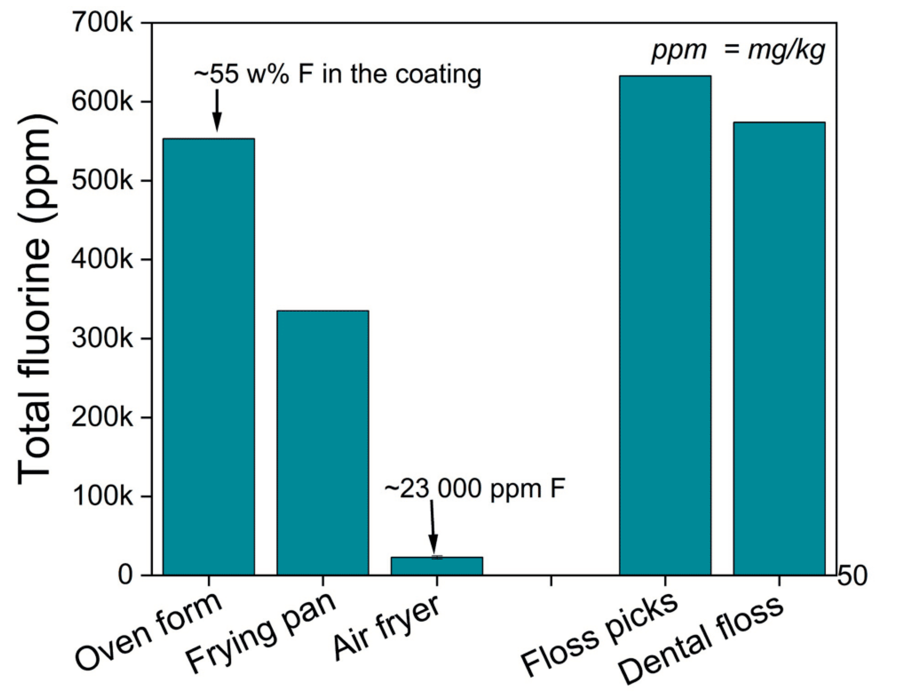
The work was financed by Vinnova (POPFREE Industry - Project no. 2021-04200) and Formas (Project no. 2020-01978)

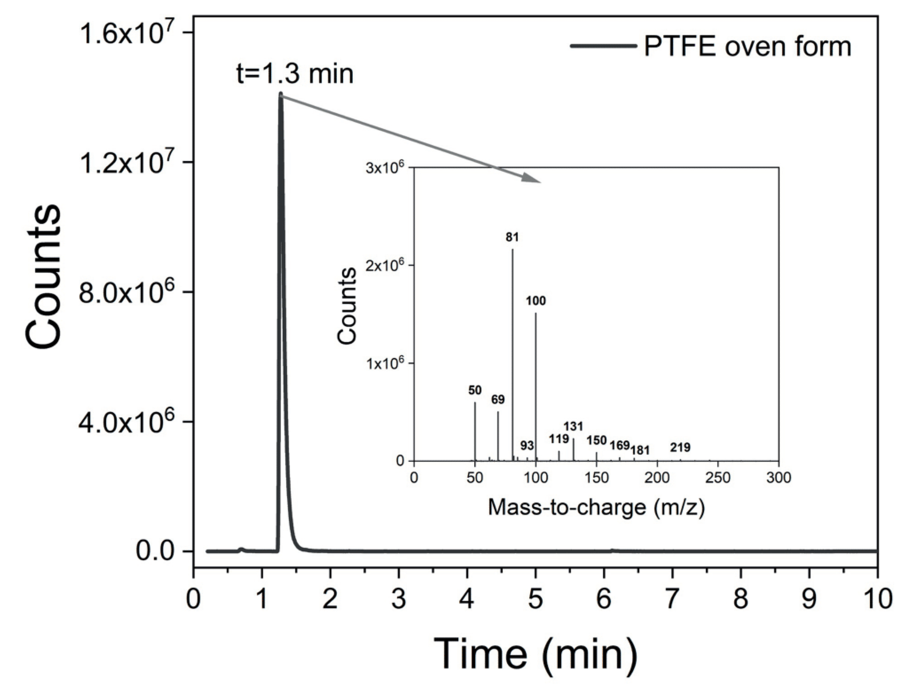
Non-stick coatings and dental floss containing high concentrations of PTFE



TF-results from selected products containing high fluorine concentrations. The oven form, frying pan and floss picks were known to contain the fluoropolymer PTFE based on the product packaging. Error bars show SD (n=2).

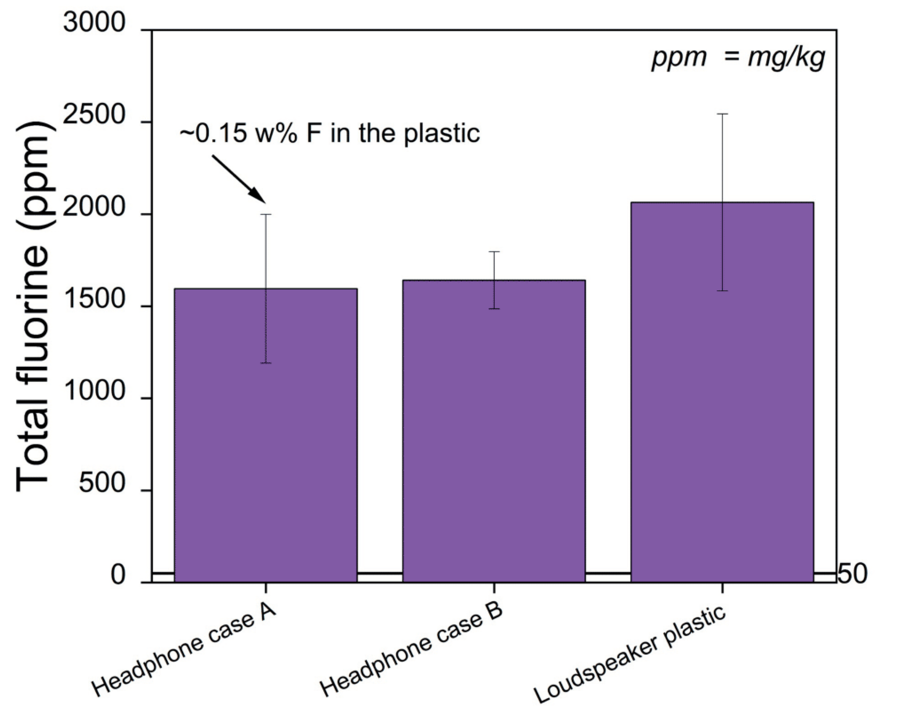
Pyr-GC/MS of one specific air fryer showed a more complex chromatogram, with pyrolysis products suggesting a siloxane-based polyester coating. The "PFAS-peak" was hidden in the total ion chromatogram, but in the extracted ion chromatogram (m/z 100) the presence of PTFE could be confirmed. Pyr-GC/MS can both verify presence of PFAS and distinguish between for example PTFE, ceramic and polyester-based coatings.

Several analysed cookware products (not shown here) showed a low TF-concentration slightly above 50 ppm but the presence of PFAS could not be confirmed with Pyr-GC/MS. This fluorine could either come from inorganic pigment in the paint, contamination from production, or be at too low of a concentration to be detected with Pyr-GC/MS.



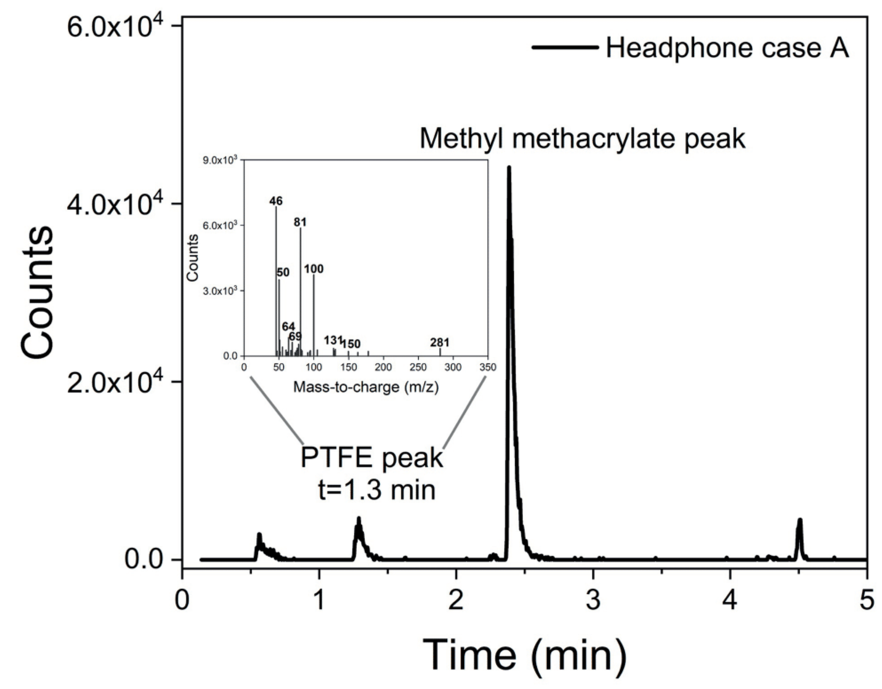
Pyr-GC/MS total ion chromatogram and mass spectrum for a PTFE oven form at t = 1.3 min. A consistent single-peak chromatogram and mass spectrum were obtained for the frying pan, the dental products and other cookware not shown here.

PTFE as an additive in consumer electronic plastic in low concentration ~ 0.1-0.2 w%



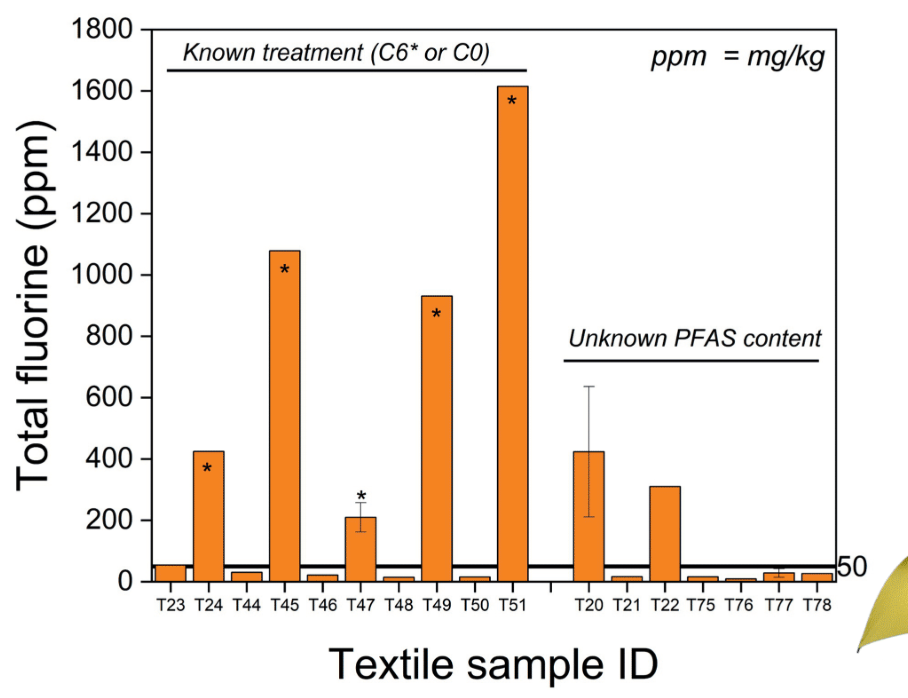
The TF-concentrations (together with Pyr-GC/MS) confirmed low levels of PTFE that is added to the plastic to provide for example anti-dripping. Error bars show SD (n=2-3).

Fluorine was also quantified in a wired glass fibre cable (950 ppm) and in two different coated parts (1600 and 200 ppm) near the heat plate in a coffee maker, but it was not possible to confirm that the fluorine originates from PFAS with Pyr-GC/MS. Further investigation and dialogue suggests that the fluorine in those coatings could be inorganic (MICA is commonly used for heat protection) but the origin of fluorine in the cable has not yet been concluded.



Pyr-GC/MS extracted ion chromatogram (m/z 100) confirmed the presence of PTFE in the plastic headphone case. Inset shows mass spectrum for peak at 1.3 min. PTFE was also found in the loudspeaker plastic and the headphone case B.

Side-chain fluorinated polymers (SFPs) in textile repellent treatments

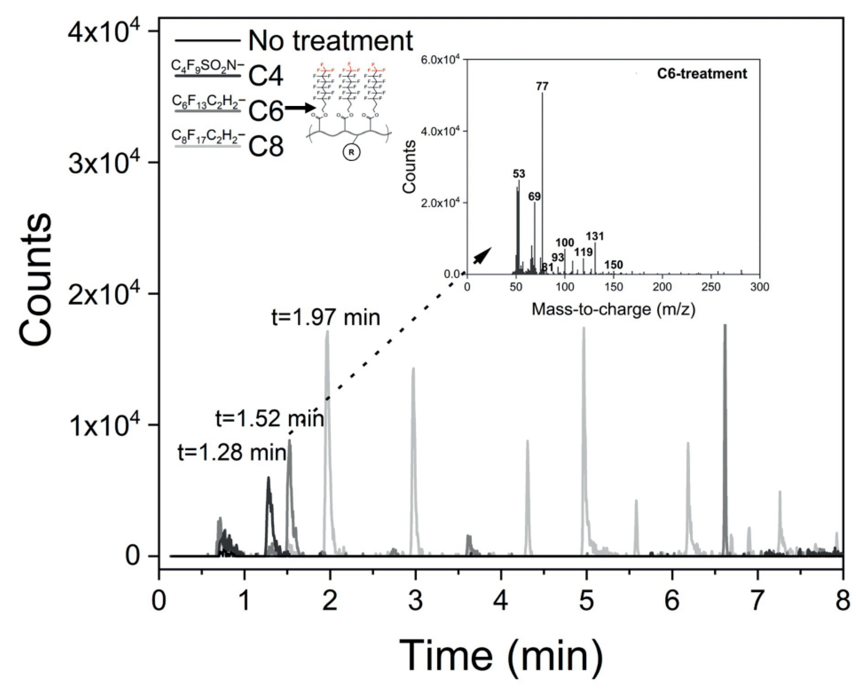


TF-results from textiles with (C6*) and without (C0) PFAS in the repellent treatment. The TF-levels indicate presence of PFAS in two of the unknown textile products where Pyr-GC/MS identified a C6-SFP in T20 and a C8-SFP in T22. Error bars show SD (n=2-3).

The proposed 50-ppm restriction level of total fluorine seems reasonable to separate textiles treated with and without PFAS.

Pyr-GC/MS can distinguish different chain lengths of the SFP by the retention times (shorter fluorinated chain reaches the detector faster). There are also different relative abundances of ions, with m/z 51/69 and m/z 77 being the major ions of C4 and C6/C8, respectively.

Extracted ion chromatograms (m/z 131) are needed to find PFAS in textiles. The retention times may alter slightly between instruments and reference products with known PFAS content set a basis for structure identification in unknown samples.



Pyr-GC/MS extracted ion chromatogram (m/z 131) showed different retention time for the first PFAS-peak based on the side chain fluorinated polymer. Insets show mass spectrum for peak at 1.52 min for the C6-treatment.

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