Per- and Polyfluoroalkyl Substances (PFAS) Presence and Migration in Metallic Pans

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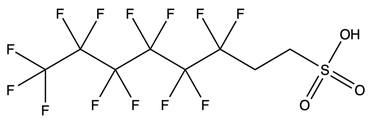
Introduction

- PFAS are synthetic compounds consisting of a carbon chain covalently bonded to several fluorine atoms



6:2 FTS

- Chemical structure makes PFAS resistant to water, oil, heat
- Carbon-fluorine bond strength prevents spontaneous degradation
- Negative health effects linked to PFAS exposure: cancer, developmental issues, reproductive issues[1]
- Widely used in commercial products since the 1950s for thermal stability and non-stick properties[2]
- This project details analysis of several commercially-available pans to determine the presence of PFAS

Citations:

1. US EPA, OW. "Our Current Understanding of the Human Health and Environmental Risks of PFAS." Overviews and Factsheets, October 14, 2021. https://www.epa.gov/pfas/our-current-understanding-human-health-and-environmental-risks-pfas.

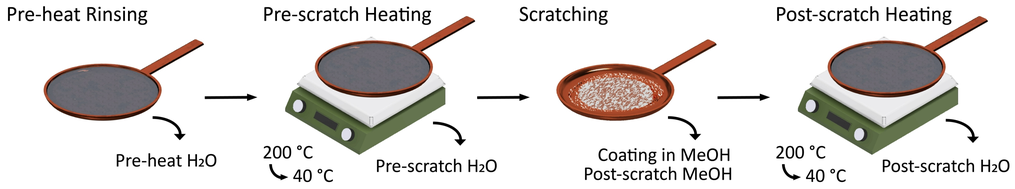
2. National Institute of Environmental Health Sciences. "Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS)." https://www.niehs.nih.gov/health/topics/agents/pfc

Figure made in ChemDraw

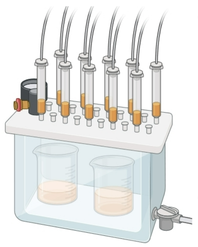
Methods

Pan Processing

Five unique sample types were collected across four stages of processing which emulated normal use.



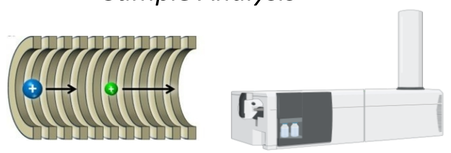
Sample Purification



- Solid Phase Extraction was conducted to purify and preconcentrate the samples using a WAX (weak anion exchange) cartridge
- The resulting solutions were dried in vacuum and reconstituted for analysis

Citations:
SPE Figure created with BioRender.com

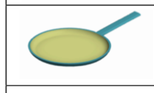
Sample Analysis



- Analysis was performed using LC-MS with a quadrupole-time of flight detector
- Drift-tube ion mobility spectroscopy was paired to this method for extra separation based on the collisional cross-section
- XPS was collected from unscratched sections

Conclusions

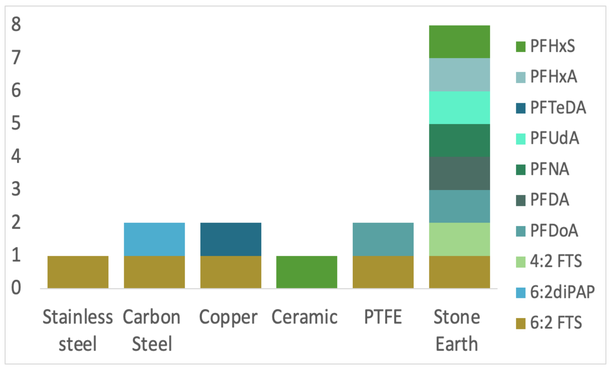
- Fully metallic pans (copper, stainless steel, carbon steel) showed smaller frequency and migration of PFAS.
- Stone earth had the largest number of PFAS and largest number of sample types containing PFAS.
- The ceramic pan only had one PFAS type, only extracted in the post-scratch water sample.

Pan Sample	Manufacturer Claims	Primary Coating Presence Findings	Primary Water Migration Findings
	**Carbon Steel:** Natural nonstick	No coating solid, mainly 6:2FTS detected in MeOH wash	No PFAS detected
	**Copper:** PTFE and PFOA free	6:2 FTS found in MeOH wash	PFTeDA detected pre-scratching
	**Stainless Steel:** PTFE Free	6:2 FTS found in MeOH wash	6:2 FTS detected post-scratching
	**Ceramic:** PFAS, PFOS, and PFOA free	No PFAS detected	PFHxS detected post-scratching
	**PTFE:** PFOA Free	Mainly 6:2 FTS detected in coating solid and in MeOH wash	Mainly 6:2 FTS detected post-scratching
	**Stone Earth:** GenX, PFBS, PFOS, and PFOA free	Highest number of PFAS detected (PFDA, PFDoA, PFNA, PFUdA, 6:2 FTS, PFHxA)	Highest number of PFAS detected post-scratching (4:2 FTS, 6:2 FTS, PFHxS, PFUdA)

Results

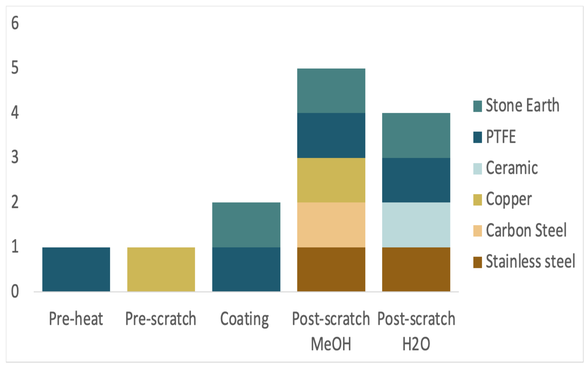
Carbon steel, copper, stainless steel, ceramic, PTFE, and stone earth pans were processed and compared for PFAS frequency, presence, and migration.

Frequency and Presence of PFAS



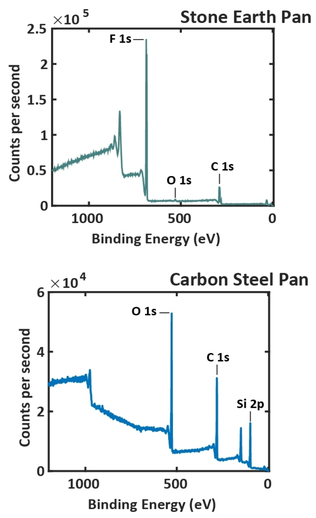
- 6:2 FTS was most frequently found.
- Stone earth had the most types of PFAS at eight overall, with five unique PFAS.
- Ceramic and stainless-steel pans only had one PFAS type.
- 6:2diPAP was only found in the carbon steel pan and PFTeDA was only found in the copper pan.

Migration of PFAS



- PFAS were most found in the Post-scratch methanol sample (Post-scratch MeOH) and second in the Post-Scratch H_2O, indicating PFAS migration after scratching.
- Ceramic pan had PFAS in only one sample type.
- Carbon steel did not produce a coating sample

XPS



Future Directions

- Quantization of PFAS amounts should be done in the future.
- Test other non-stick kitchenware.
- Explore PFAS migration in pans with different treatment types, such as pre-seasoned pans.

Acknowledgements

This material is based upon work conducted by the Baker group at UNC. PFAS analysis and mass spectra matching was performed using Skyline software package. XPS was conducted in partnership with the Chapel Hill Analytical and Nanofabrication Laboratory (CHANL). Research was done in CHEM 541L with instructors Domenic Tiani, Emily Crawford, Haley Jostes, and Andre Orr.