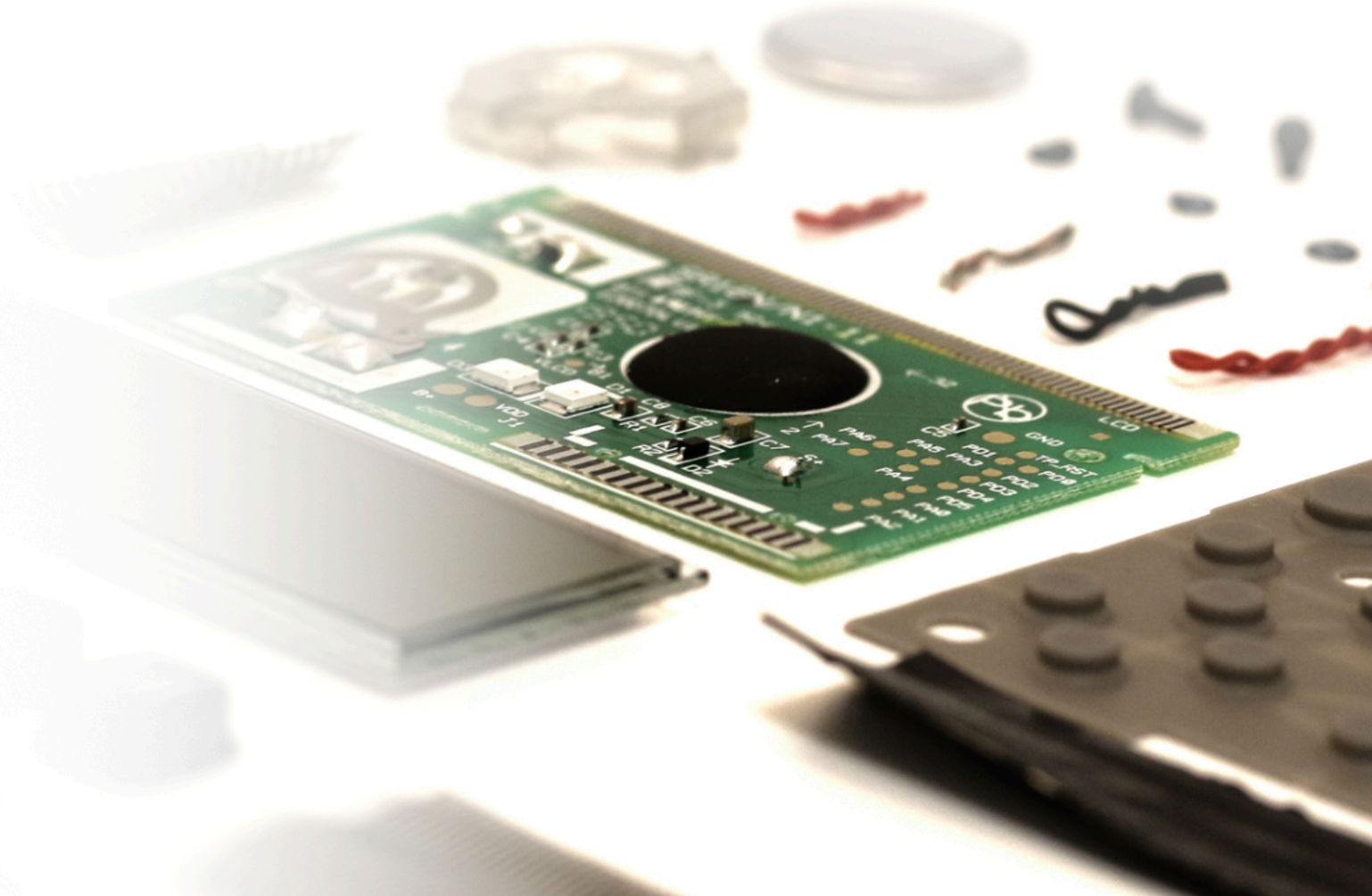
Claigan
Less Journey. More Results.

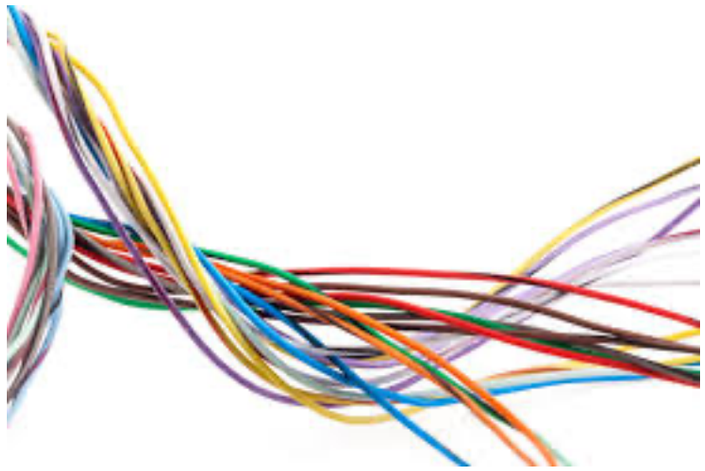
Claigan Webinar
PFAS Compliance

Presented by:
Bruce Calder
VP Consulting Services at Claigan

December 14 2022



Overview - Agenda



- What are PFAS?
- Why do we care?
- Why so many PFAS
  - Non-polymer
  - Polymer
- Regulations
  - Reporting
  - Restriction
- Sources of PFAS
- How to comply
- Testing options
- Q&A

PFAS
“Forever Chemicals”

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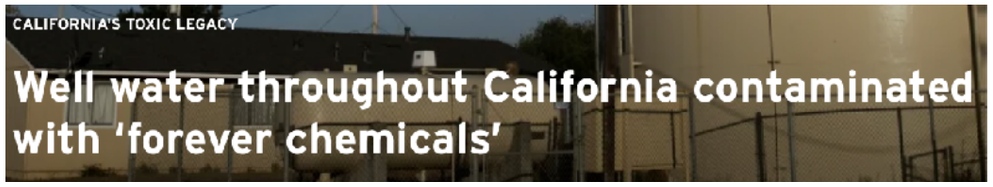
ldlife | Energy | **Pollution**

This article is more than **3 months old**

Lethal ‘forever chemicals’ taint our food, water and even blood. The EPA is stalling

David Bond



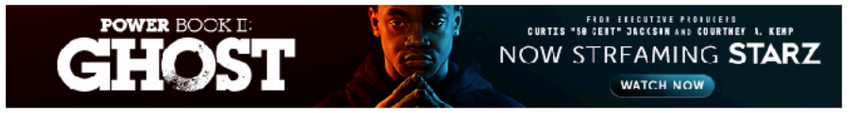
Quirks & Quarks

'Forever chemicals' can have far-reaching consequences, need more regulation in Canada, scientists say

'Very significant legislative gap' for PFAS substances, says Environmental Defence's Muhannad Malas

Home

CTV NEWS



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U.S. EPA unveils strategy to regulate toxic 'forever chemicals'

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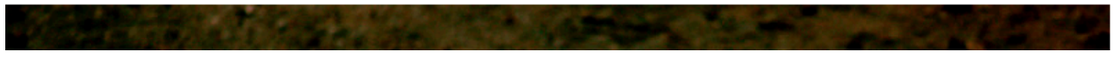
Europe readies to restrict use of toxic 'forever chemicals'



WYPR News

Working to ban a 'forever chemical'

WYPR - 88.1 FM Baltimore | By Joel McCord
Published February 1, 2022 at 9:58 AM EST

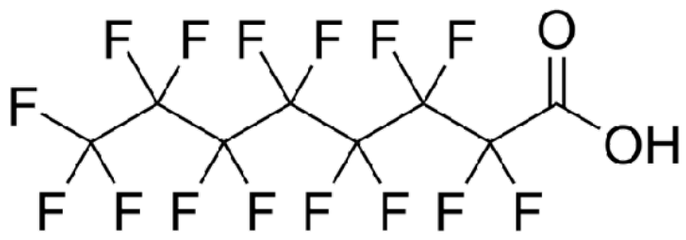
▶ LISTEN • 4:06

What are PFAS

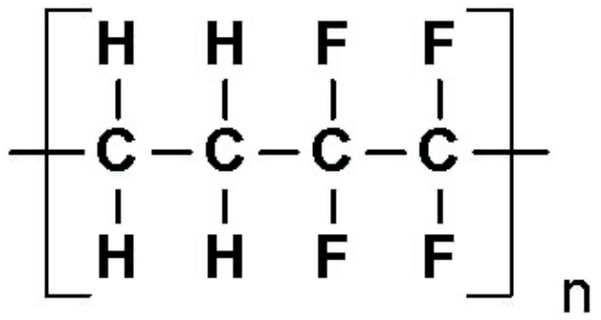
- PFAS (Maine)
  - PFAS (perfluoroalkyl and polyfluoroalkyl substances) means substances that include any member of the class of fluorinated organic chemicals containing one fully fluorinated carbon atom.

- Which means
  - At least one carbon with all hydrogens replaced by fluorines

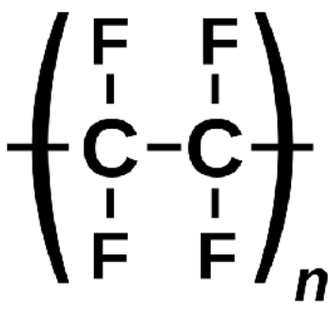
PFOA



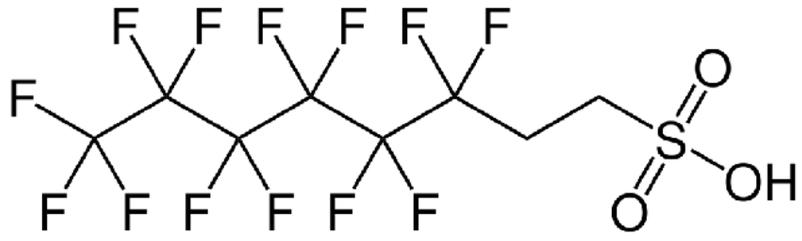
Fluorinated Polyethylene



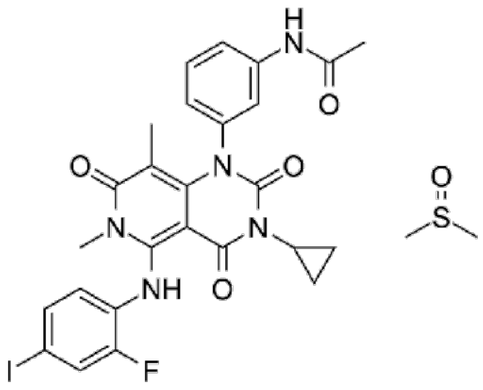
PTFE



6:2 FTS

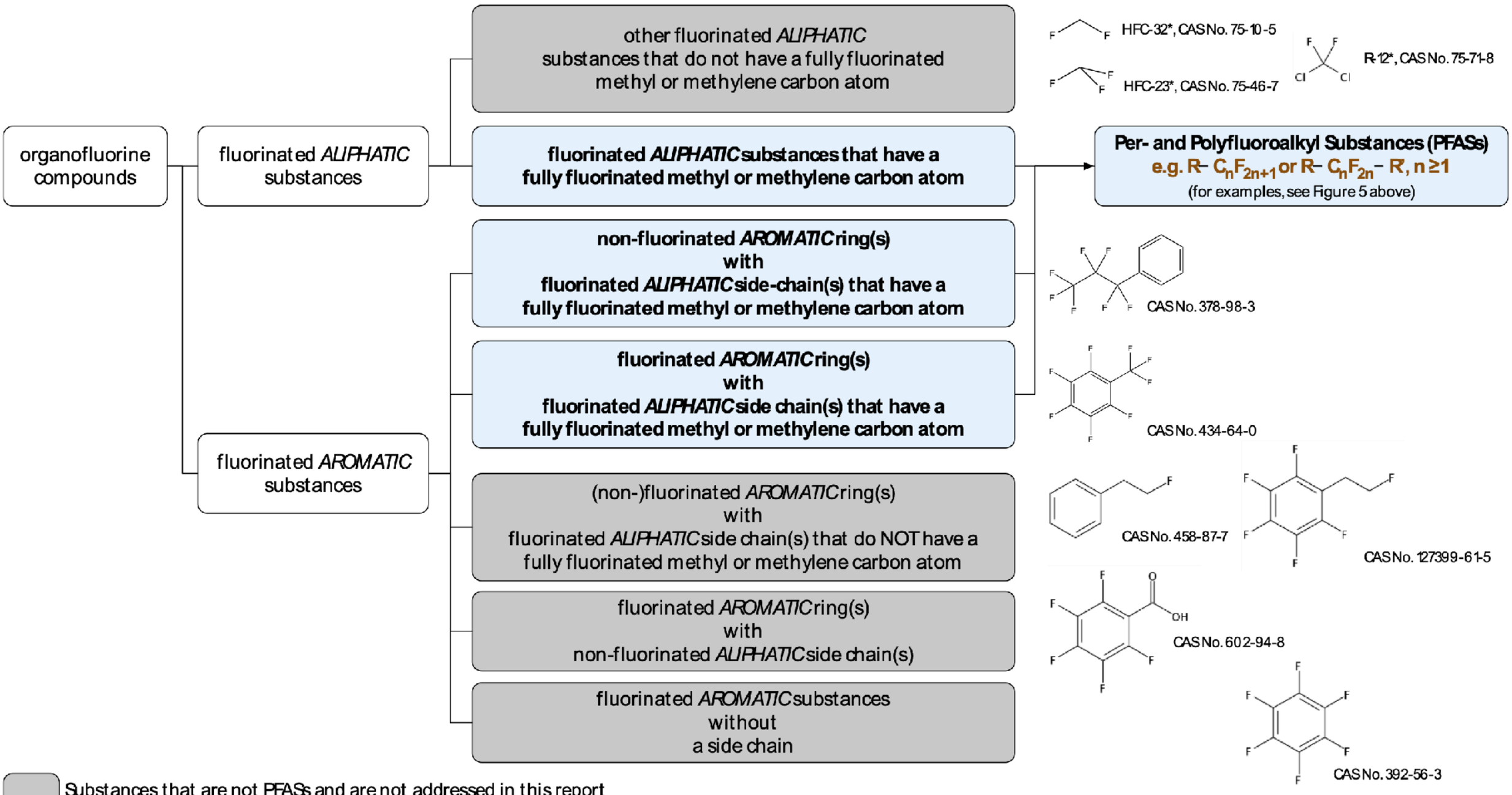


Trametinib



Why so many PFAS?

- Reference

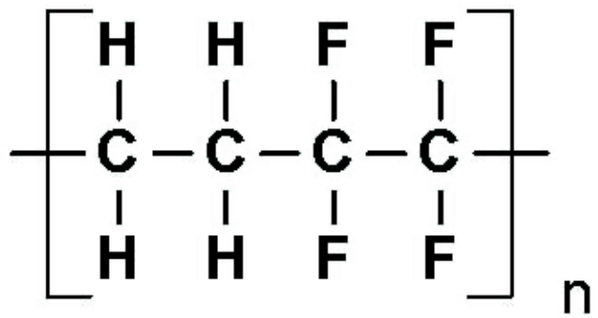


* HFC-32, HFC-23 and R-12 are not PFASs, despite the presence of moieties such as – CF_2– or – CF_3, because not all H on the fluorinated carbon atom are replaced by F, i.e., they do not have a fully fluorinated carbon atom.

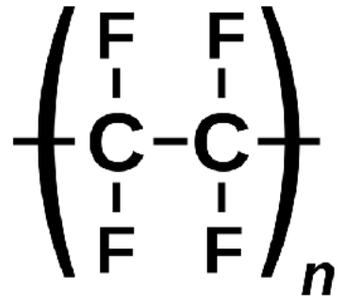
PFAS Simplified

- Polymer PFAS
  - PFAS with repeating chains
    - PTFE, PVDF, FKM

Fluorinated Polyethylene

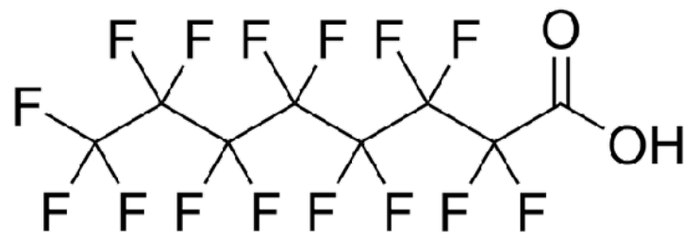


PTFE

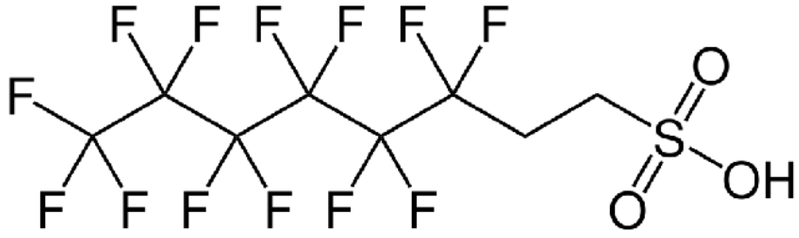


- Non-Polymer (monomer) PFAS
  - PFAS without a repeating chain
    - PFOA, 6:2 FTS, PFOS

PFOA



6:2 FTS



Full Nomenclatures

- If you want a headache

Figure 9. A comprehensive overview of PFAS groups, their structural traits, examples and notes on whether corresponding common nomenclatures (including acronyms)

Why do we care?

- Restricted (PFOA & longer)
  - EU (+related non-EU related countries. ie. Switzerland)
  - California (Proposition 65 and AB1200)

- Planned Restrictions (PFOA & longer)
  - Canada (Canadian Prohibition) - Date TBD
  - Vietnam - Date TBD

- Reporting (Upcoming)
  - Maine
  - US (federally) - TSCA (does not apply to FDA regulated devices)
  - US (state level - may be in parallel to Maine)
  - EU

OECD
BETTER POLICIES FOR BETTER LIVES

Portal on Per and Poly Fluorinated Chemicals

Why so many PFAS?

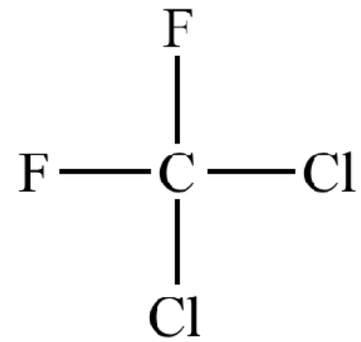
- There are a lot of PFAS substances listed in most regulations
- Why?
  - Most regulations need to list a CAS or EC number
  - The definition includes any chemical with a fully substituted carbon attached to a fluorine
    - Which is a lot
    - 20,000+ potential CAS numbers

- And history has proven that industry can get inventive with fluoroalkyl regulation

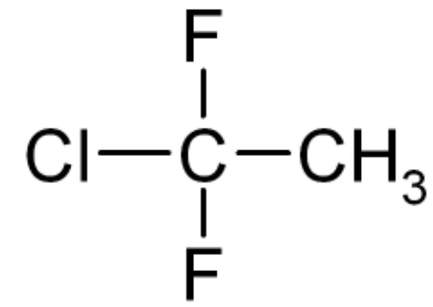
CFC / HCFC / Fluoroether

- History of CFCs
  - New chemicals were created as old ones became regulated

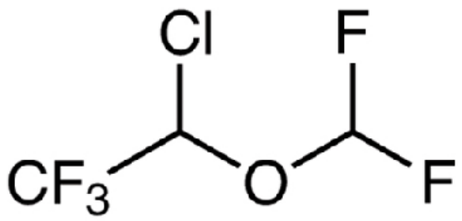
CFC



HCFC

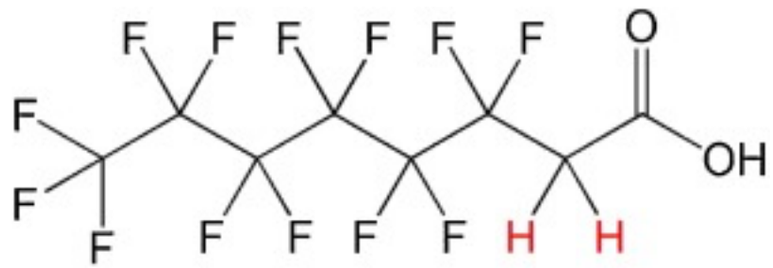


Fluoroether

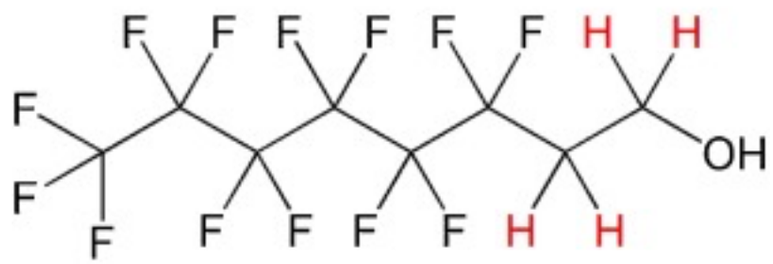


Non-Polymer PFAS

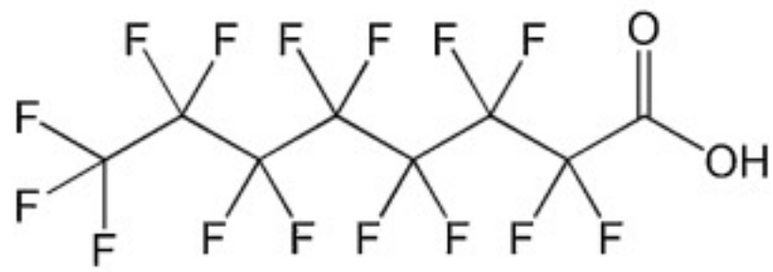
- **Non-Polymer PFAS**
  - Non-repeating PFAS (monomers)
  - Examples
    - PFOA (carboxylate family)
    - PFOS (sulphonate family)
  - Fluorotelomers
    - Fluorotelomer
    - Fluoroacrylates
    - Fluorotelomer sulphides



6:2 FTCA

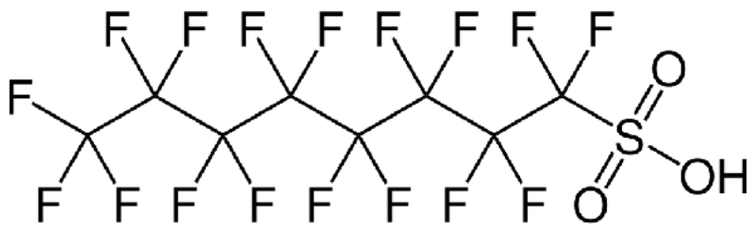


6:2 FTOH



PFOA

PFOS



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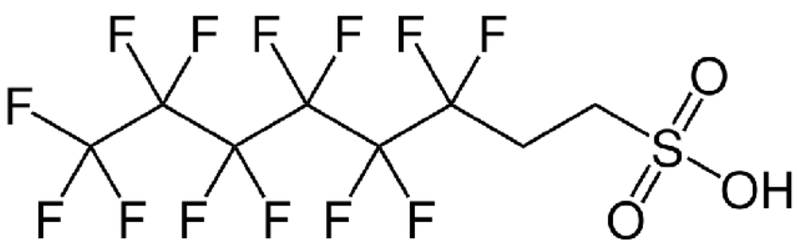
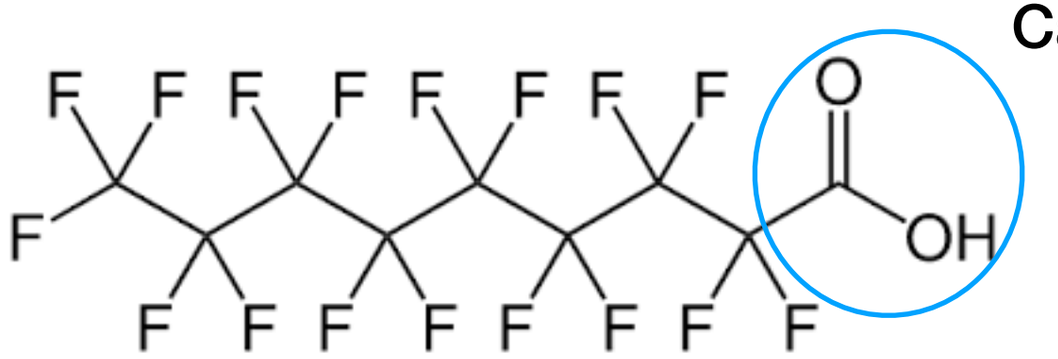


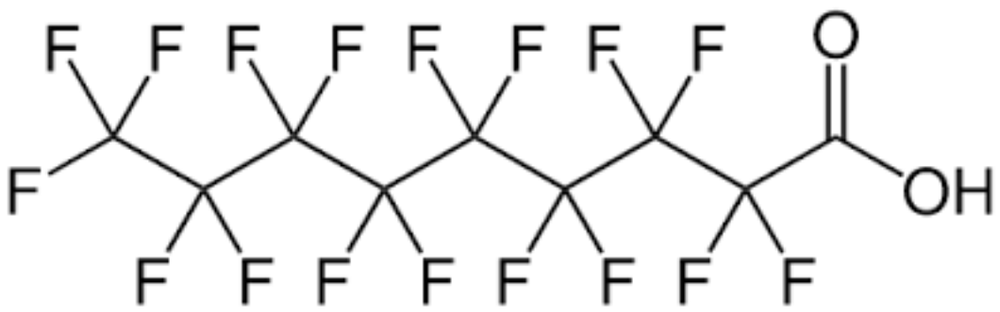
Carboxylates
REACH, POP, US TSCA, Prop 65



Carboxylate Group

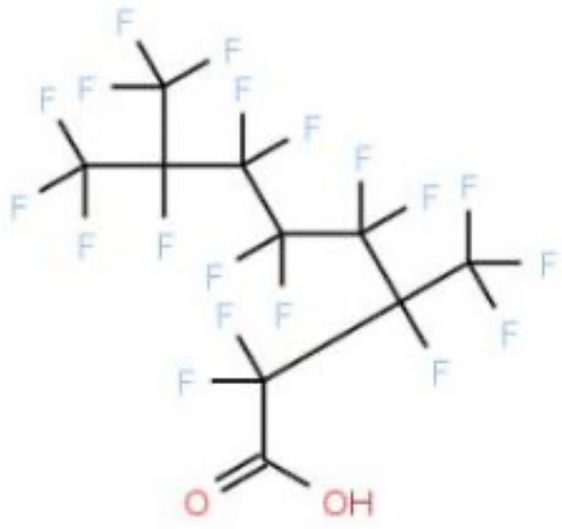
Note - ‘H’ can be Na, K, NH4, CH3 etc..

Linear



PFNA

Branched

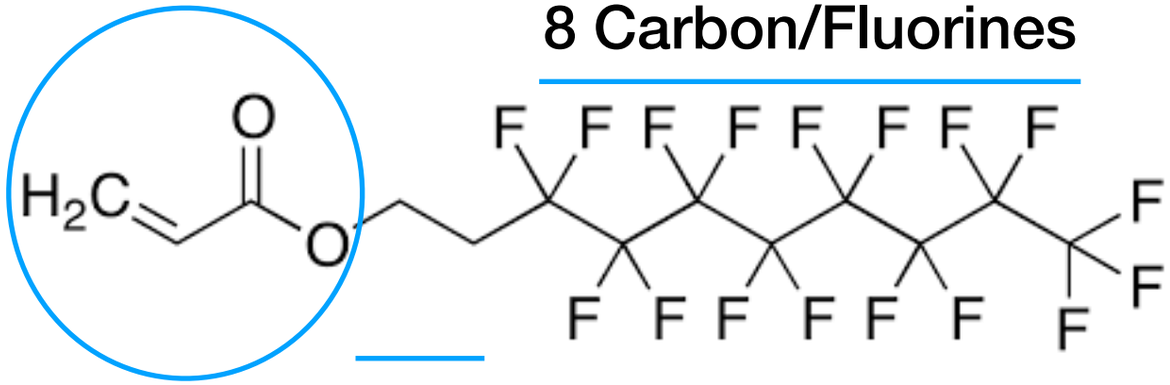


PF-3,7 DMOA

Fluoro-acrylates
REACH Restricted as LCPFAC

Acrylate Group

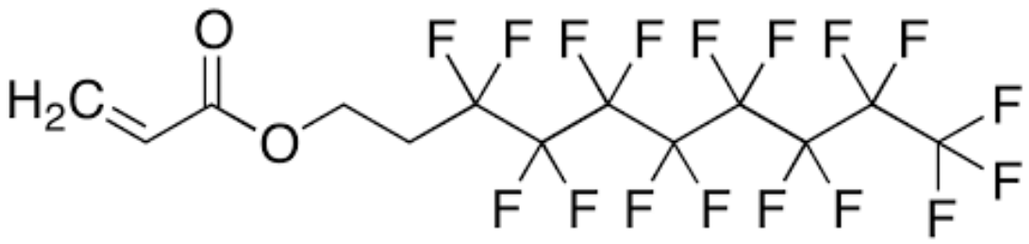
8 Carbon/Fluorines



2 Carbons

8:2 FTA

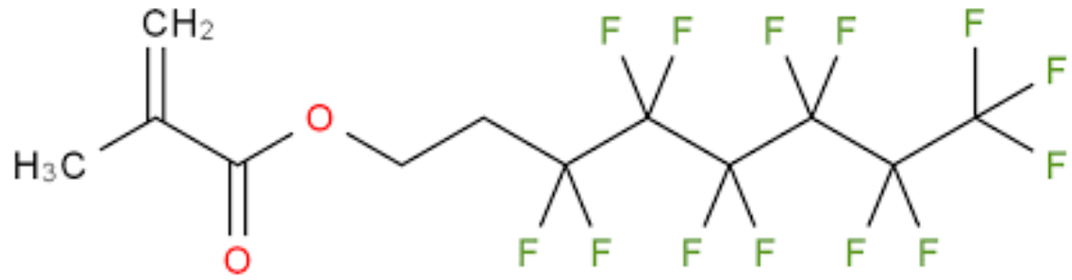
Acrylate



Acrylate

8:2 FTA

Methyl Acrylate



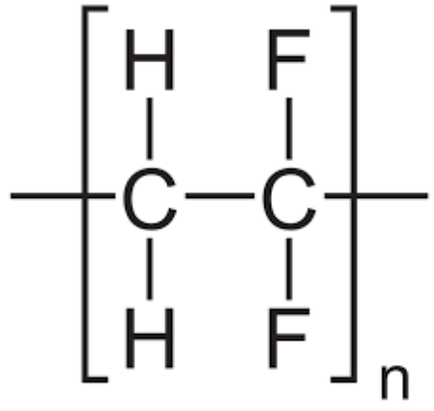
Methyl Acrylate

8:2 FTMA

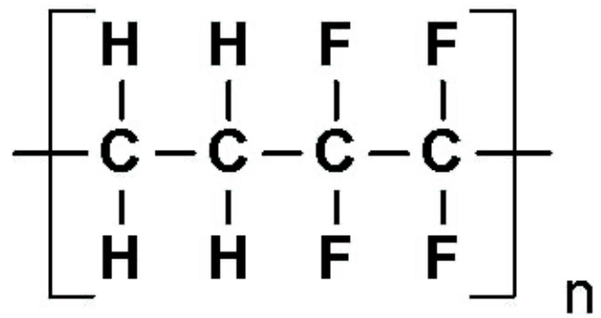
Polymer PFAS Substances

- **Polymer PFAS substances**
  - Repeating PFAS (polymers)
  - Examples
    - PTFE
    - Fluorinated polyethylene
    - PVDF
    - FKM
    - Fluoroacrylic polymers
    - Fluorosilicone rubber

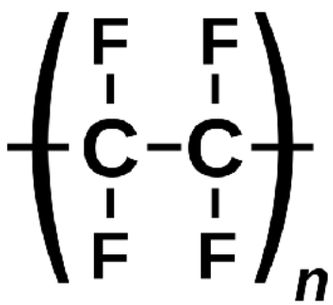
PVDF



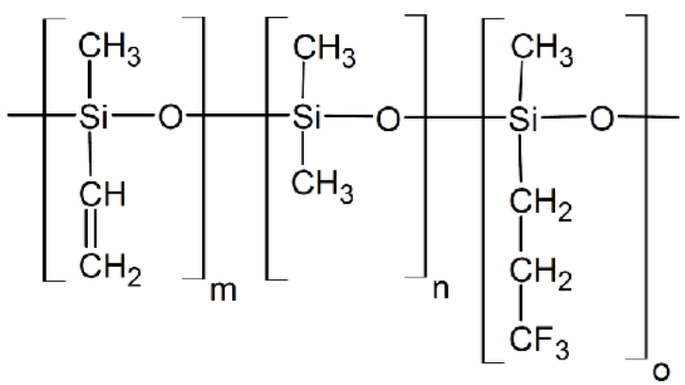
Fluorinated Polyethylene



PTFE

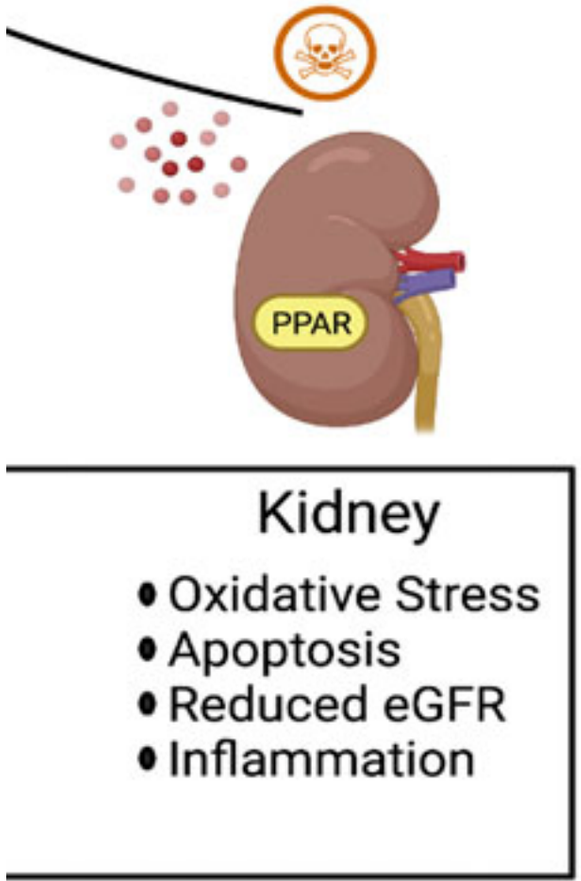


Fluorovinylmethylsiloxane Rubber (FVMQ)



What makes PFASs dangerous?

- **Non-Polymer PFAS**
  - PFOA and similar are surfactants (detergents)
  - Your kidneys use protein surfactants to purge dead cells and fight infection (in particular bacteria).
  - In high concentration, they change the surfactant levels in your kidneys
    - Which affects kidney function and can lead to cancer.



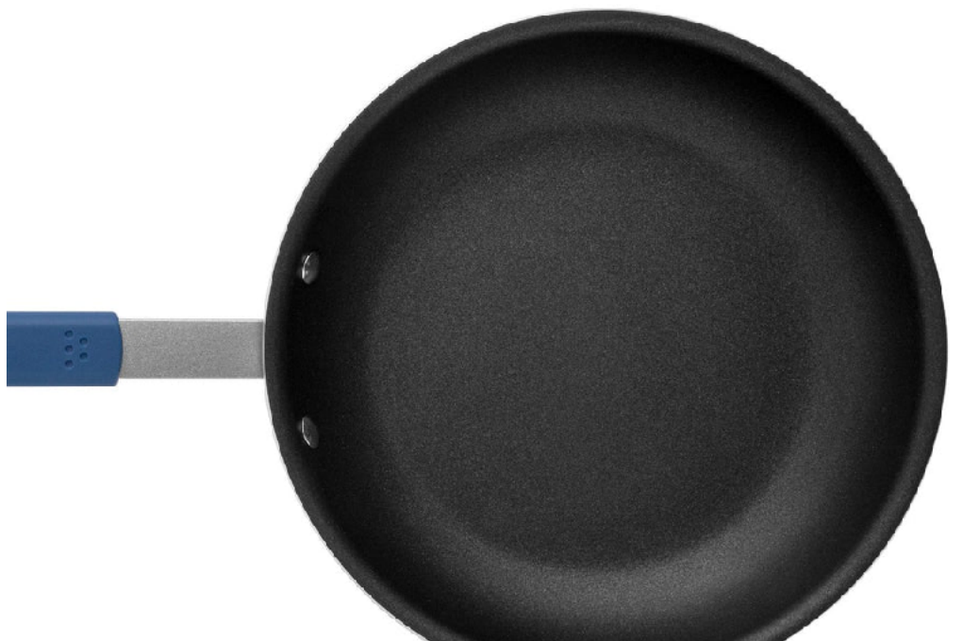
Non-Polymer PFAS Dangers

- **Non-Polymer PFAS** (PFOA and similar)
  - Very little danger at the < 1ppm level in plastics
  - In comparison
    - Average concentration of PFOA in PTFE -
      - 100 ppb
    - Average concentration of surfactant in laundry detergent -
      - 200,000,000 ppb
  - 2 millon times concentration different for same effect

- The most significant different is that fluoroalkyl substances do not degrade in the environmental
  - Which makes them consistently measurable in water by highly sensitive equipment (often in the parts per trillion)

What makes PFASs dangerous?

- **Polymer PFAS**
  - Very inert with little reactivity with humans or their environment
  - If you burn them (>550C / 930F) they release carbon monoxide and a variety of fluorinated substances
  - The fluorinated substances are highly toxic but is usually produced in low concentration
  - Carbon monoxide is toxic and is usually produced in high concentration



Regulation
Two Types

- **Restriction** (PFOA and similar monomer substances)
  - Restriction on the PFOA substances
    - Such as PFOA and other longer chains perfluoroalkyl carboxylates (LC-PFAC)
    - Or substances that degrade into these substances
      - Example - fluorotelamers and fluoroacrylates

REACH

European Commission

Persistant Organic Pollutants (POPs)

Regulation
Two Types

- **Reporting** (PFAS)
  - Reporting intentionally added PFAS
    - Which are generally polymers and polymer coatings
    - Non-polymer substances (PFOA) are **generally not** reportable as they are either
      - A manufacturing aid, or
      - An unintentional byproduct of manufacturing

- Degradation products can be reportable but are generally covered by the main reportable. Guidance TBD

Polyfluoro uses
Solid Polymer

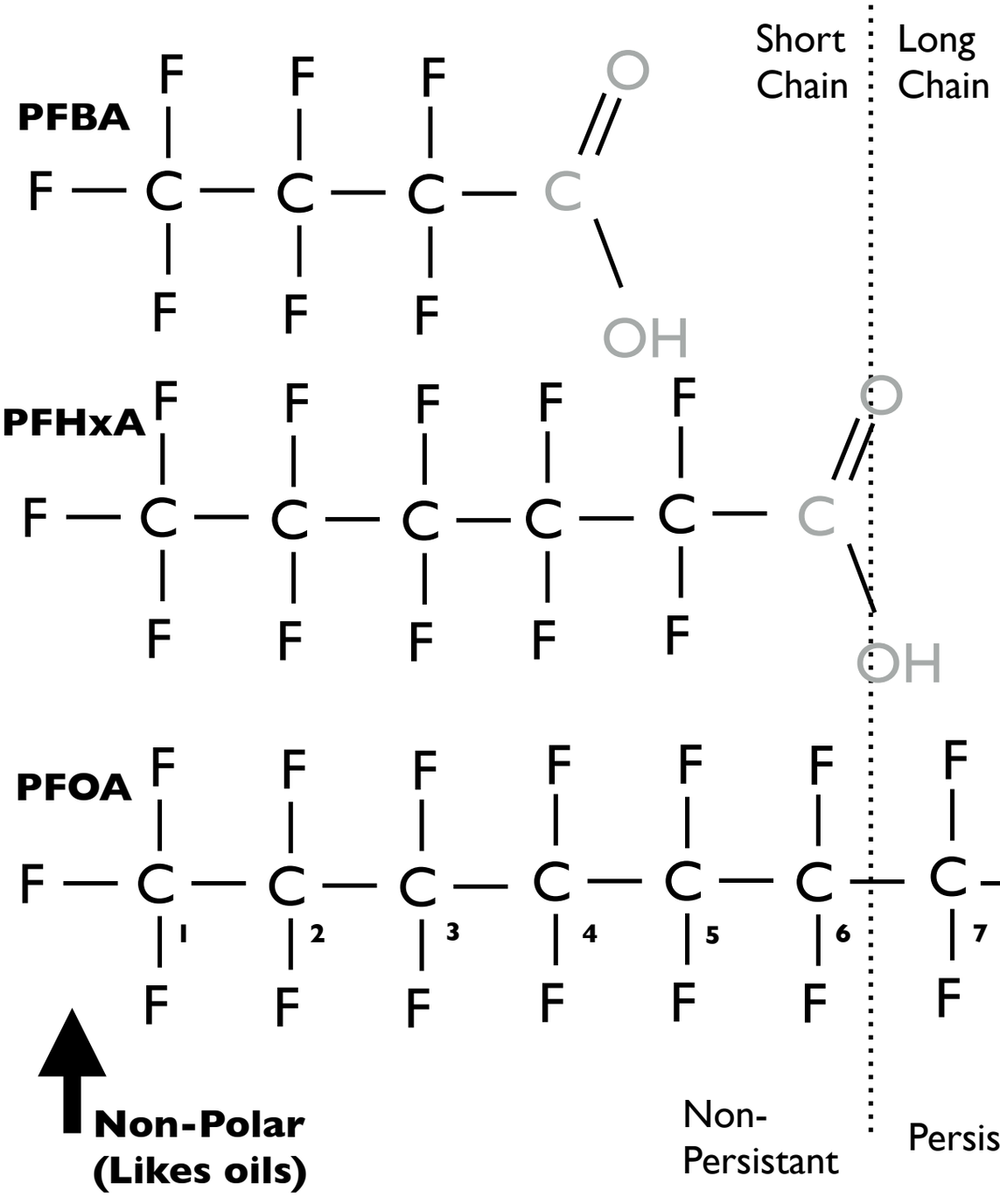
- Solid fluoropolymer made from fluoropolymer
  - PTFE connector
  - PVDF tube
  - FKM o-ring
  - **PFOA risk -** as a surfactant in the manufacturing process

- Fluorination of another polymer
  - Fluorine and oxygen gas process
  - Example - fluorinated polyethylene
  - **PFOA risk -** oxygenation generates carboxylates including PFOA and family

Perfluoroalkyl Substances

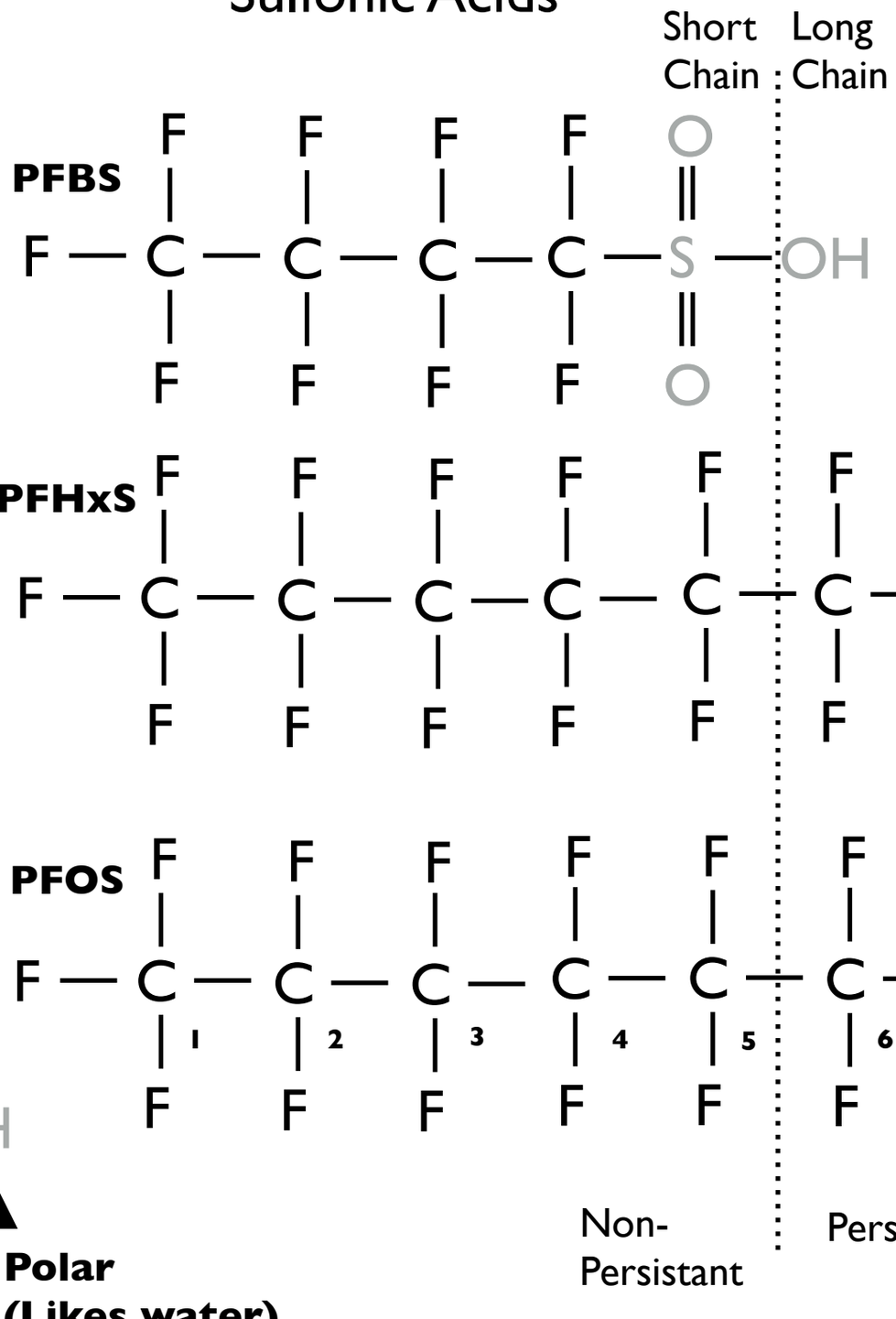
Perfluorinated carboxylate chemicals

Carboxylic Acids



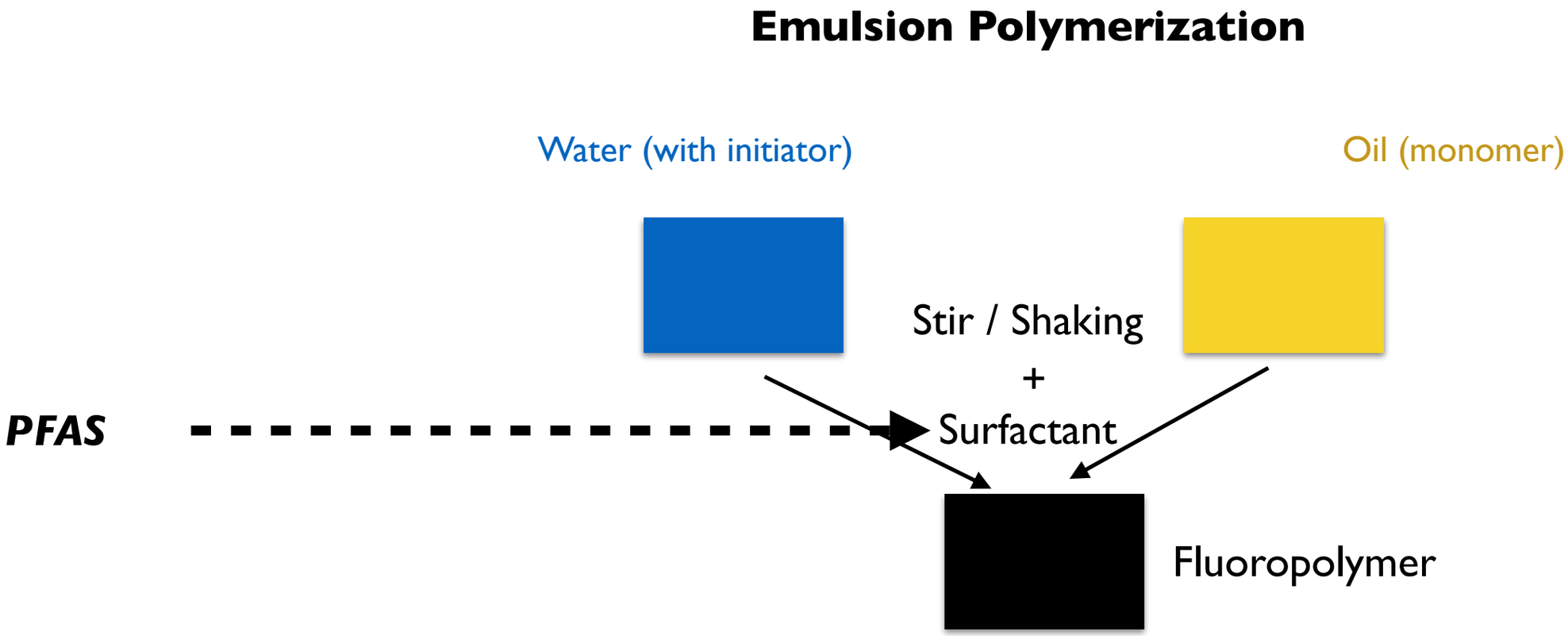
Perfluoroalkyl sulfonate chemicals

Sulfonic Acids



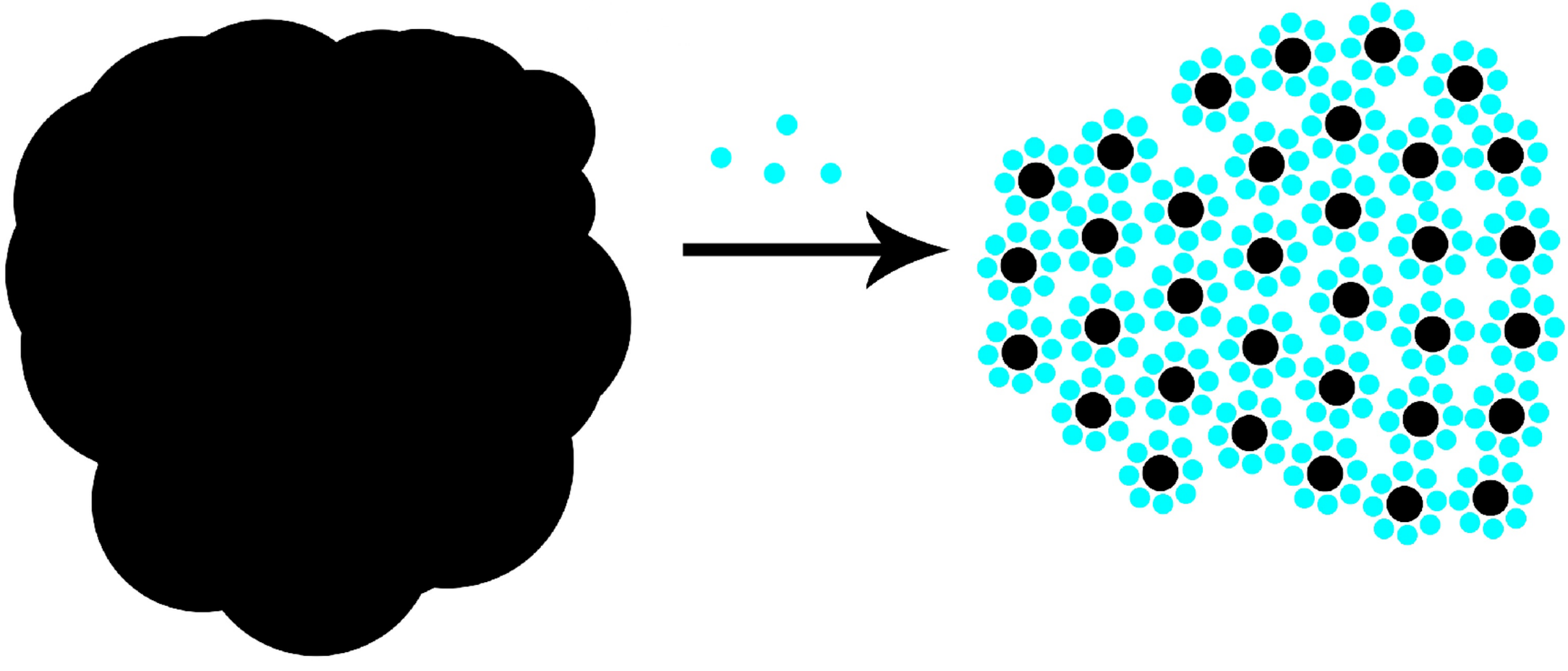
Emulsion Polymerization

- Emulsion
  - Oil and water mixture to polymerize
  - Needs surfactant to bind materials in oil to water
  - ie. LC-PFAC risk



Surfactant

- Surfactant
  - Breaks ups the larger oil (monomer) globules and makes them into more water friendly small globules
  - Allows more reactivity between oil and water



Polyfluoro uses
Solid Polymer

- Solid fluoropolymer made from fluoropolymer
  - PTFE connector
  - PVDF tube
  - FKM o-ring
  - **PFOA risk -** as a surfactant in the manufacturing process

- Fluorination of another polymer
  - Fluorine and oxygen gas process
  - Example - fluorinated polyethylene
  - **PFOA risk -** oxygenation generates carboxylates including PFOA and family

PFAS Coatings

- Polyfluoro cured on surface
  - PTFE water spray and high temperature curing into a solid
  - **PFOA risk** - as a surfactant in the powder manufacturing

- Polyfluoro suspended in another polymer
  - PTFE powder suspended in an acrylic or other polymer
  - **PFOA risk** - as a surfactant in the powder manufacturing

- Fluoroacrylate coating
  - Fluoroacrylate or sulphonate coating
  - **PFOA risk** - degradation of fluoroacrylate into PFOA

PFAS Lubricants

- Polyfluoro lubricants
  - PTFE powder suspending in mineral oil (or similar)
  - **PFOA risk -** as a surfactant in the powder manufacturing

Cosmetics

- Ingredient
  - C9-15 Fluoroalcohol Phosphate

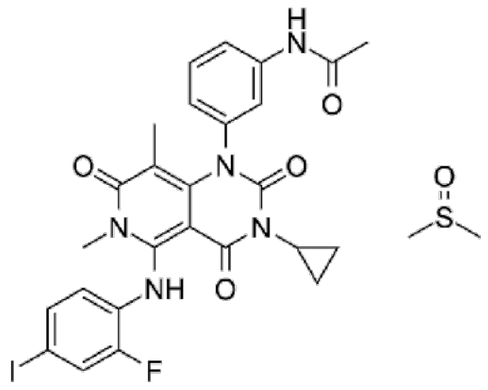
- C9-15 Fluoroalcohol Phosphate
  - **PFOA risk** - degrades easily into PFOA

- Use
  - Higher spf make-up

Miscellaneous

- Lots of miscellaneous uses
  - Fire extinguishing foam (Sulphonated fluorotelomers)
  - Lithium ion batteries (PVDF cathode binder)
  - Fluorinated medicines
    - (Which may be removed from reporting in definition updates)

Trametinib



How to Comply
Reporting vs Restriction

- PFAS **reporting**
  - Presence of intentionally added PFAS
  - Dominated by fluorine presence
  - Virtually always fluoropolymers or fluoropolymer coatings

- PFOA **restriction**
  - Restriction on manufacturing aids and degredation products of fluoropolymers
  - Requires detailed testing of fluorinated substances

Typical questions we get

- What specific PFAS Chemicals are you able to test for?
- What test methods are available to test for PFAS?
- What types of samples can be used for these tests?

Starting Point Simplification

- For articles (physical products)

- Fluoropolymers (ie. PTFE)
  - Reportable
  - Non-restricted
    - Unless they contain restricted PFOA or similar.

- Non-Polymer PFAS (ie. PFOA)
  - Not generally reportable (not intentionally added)
  - Select groups are restriction (such as PFOA and longer)

Compliance Process
Measuring Fluorine Concentration

- Process for PFAS compliance
- **Step 1**
  - Test directly for fluorine

  - No fluorine. No fluoroalkyl substances.

- WDXRF is the fast approach to identification of low levels of fluorine concentration

Compliance Process
Identification of Fluoro

- Process for PFAS compliance
- **Step 2**
  - Identification of intentionally added fluoroalkyl substance
  - Virtually all intentionally added PFAS are fluoropolymers or fluoropolymers suspended in another material
- Identification by
  - FTIR, supplemented by
  - Secondary elements (such as S and Si)

Compliance Process
Identification of Restricted Perfluoro

- Process for PFAS compliance
- **Step 3**
  - Measuring PFOA substances in fluoropolymers and fluoro coatings by LC-MS/MS
  - The major uses of PFOA (and similar) can be identified by polyfluoro present
- Identification and quantification by
  - LC-MS/MS

Claigan Approach

- PFAS compliance
  - **Step 1 -** Fluorine screening
  - **Step 2 -** Polymer identification
  - **Step 3 -** (Restriction) - LC-MS/MS of the identified polymer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Typical questions we get

- What specific PFAS Chemicals are you able to test for?
  - **Step 1 - Test for fluorine**
  - **Step 2 - Identify fluoropolymer**
  - **Step 3 (restriction) - Test for PFOA and similar**

- What test methods are available to test for Fluorine?
  - **See above**

- What types of samples can be used for these tests? (Fabrics, plastics, etc?)
  - **All.**
  - Note - a common PFAS is a fluoro coating on metal filter screens

Claigan Approach

- PFAS compliance
  - **Step 1 -** Fluorine screening
  - **Step 2 -** Polymer identification
  - **Step 3 -** (Restriction) - LC-MS/MS of the identified polymer


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Q&A