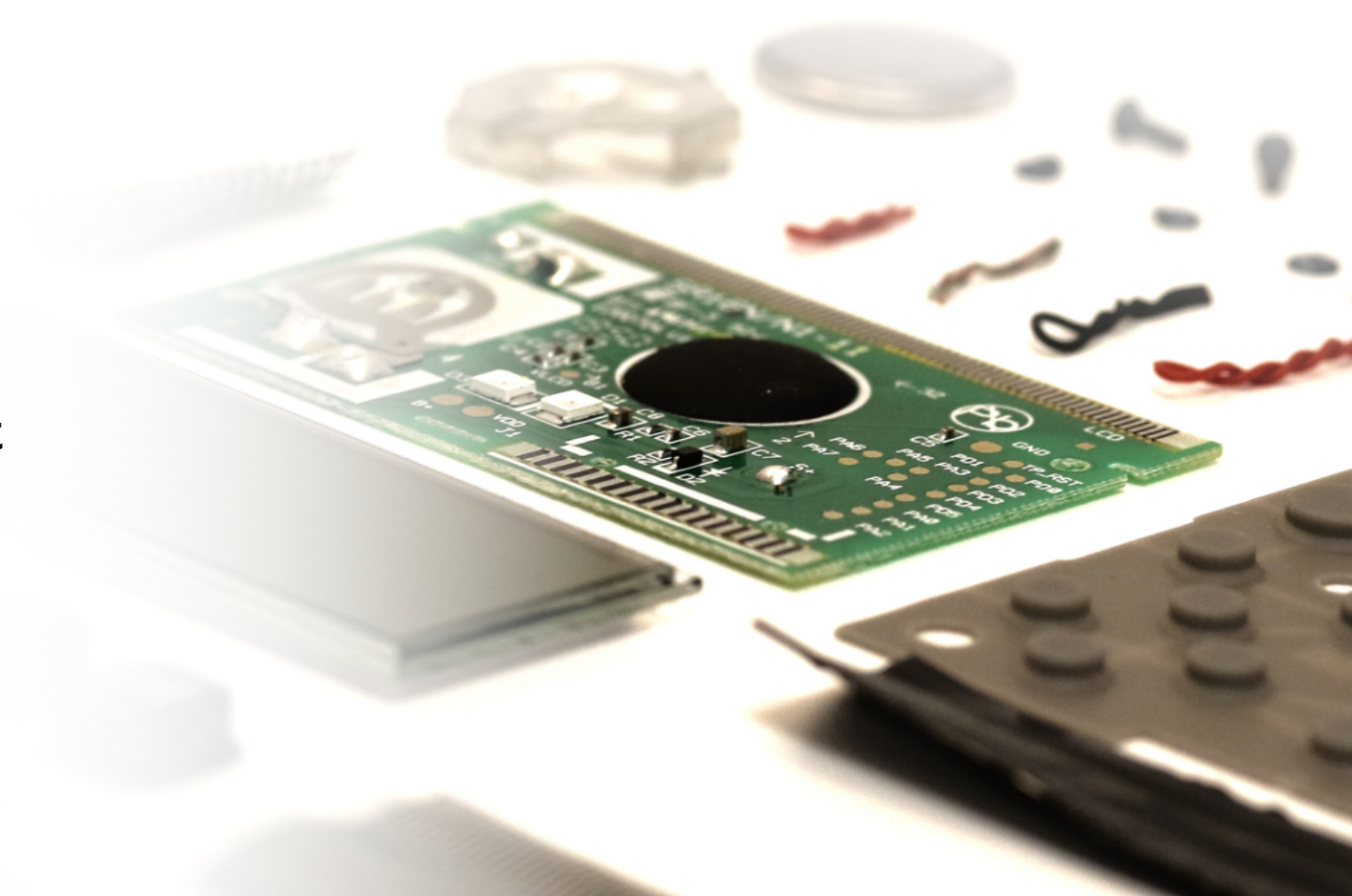


Where are PFAS in Products?

Testing data 2022/2023

Presented by:
Bruce Calder
VP Consulting and Chief Scientist

October 4, 2023

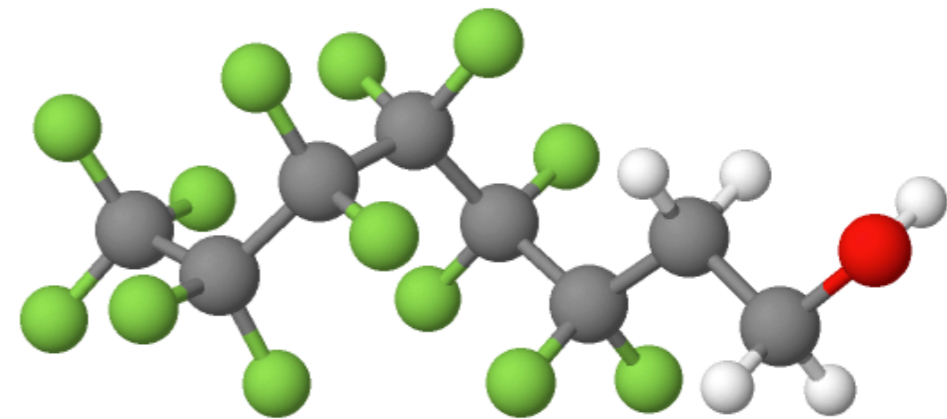


Where are PFAS in Products?

- **Lots of news stories**
 - But where are PFAS, really?

'Forever chemicals' linked to infertility in women, study shows

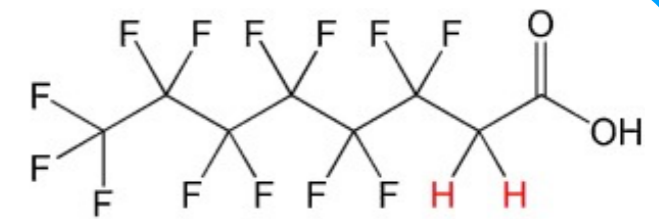
Study links in utero 'forever chemical' exposure to low sperm count and mobility



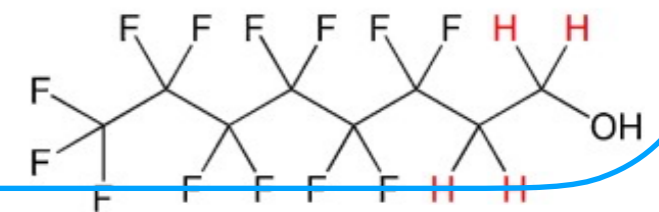
6:2 FTS

PFAS Simplified

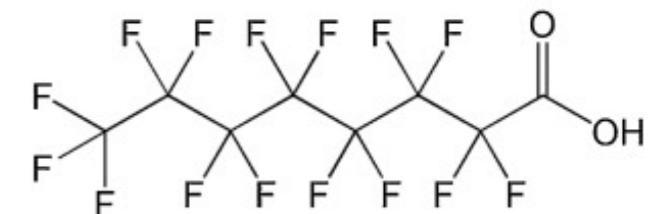
- **Non-Polymer PFAS**
 - Non-repeating PFAS (non-polymer)
 - Normally **‘water soluble PFAS’**
 - **Included in polymers PFAS**



6:2 FTCA



6:2 FTOH



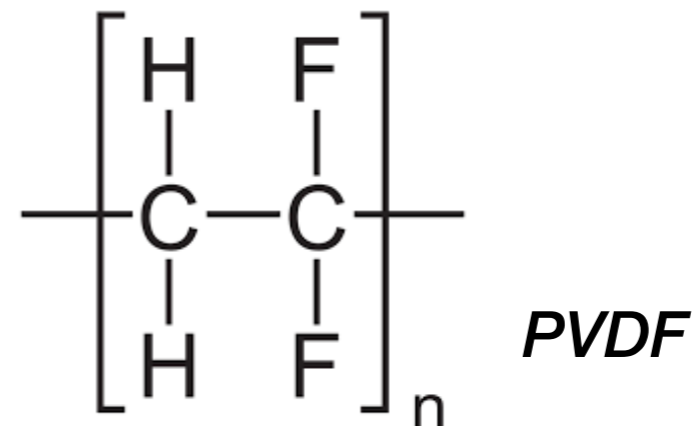
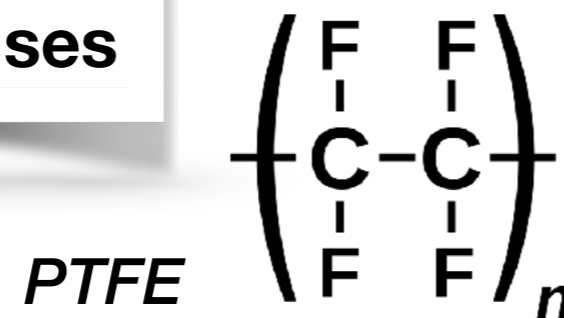
PFOA

1% of Intentional Uses

LC-MS/MS

- **Polymer PFAS**
 - Repeating chains
 - Normally the **‘intentionally added PFAS’**

99% of Intentional Uses



PFAS in Drinking Water

- Comparison chart of fluoro salts in different materials

2. PFAS News Articles and Related Science Papers (2021 to 2023)

Article	Year	Paper	PFAS Detected in Water or Blood/Serum	High conc. or correlated PFAS	Fluoro polymer (Y/N)	PFOA (Y/N)
'Forever chemicals' linked to infertility in women	2023	Exposure to perfluoroalkyl substances and women's fertility outcomes in a Singaporean population-based preconception cohort	PFDA, PFOS, PFOA, PFHpA	PFDA	N	Y
Study links in utero 'forever chemical' exposure to low sperm count and mobility	2022	Maternal Exposure to Per- and Polyfluoroalkyl Substances (PFAS) and Male Reproductive Function in Young Adulthood: Combined Exposure to Seven PFAS		PFHxS, PFHpA, PFOA, PFOS, PFNA, PFDA, PFUnDA	N	Y
'Forever chemicals' and acids used in plastic production connected to poor pregnancy outcomes: study	2023	Extending <u>Nontargeted</u> Discovery of Environmental Chemical Exposures during Pregnancy and Their Association with Pregnancy Complications—A Cross-Sectional Study	PFNA, PFOA, PFOS, PFDeA, PFUdA, PFHxS - detected in food and food packaging	PFOS, PFHxS	N	Y

PFAS in Drinking Water & Humans

- Polymer PFAS
 - Not found in humans or drinking water
- Non-Polymer PFAS
 - Found in humans drinking water



BAD

Where do they come from?

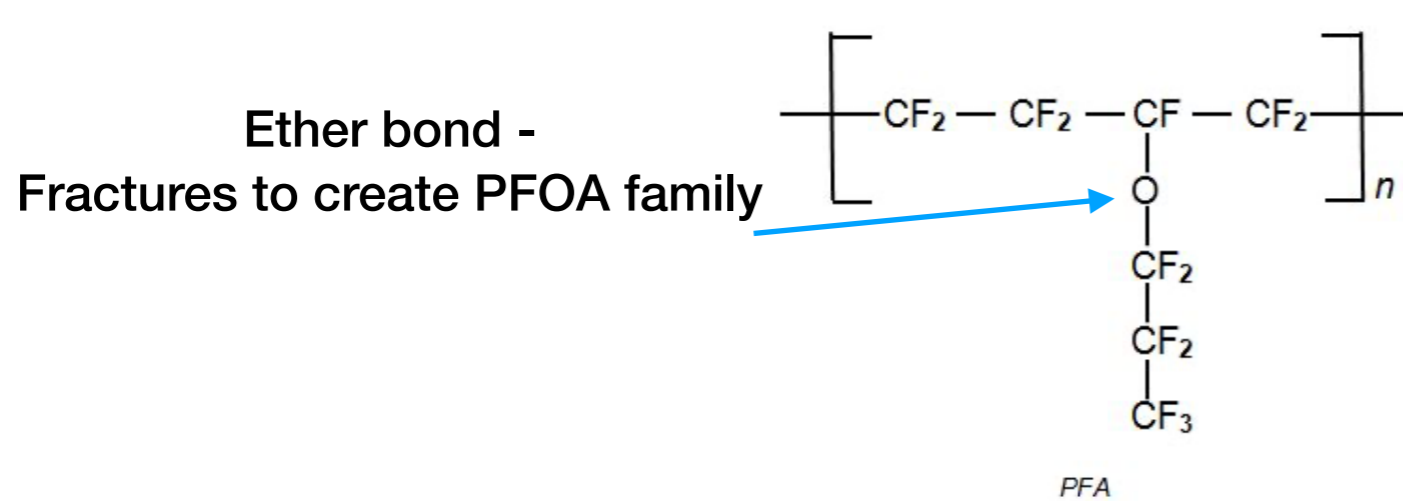
PFAS in Drinking Water & Humans

- Cookware?
 - No.
 - Cookware does **NOT** contain any PFAS found in drinking water or humans
 - And does not degrade into any PFAS found in drinking water or humans.
- So where is it from
 - Degradation of specific fluoropolymers, or
 - Degradation of specific surfactants

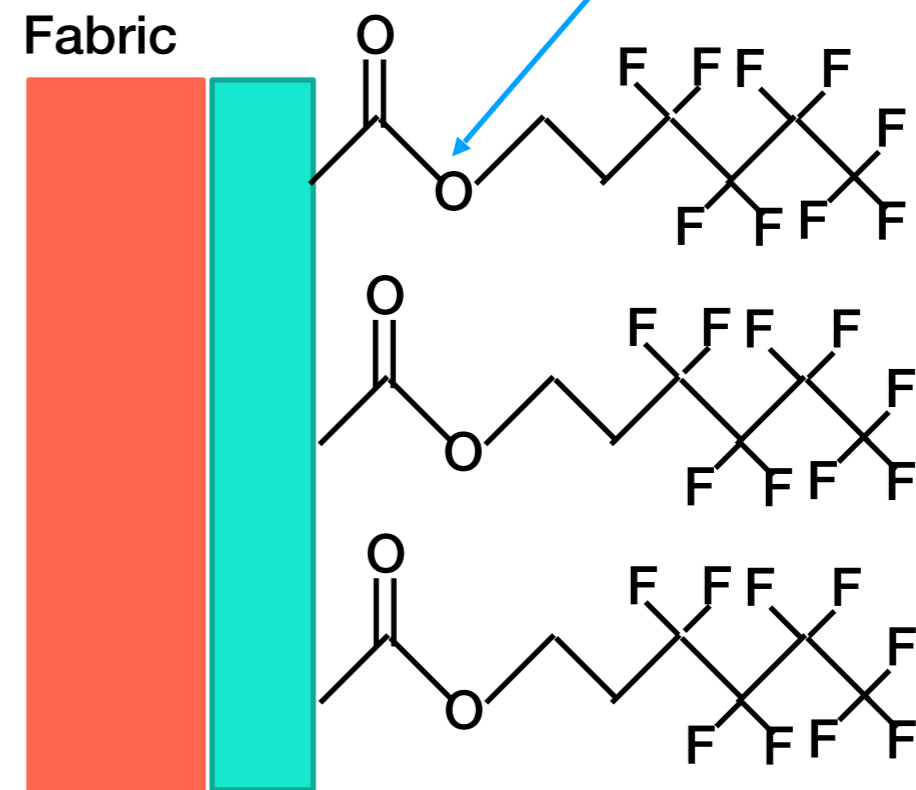


Fluoropolymer Degradation Method #1

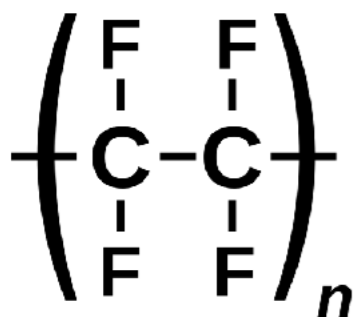
- Weak C-O-C bond



Weak C-O-C bond
Fractures to create PFOA

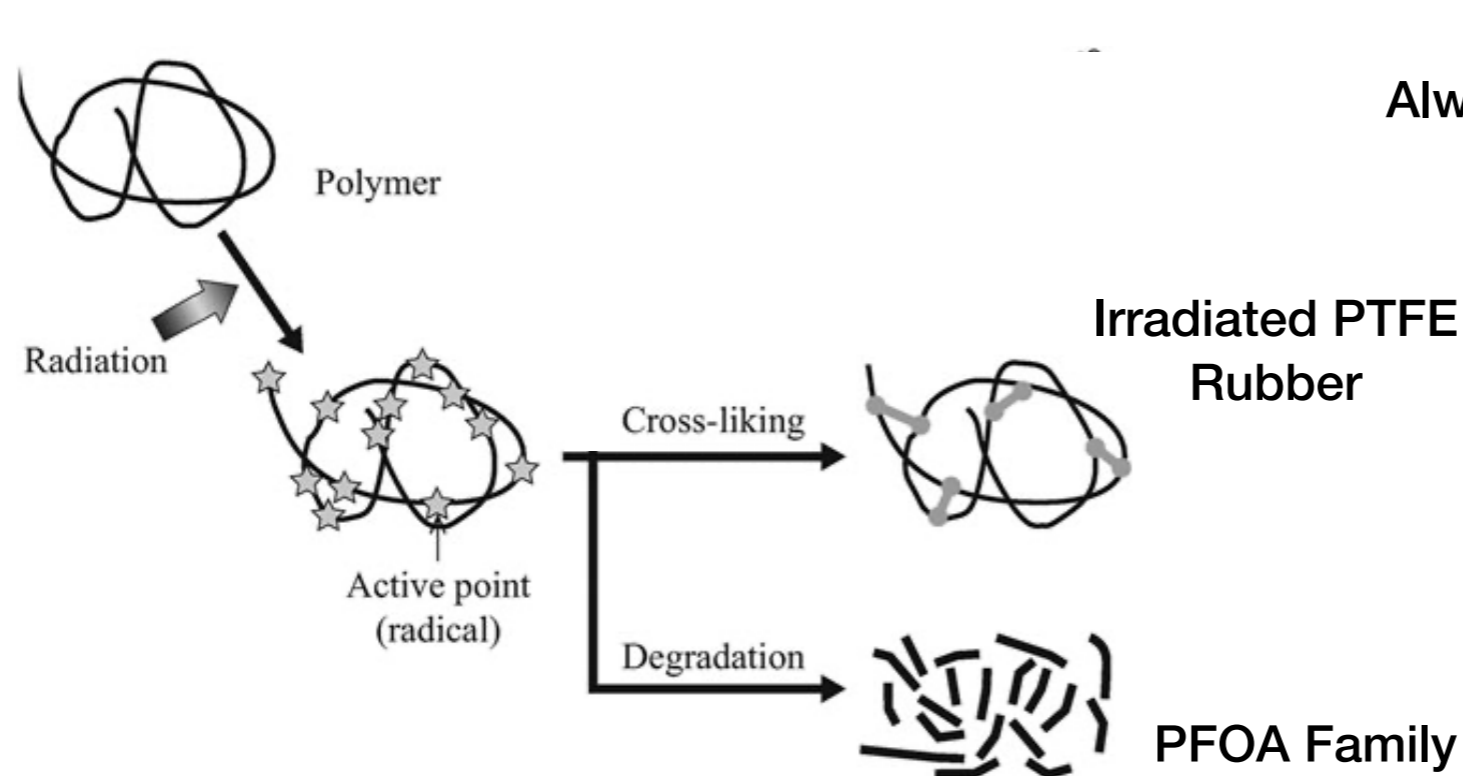


NOTE
PTFE Does Not Degrade
No C-O-C Bond

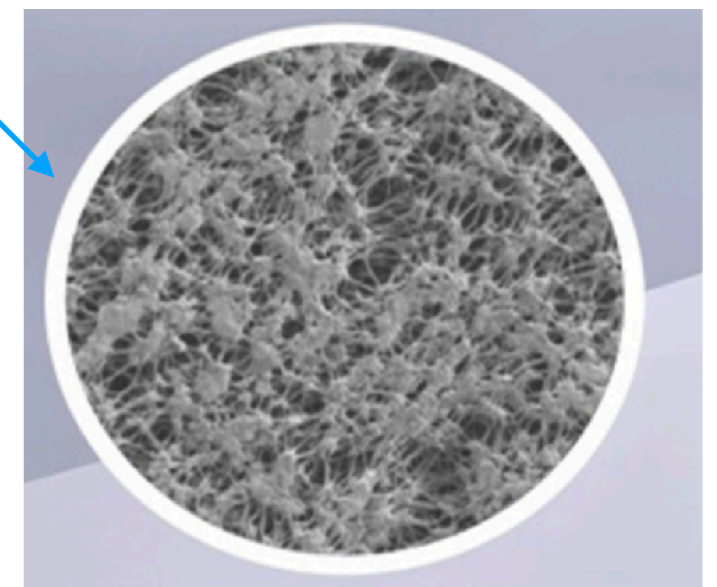


Fluoropolymer Degradation Method #2

- Irradiation of Fluoropolymer
 - Irradiated PTFE and PVDF
 - To 'rubberize' them
 - ePTFE
 - Rubberized as part of expanding in fibre



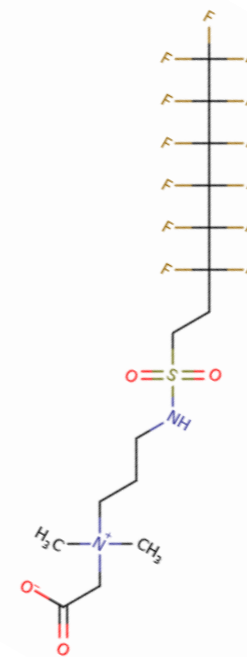
ePTFE and ePVDF
Always contain PFOA family



Fluorosurfactant Degradation

Group #1

- Fluorosurfactant uses
 - Fire fighting foam
 - C6 fluorotelomer based surfactants
 - FKM and FFKM (fluoroelastomers)
 - C6 fluorotelomer based surfactant for manufacturing



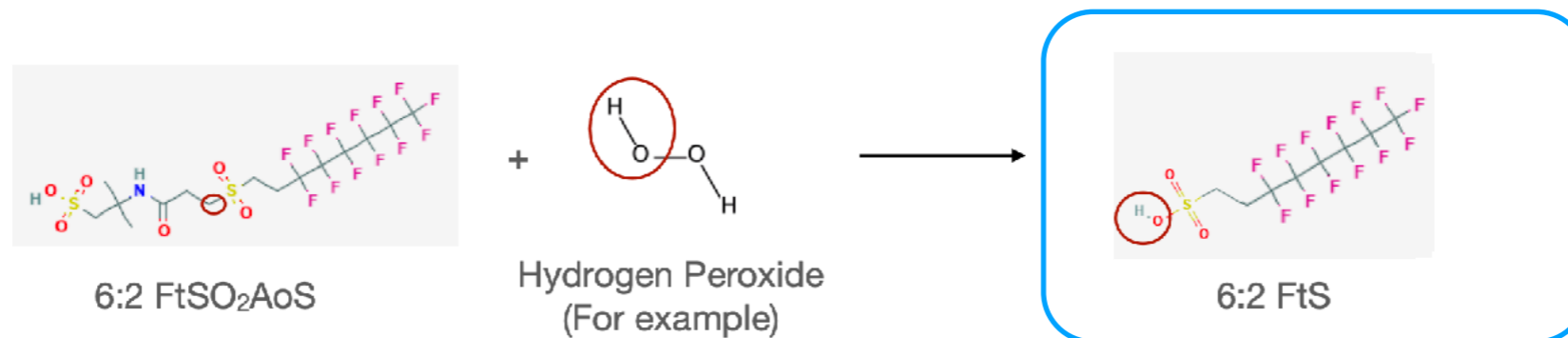
Fluoro surfactant

Non-Ionic Surfactant Used in Fluoroelastomers (ie. Viton)

Regular Chemical Transformation into 6:2 FTS



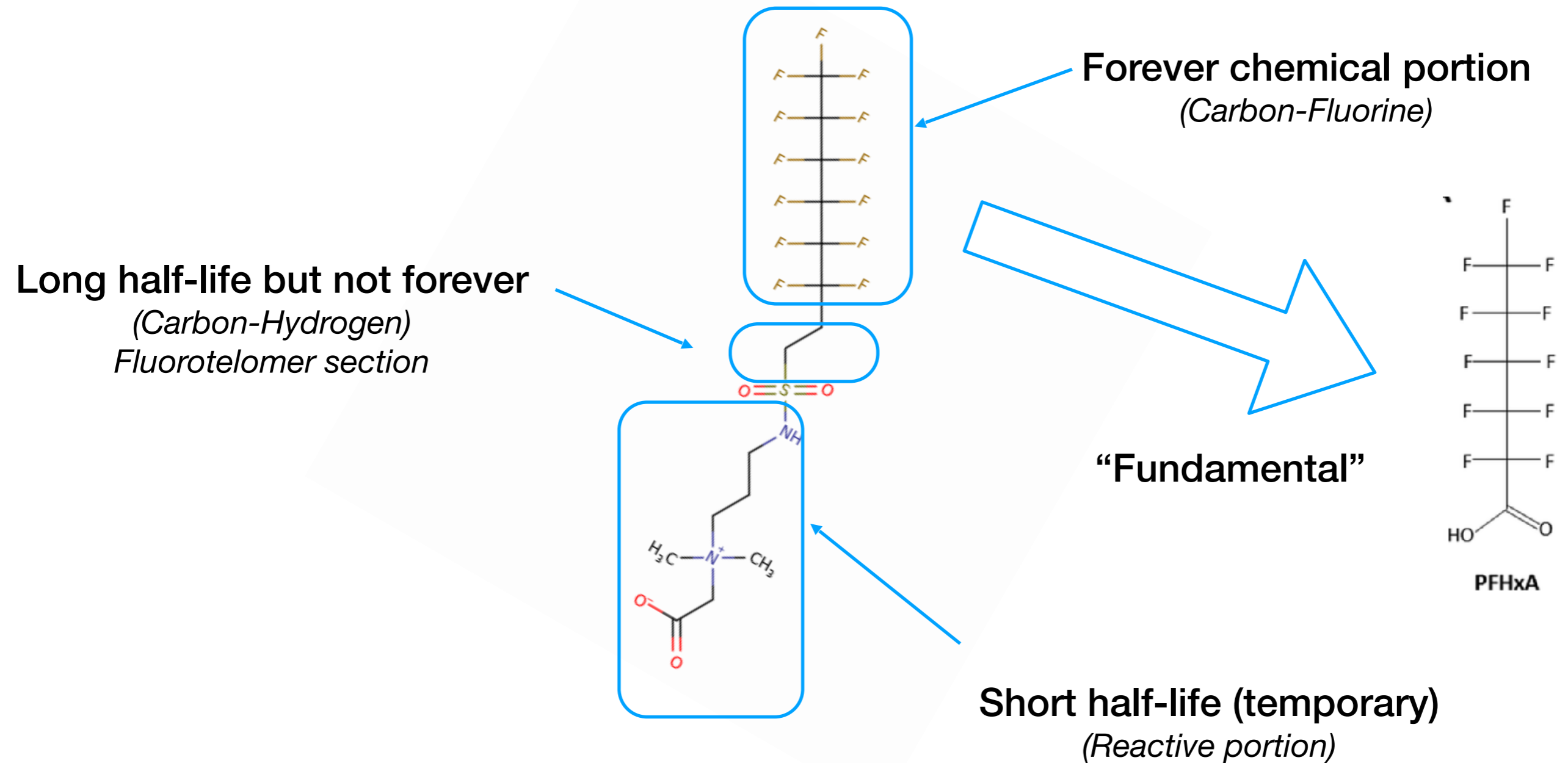
- For 6:2 FtTAoS to transform into 6:2 FtSO₂AoS it must undergo a double oxidation
- Sulphur is able to make many bonds at once. This is because it is a larger atom and therefore can have an expanded octet



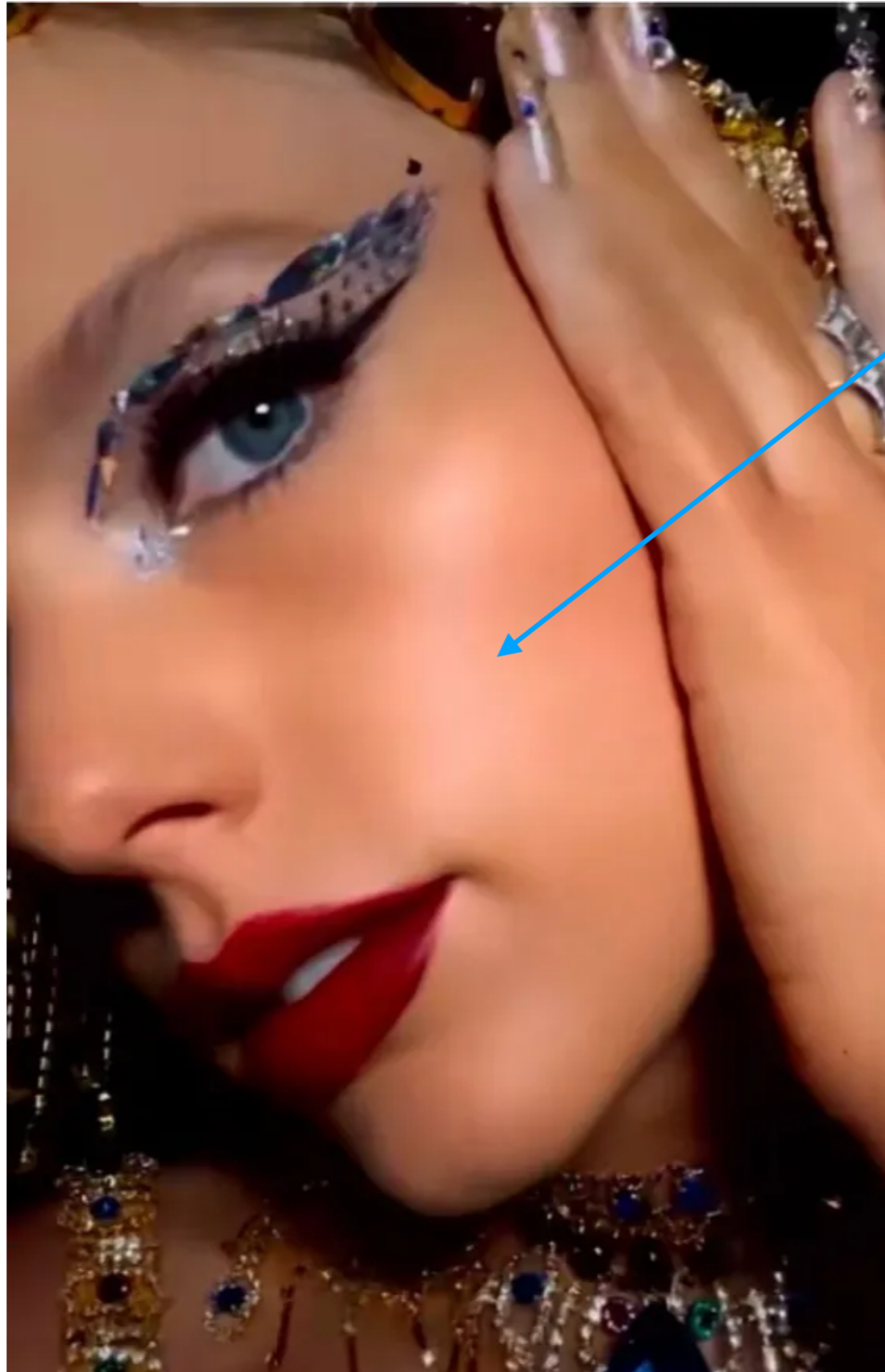
Starting surfactant in Fluoroelastomers

Measured sulphonate in end fluoroelastomer + some smaller PFOA family (C4-C6)

Reactive Portions of PFAS Surfactants



Example



**Concealer
(Now)
Silicone Rubber based**



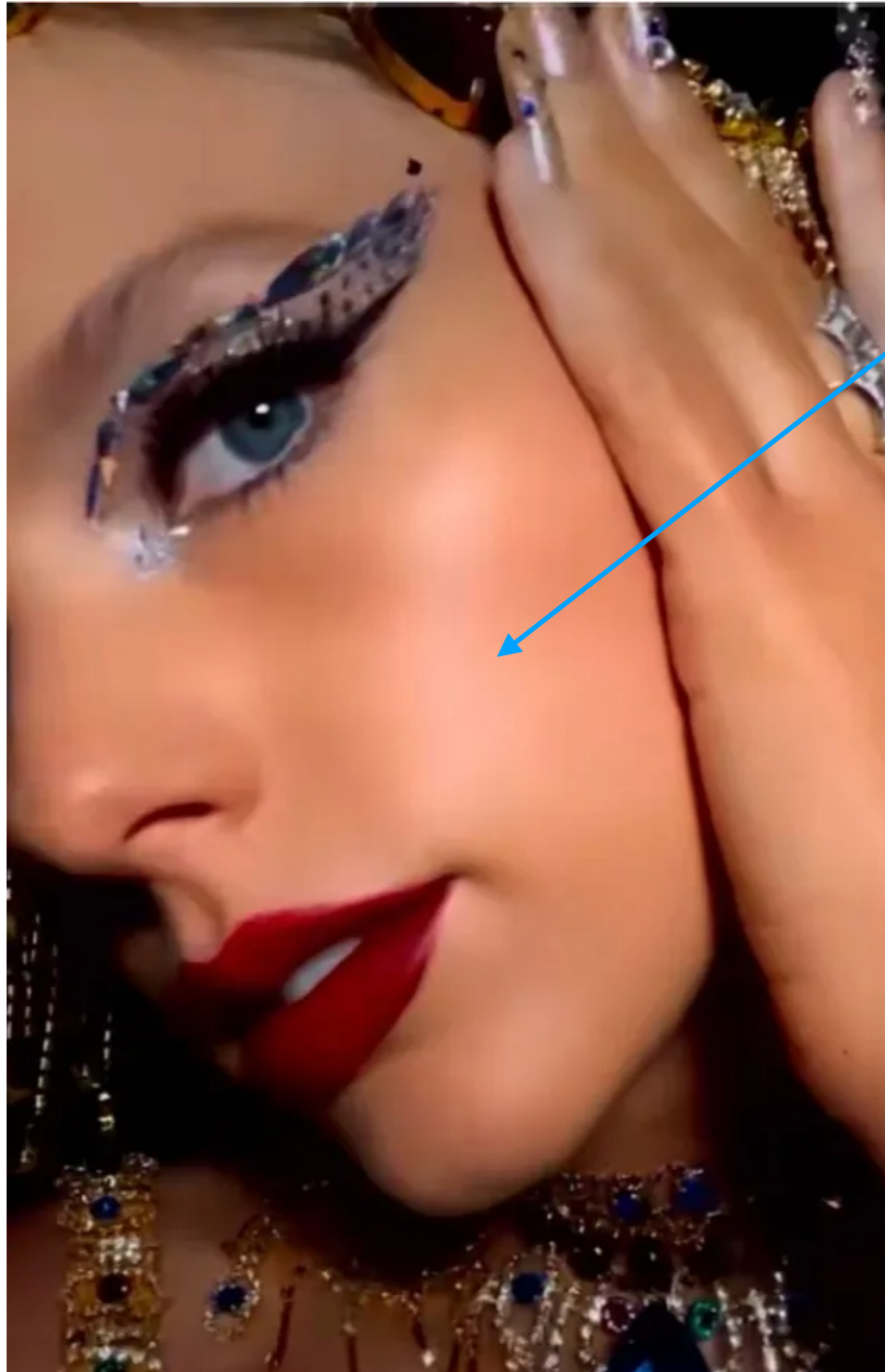
Silicone rubbers

- Dimethicone
- Trimethylsiloxysilicate
- Cetyl PEG/ PPG-10/ 1 Dimethicone
- Trimethylsiloxyphenyl Dimethicone
- Dimethicone/ Vinyl Dimethicone Crosspoly.
- Trisiloxane

Regulations

- Will contain some level of EU banned D4 and D5 siloxanes

Example



Setting Powder Microplastics

Microplastics

- PTFE (historically)
- Nylon-12
- Polymethyl Methacrylate



Regulations

- Banned in the EU (2035)

PFAS Testing

Intentionally Added Fluorine

- Two (2) Fluorine testing methods
 - Combustion - Ion Chromatography (C-IC)
 - Incinerate (combust) the product and test residual fluorine in ash
 - Cannot measure F in coatings on plastics < 10,000 ppm F
 - 30% of situations



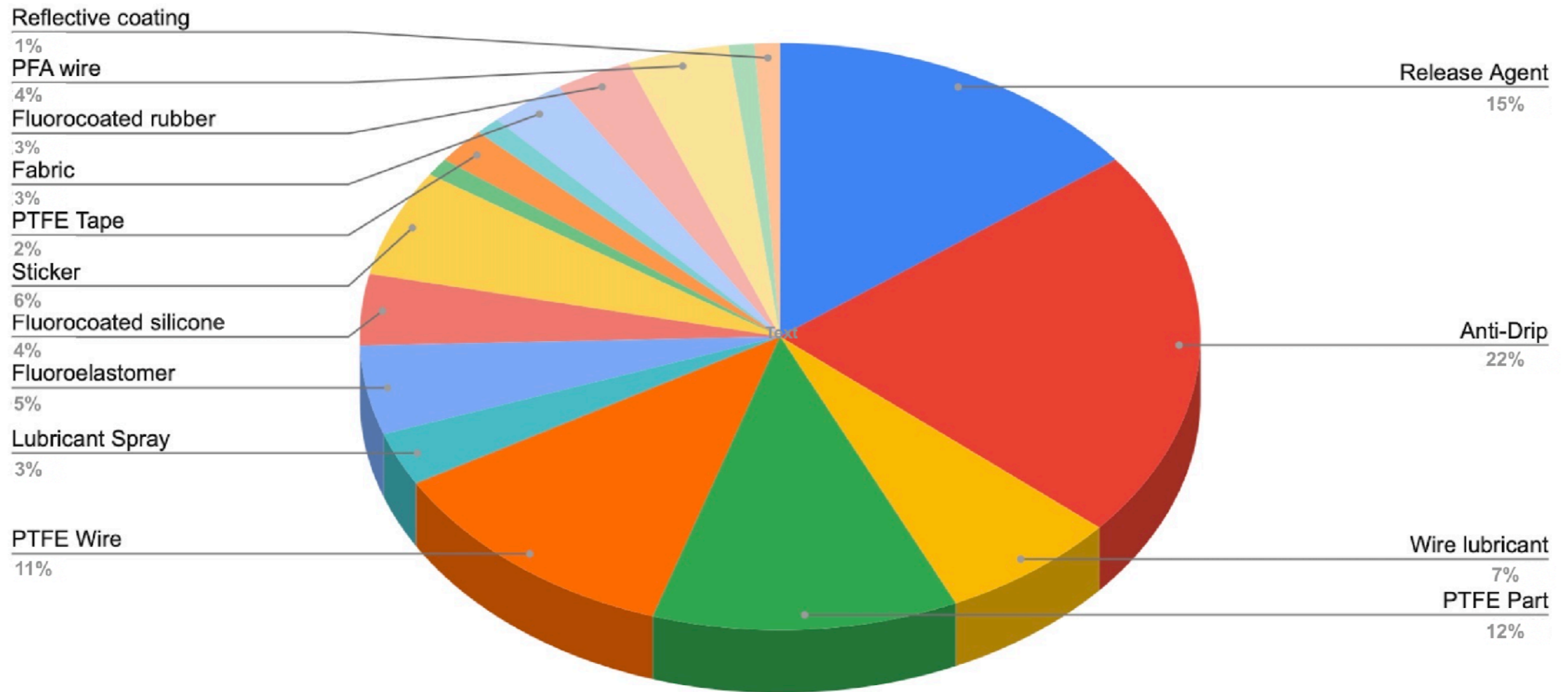
- Wavelength Dispersive X-Ray Fluorescence (WD-XRF)
 - Directly test the fluorine content of a part
 - Accurate down to 50 ppm F in coatings



PFAS Uses WD-XRF Results

- Products tested in February / August 2023

Location of PFAS in Complex Articles - 2023 Testing Data

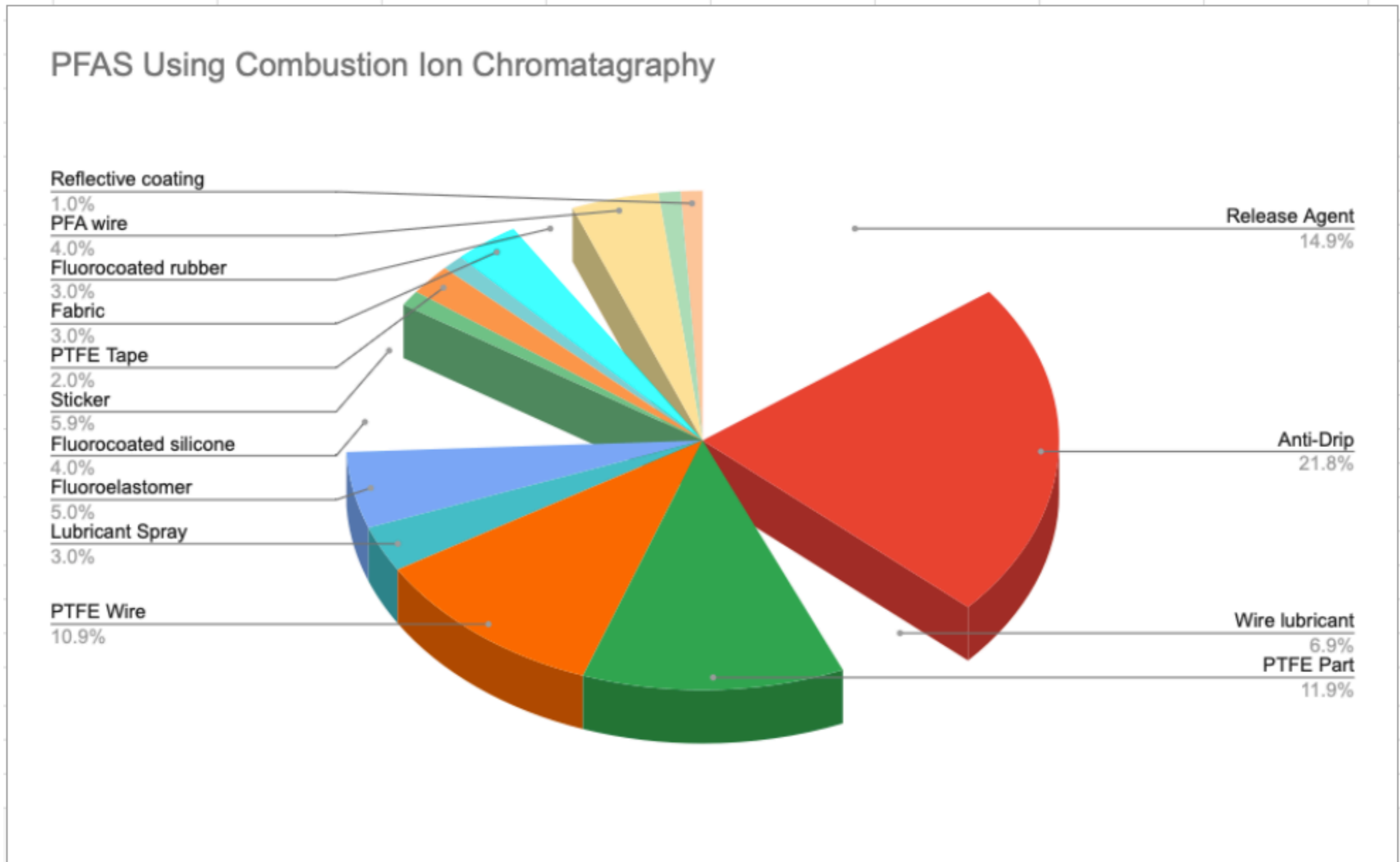


Small slices not labelled on graph
1% PFA Part
1% PTFE in Low Friction Plastic

PFAS Results

If you used CIC instead of WD-XRF

- 30% of PFAS instances would be missed with CIC

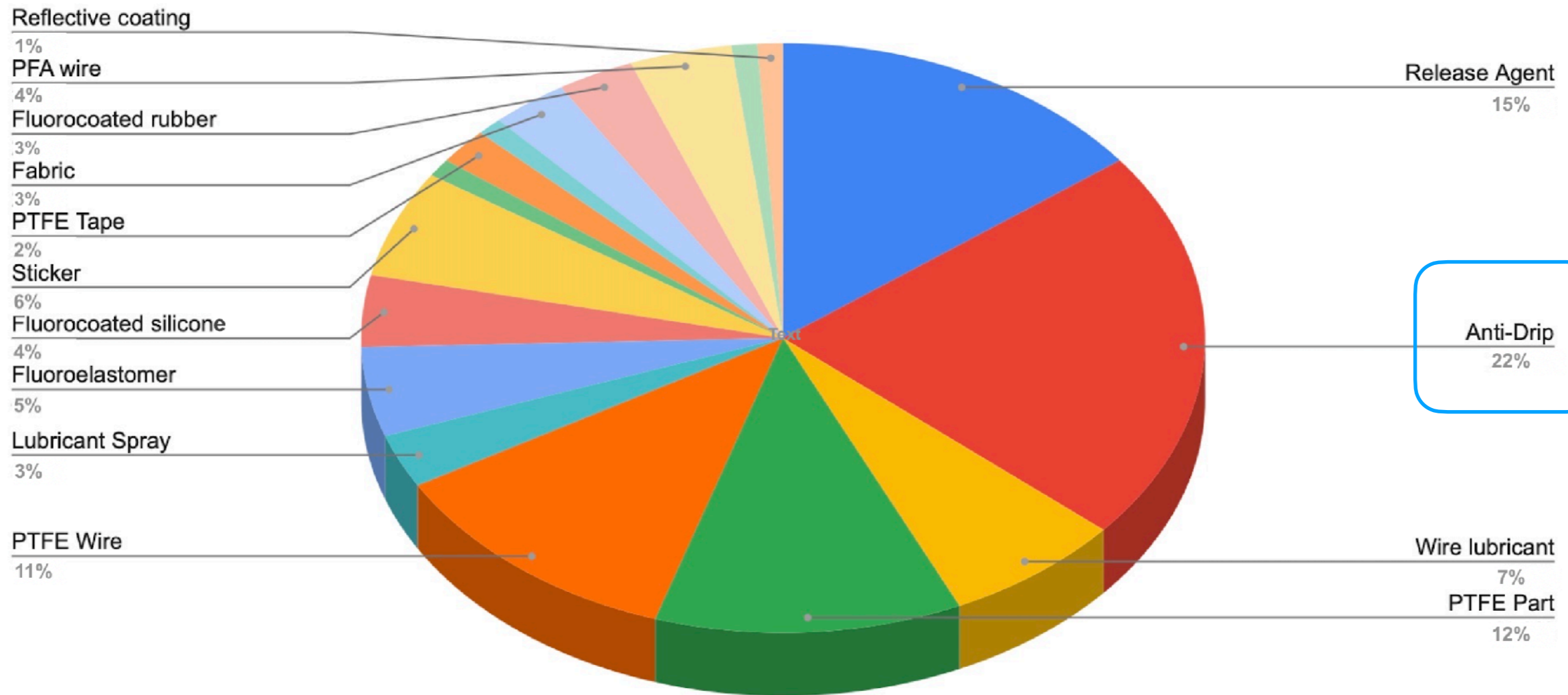


PFAS Uses

WD-XRF Results

- Products tested in February / August 2023

Location of PFAS in Complex Articles - 2023 Testing Data



Small slices not labelled on graph
1% PFA Part
1% PTFE in Low Friction Plastic

PTFE as an anti-drip agent

- **Use**

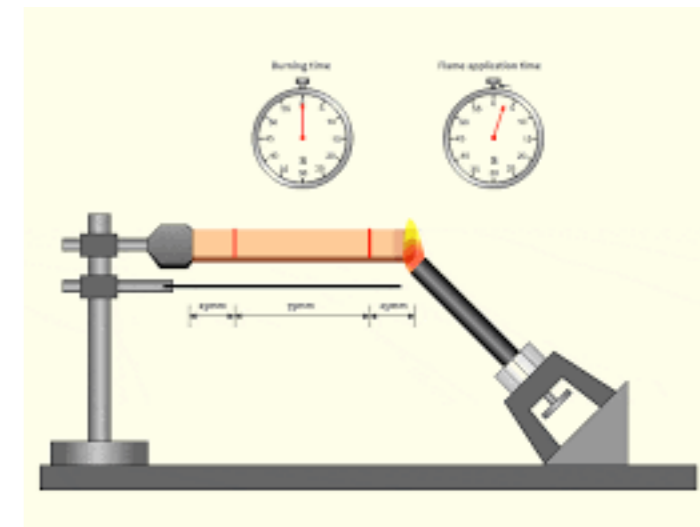
- PTFE used as an additive drip agent in plastics to meet flammability safety requirements

- Description

- PTFE powder added to ABS, PC, PBT and other plastics to ensure no drip for UL94 and LVD fire safety

- Justification

- The most common PFAS in electronics
- Related to fire safety
- **No PFOA family**



Fluoro fabric coatings for waterproofing

- **Use**

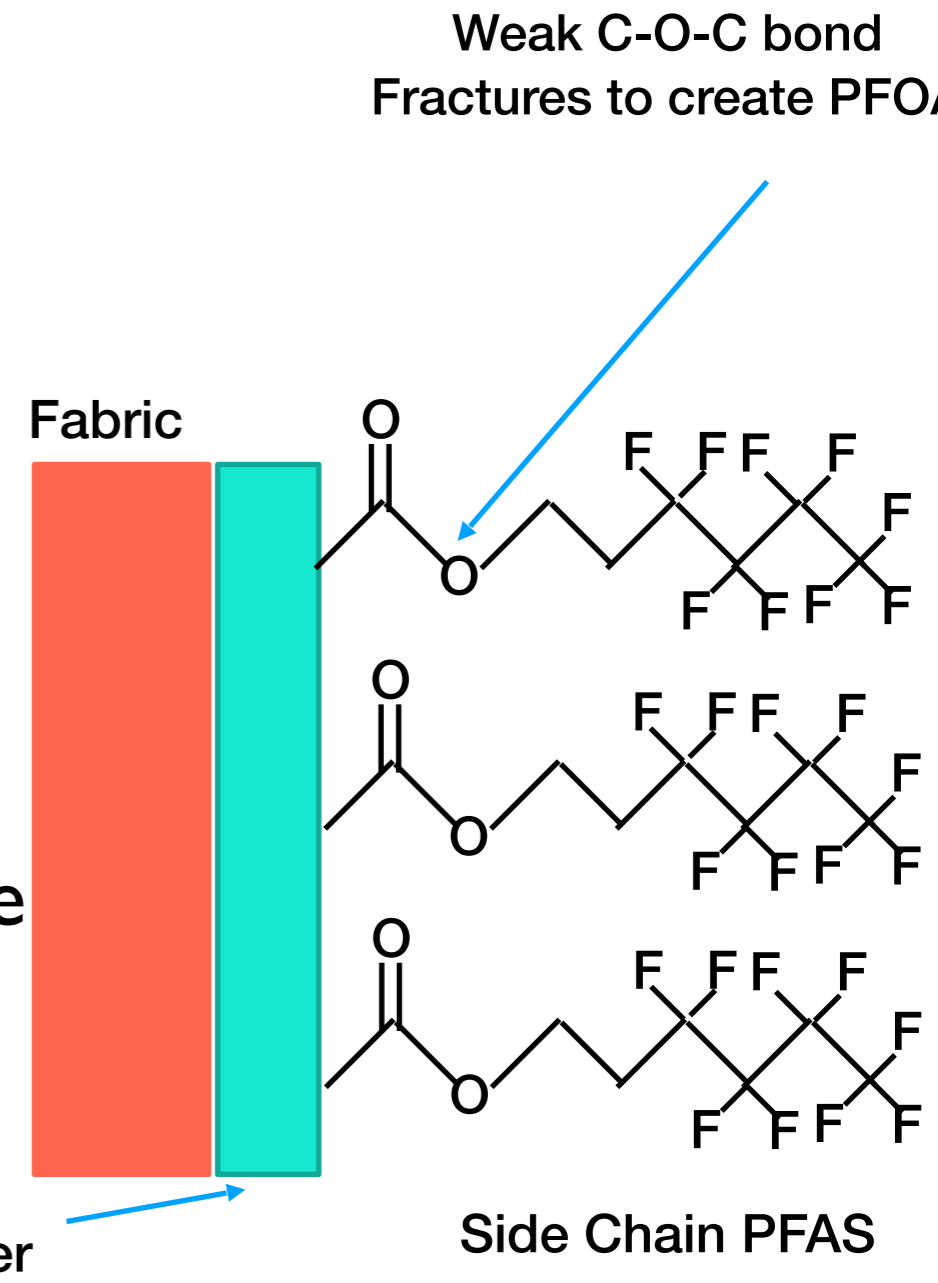
- Fluoroacrylic coatings necessary for water and stain resistance of fabrics.

- **Examples**

- Winter jackets
- “Made in China” tag in shirt
- Bbq cover

- **Notes**

- Has water, oil, and chemical resistance
- **Contains full PFOA family**
- Banned in EU



Example

PTFE tape

- **Use**

- PTFE tape for moisture insulation or joining of fluid components.

- **Description**

- PTFE tapes for joining fluid components



- **Details**

- Hydrophobic
- Commonly from irradiated PTFE
- Commonly (but not always) contains PFOA family
- PFOA contained is banned in EU.

Fluoropolymer wire insulator

- **Use**

- PTFE, ETFE, PFA, PVDF, FEP, and PFA as a wire insulator.

- **Description**

- Common higher performance wire insulator
- Temperature and chemical resistance

- **Justification**

- Better performance characteristics than PVC
- No PFOA family

- **Except - PFA**

- Contains full PFOA family 50% of time



Fluoroelastomers for seals

- **Uses**

- Fluoroelastomers (including perfluoroelastomers) as sealing material in situations requiring chemical or oil resistance.
- Fluoroelastomers (FKM) and perfluoroelastomers (FFKM)

- **Description**

- Fluoro rubbers for seals due to resistance properties

- **Justification**

- Unique chemical and temperature properties
- Residual from manufacturing surfactant
 - 6:2 FTS
 - Short chain PFOA family



Draft Derogation

PTFE for dielectric purposes

- **Use**

- PTFE and ETFE used for dielectric purposes.



- **Description**

- PTFE and ETFE as a dielectric or insulator for connectors and antennas

- **Details**

- PTFE has tremendous insulator / dielectric properties
- No PFOA family
 - Unirradiated PTFE

Reminder

PFAS in Drinking Water & Humans

- Polymer PFAS
 - Not found in humans or drinking water
- Non-Polymer PFAS
 - Found in humans drinking water



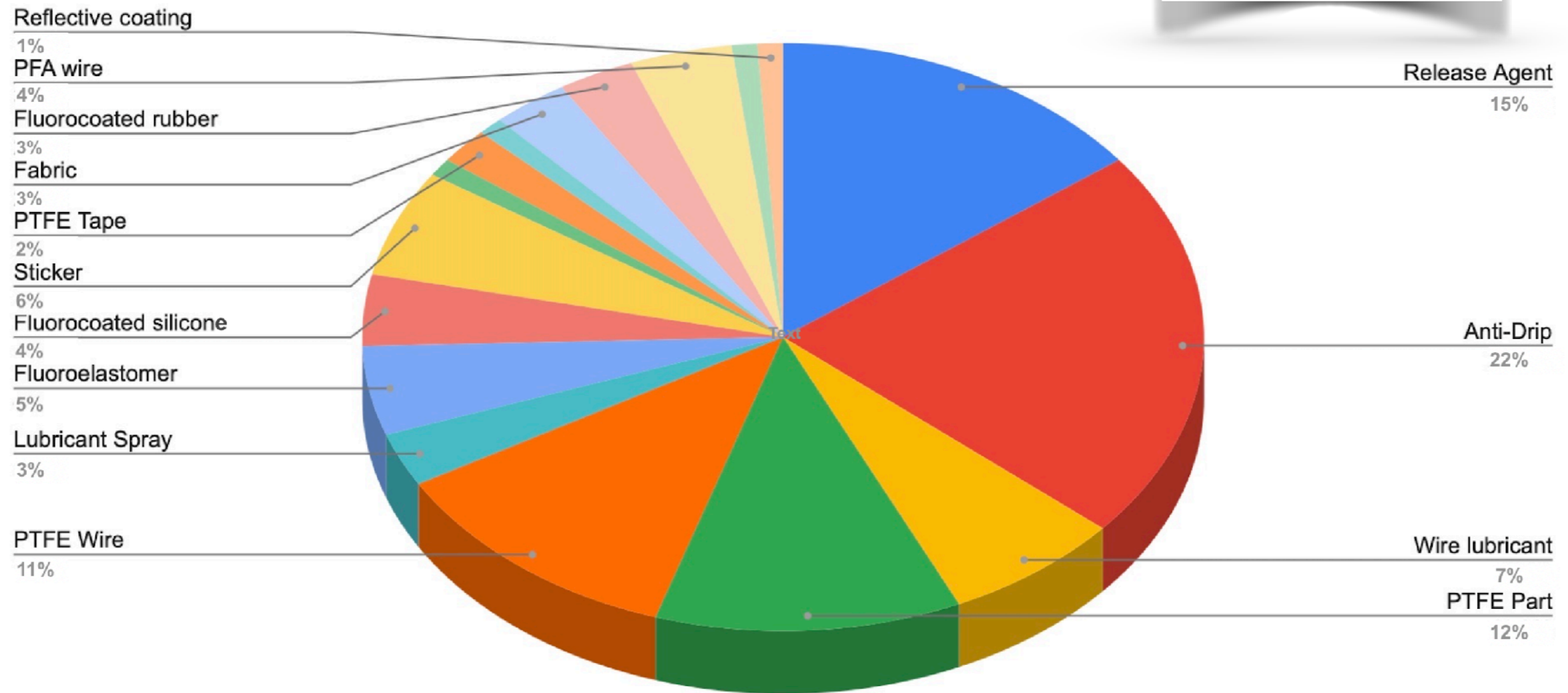
BAD

PFAS Uses WD-XRF

- Products tested in February / August 2023

Location of PFAS in Complex Articles - 2023 Testing Data

Questions?



Small slices not labelled on graph
1% PFA Part
1% PTFE in Low Friction Plastic