Polymeric and Nonpolymeric Per- and Polyfluoroalkyl Substances in Outdoor Building Materials

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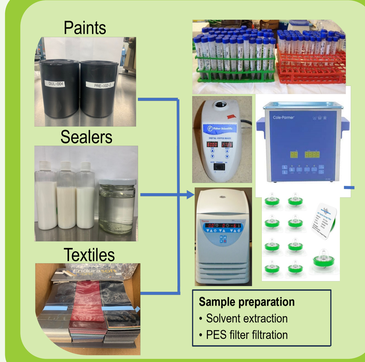
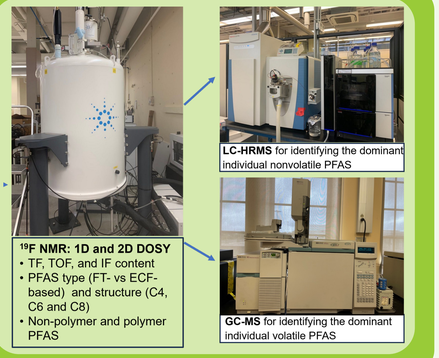
Introduction

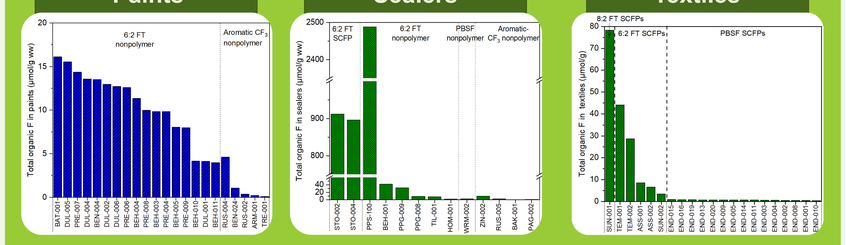
- PFASs are produced extensively throughout the world
- Given the potential toxicity of PFASs, we wished to document their use in different outdoor building materials by characterizing:
  - → Total Organic Fluorine (TOF) by ^{19}F NMR
  - → the type and identity of non-polymeric & polymeric PFAS (e.g., side-chained fluorinated polymers (SCFPs))

Methods



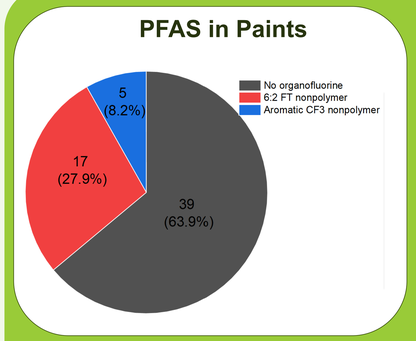


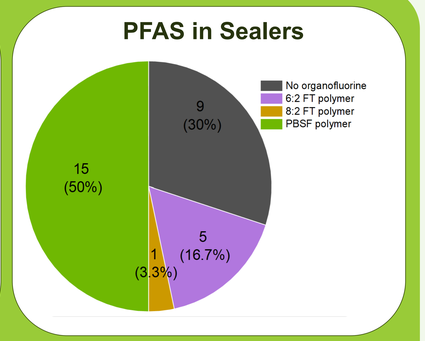
^{19}F NMR: Total Organic Fluorine

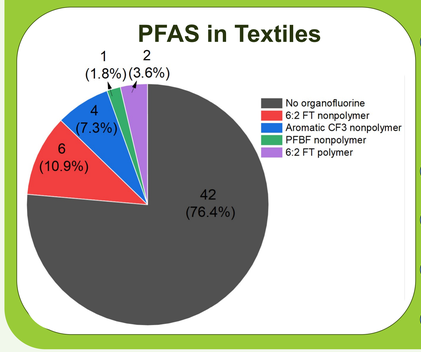


- **Paints:** **found in 36% of samples** tested **(22/61)**, 0.1 - 16 μmol/g (comparable to the levels reported for the US paints[3])
- **Sealants:** **found in 24% of samples** tested **(13/55)**, 0.40-2490 μmol/g
- **Textiles:** **found in 70% (21/30) of samples tested,** 0.3-74 μmol/g

^{19}F NMR : Major Types of PFAS

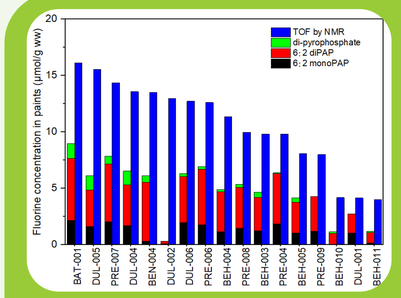


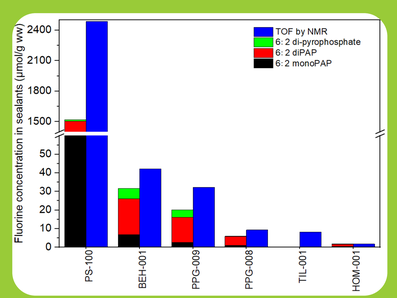




- Aromatic-CF_3 non-polymers: paints, sealers
- 6:2 FT nonpolymers: paints, sealers
- PFBF non-polymers: sealers
- PBSF polymers: textiles
- 6:2 FT polymers: textiles, sealers
- 8:2 FT polymers: textiles

LC-HRMS: Major Types of PFAS





→ 27-66% of TOF in all 6:2 FT nonpolymer-containing paints and sealers (except one paint) can be described by the following three PFASs:

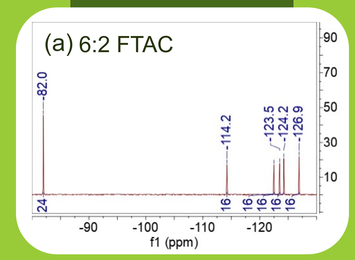
- **6:2 diPAP**
- **6:2 monoPAP**
- **6:2 FT di-pyrophosphate**

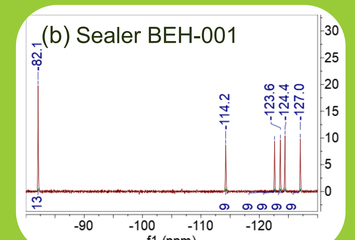
Acknowledgments

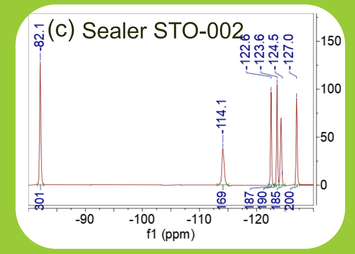
- NSERC Discovery Grant.
- MeFBSE standard from the Mabury Group
- Environment and Climate Change Canada
- Green Science Policy Institute.

1D and 2D NMR ^{19}F Spectra

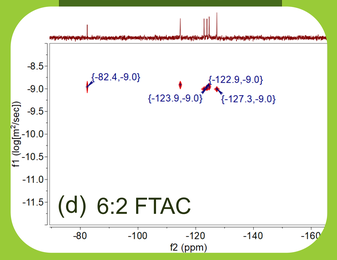
1D ^{19}F NMR

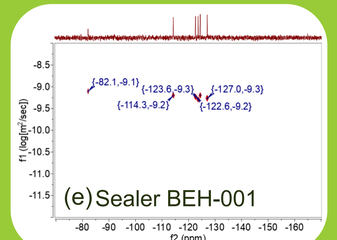


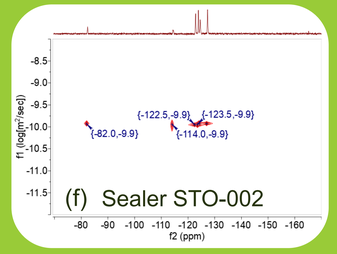




2D ^{19}F DOSY







- Sealant BEH-001 (b) yielded a mix of 6:2 FT non-polymers (similar to the 6:2 FTAC standard (a))
- Sealant STO-002 revealed the presence of 6:2 SCFPs as marked by broader ^{19}F resonances and slower diffusion versus the FTAC standard

Conclusions

1. Exterior building materials can contain polymeric and nonpolymeric PFAS
2. 1D & 2D diffusion ordered spectroscopy (DOSY) liquid-state ^{19}F NMR methods have been developed to characterize TOF and non-polymer and polymer PFAS (SCFPs)

References

1. Rankin, K., H. Lee, et al(2014). Environ. Sci. Technol. 48(21): 12783-12790.
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3. Cahuas, L., D. J. Muensterman, et al (2022). Environ. Sci. Technol. 56(23): 17070-17079.