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PFAS Removal from Hard-to-treat Waste Streams

Mohamed Ateia Ibrahim, PhD

Office of Research and Development
US Environmental Protection Agency


Dr. Ashley Butzlaff


Dr. Bineyam Mezgebe


Paola Montoyo


Dyandra Lassalle


Ashton Collins

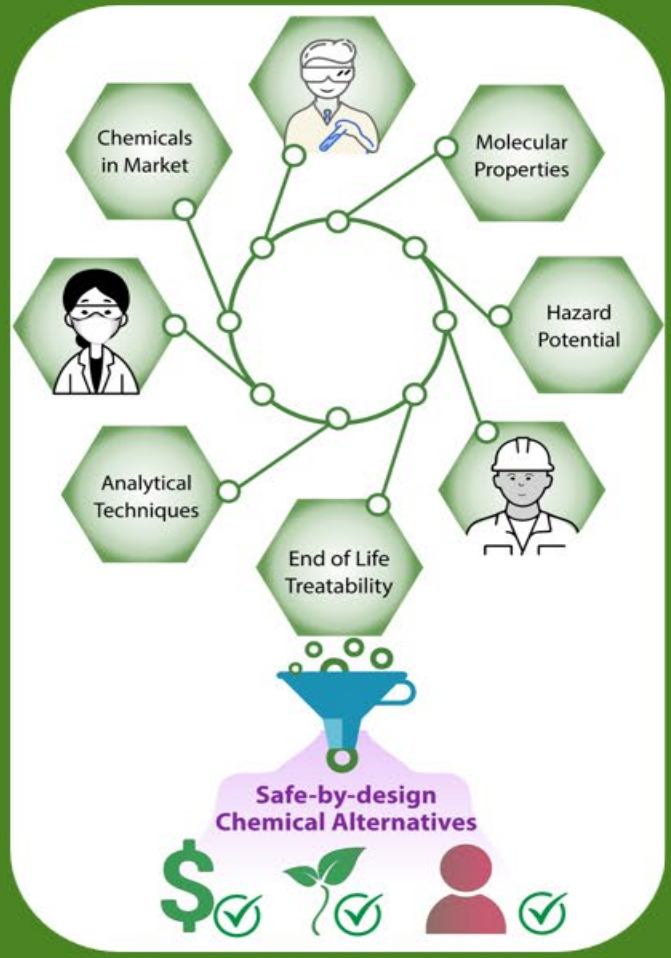
You

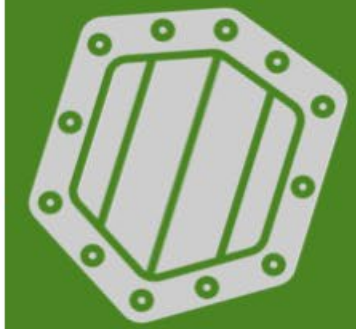
PFAS

PFAS-Replacements

D A D

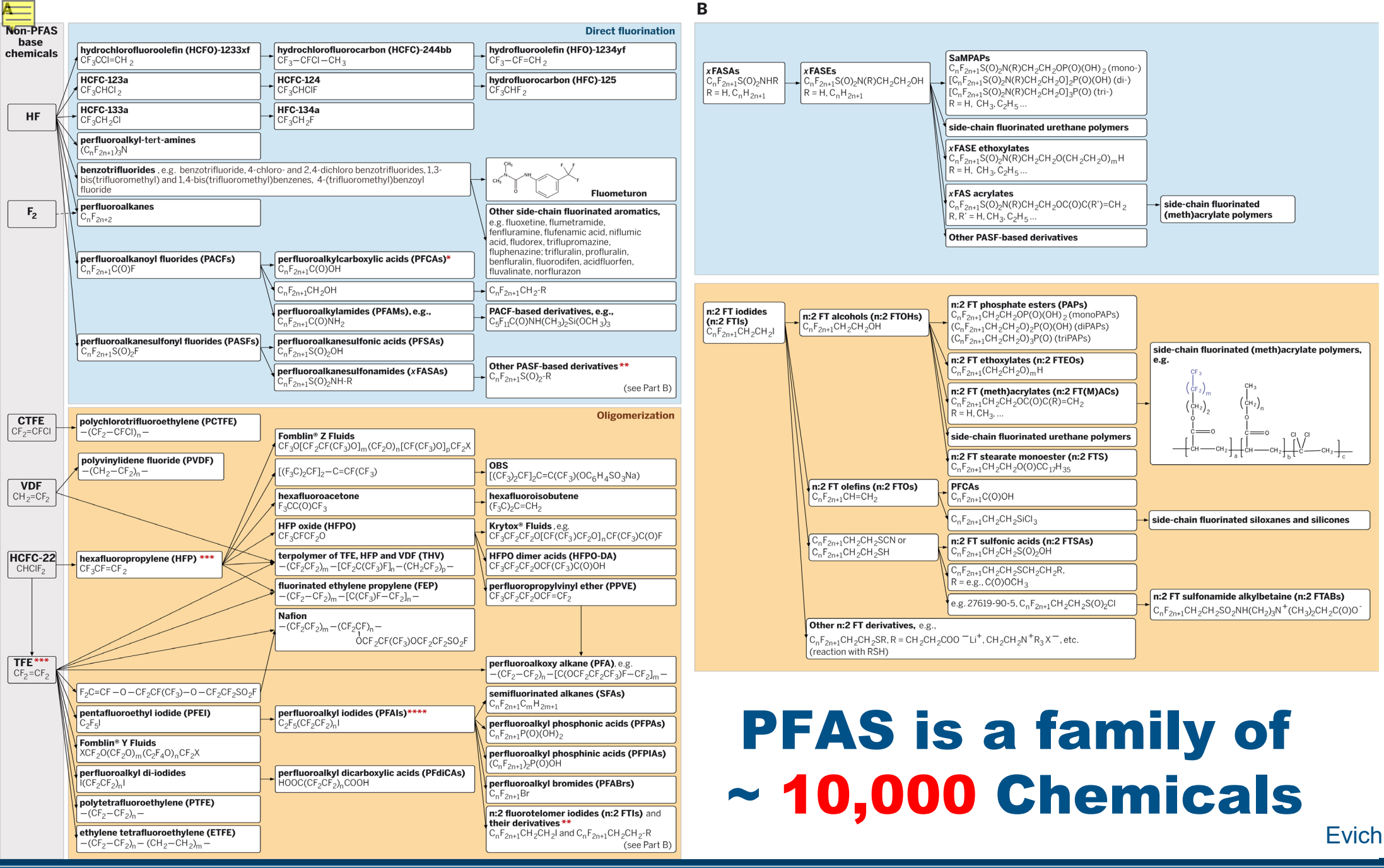
Detect • Adsorb • Destroy





Monday, August 14, 2023 from 9:55 AM - 10:15 AM
Room 3008, West Bldg. - Moscone Center

Monday, August 14, 2023 from 8:40 AM - 9:00 AM
Room 3001, West Bldg. - Moscone Center



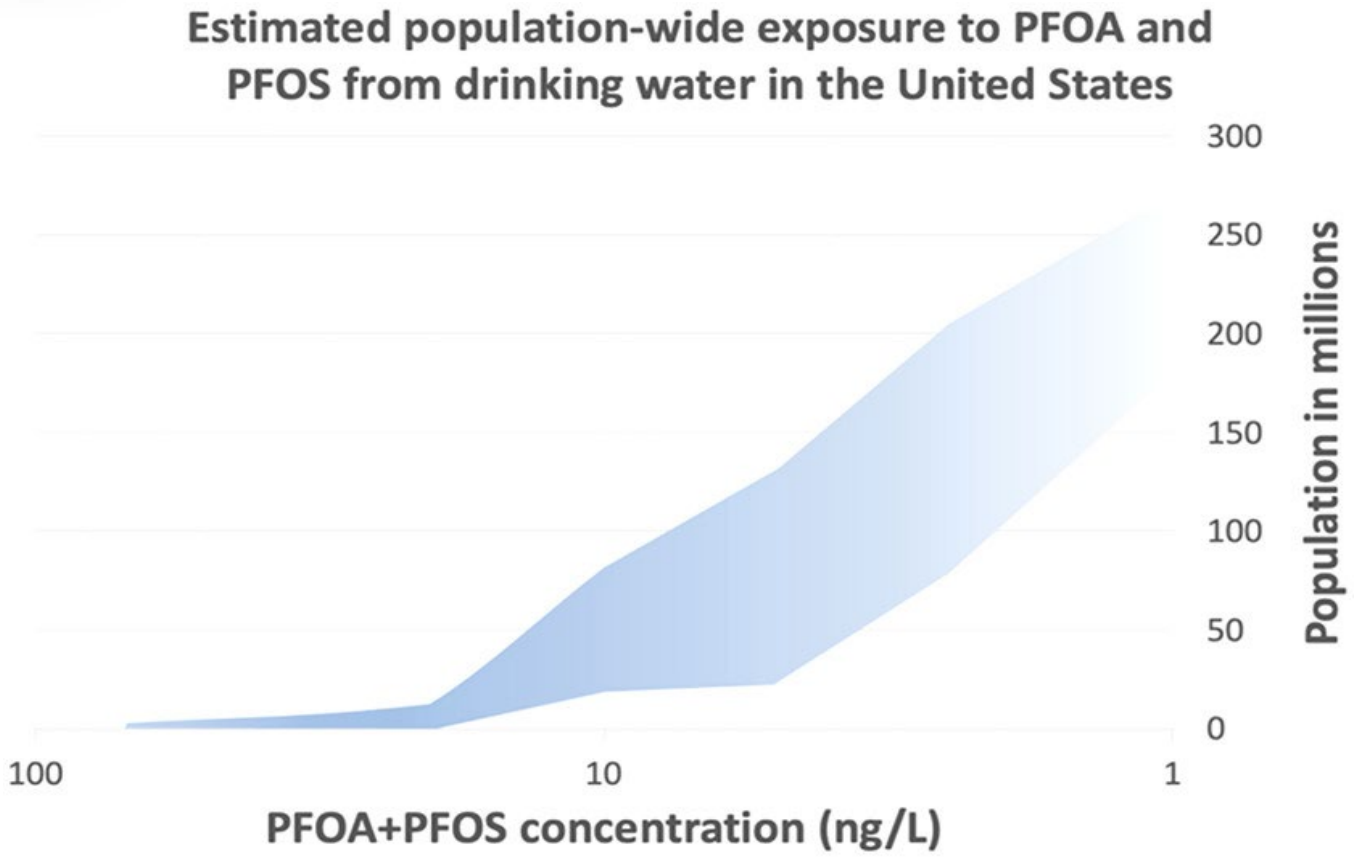
PFAS is a family of ~ 10,000 Chemicals

Evich et al., *Science*, 2022

Environmental Science & Technology Letters
pubs.acs.org/journal/estlcu
Letter

Population-Wide Exposure to Per- and Polyfluoroalkyl Substances from Drinking Water in the United States

David Q. Andrews* and Olga V. Naidenko

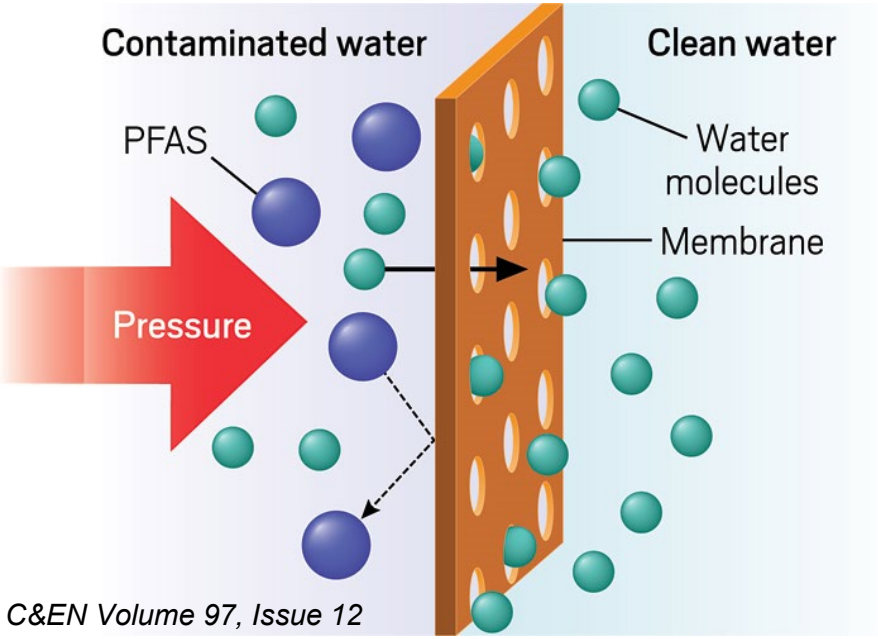


ACS ES&T Water

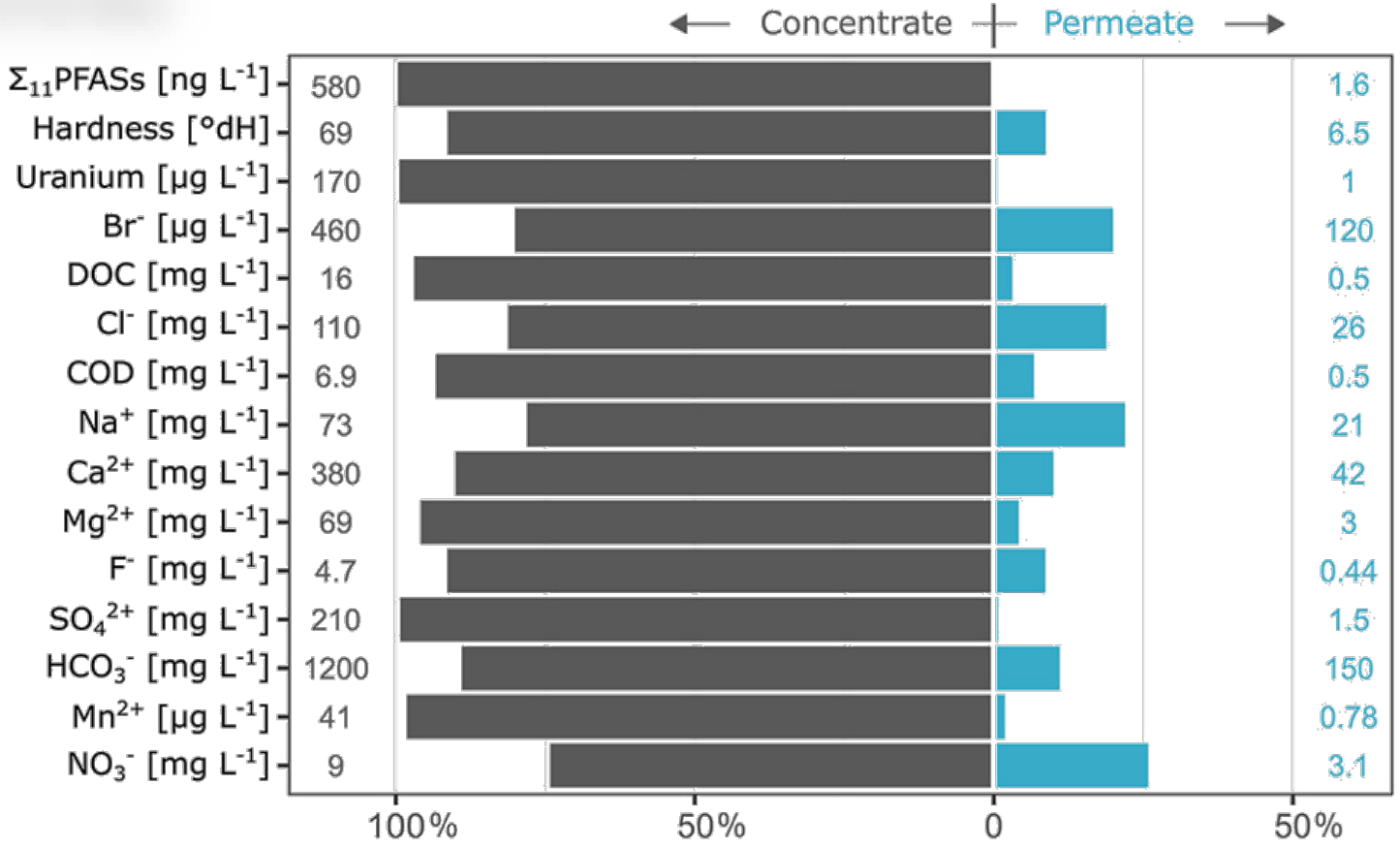
pubs.acs.org/estwater Article

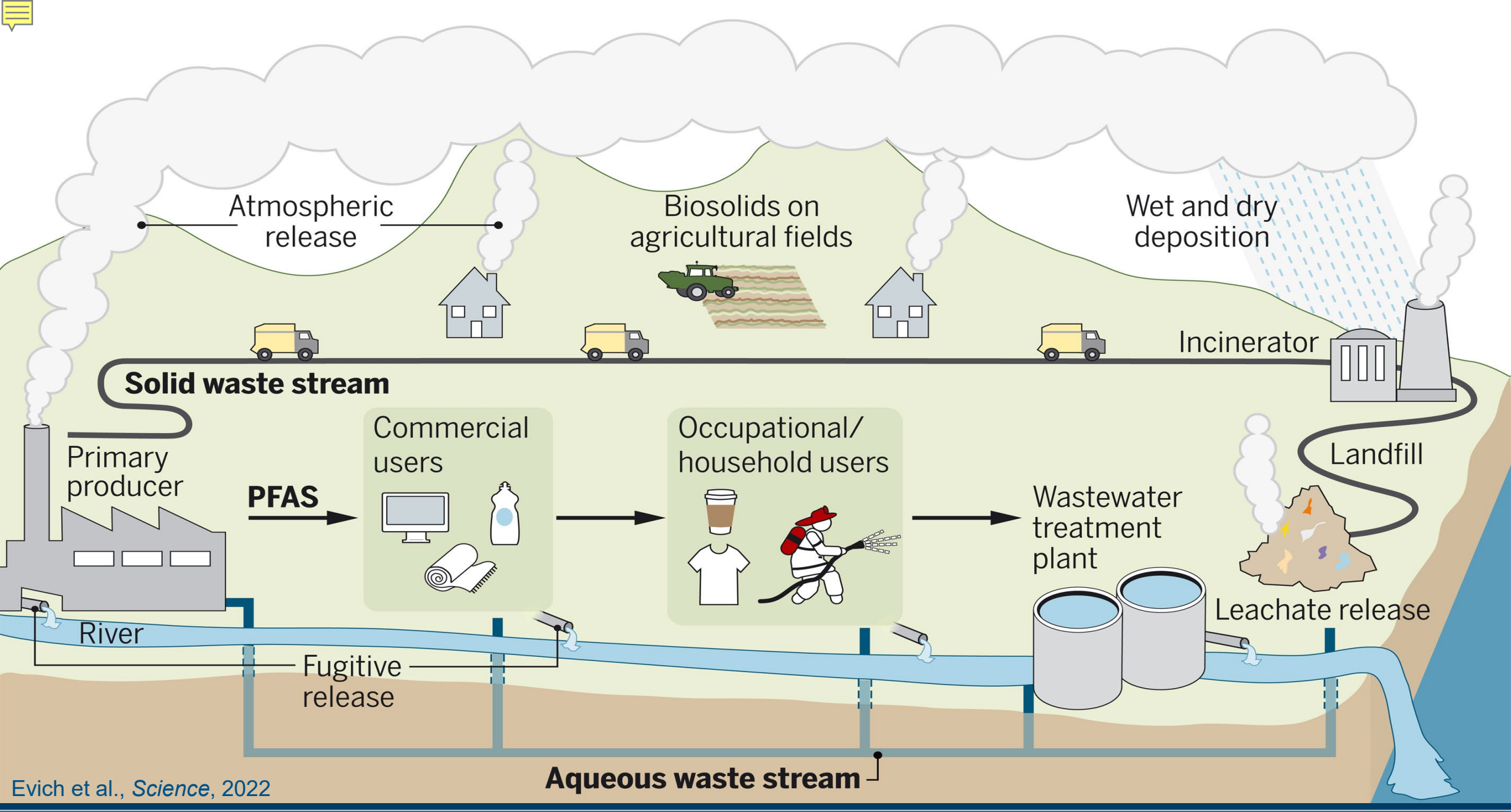
The Price of Really Clean Water: Combining Nanofiltration with Granular Activated Carbon and Anion Exchange Resins for the Removal of Per- And Polyfluoralkyl Substances (PFASs) in Drinking Water Production

Vera Franke,* Malin Ullberg,* Philip McCleaf, Maria Wålinder, Stephan J. Köhler, and Lutz Ahrens

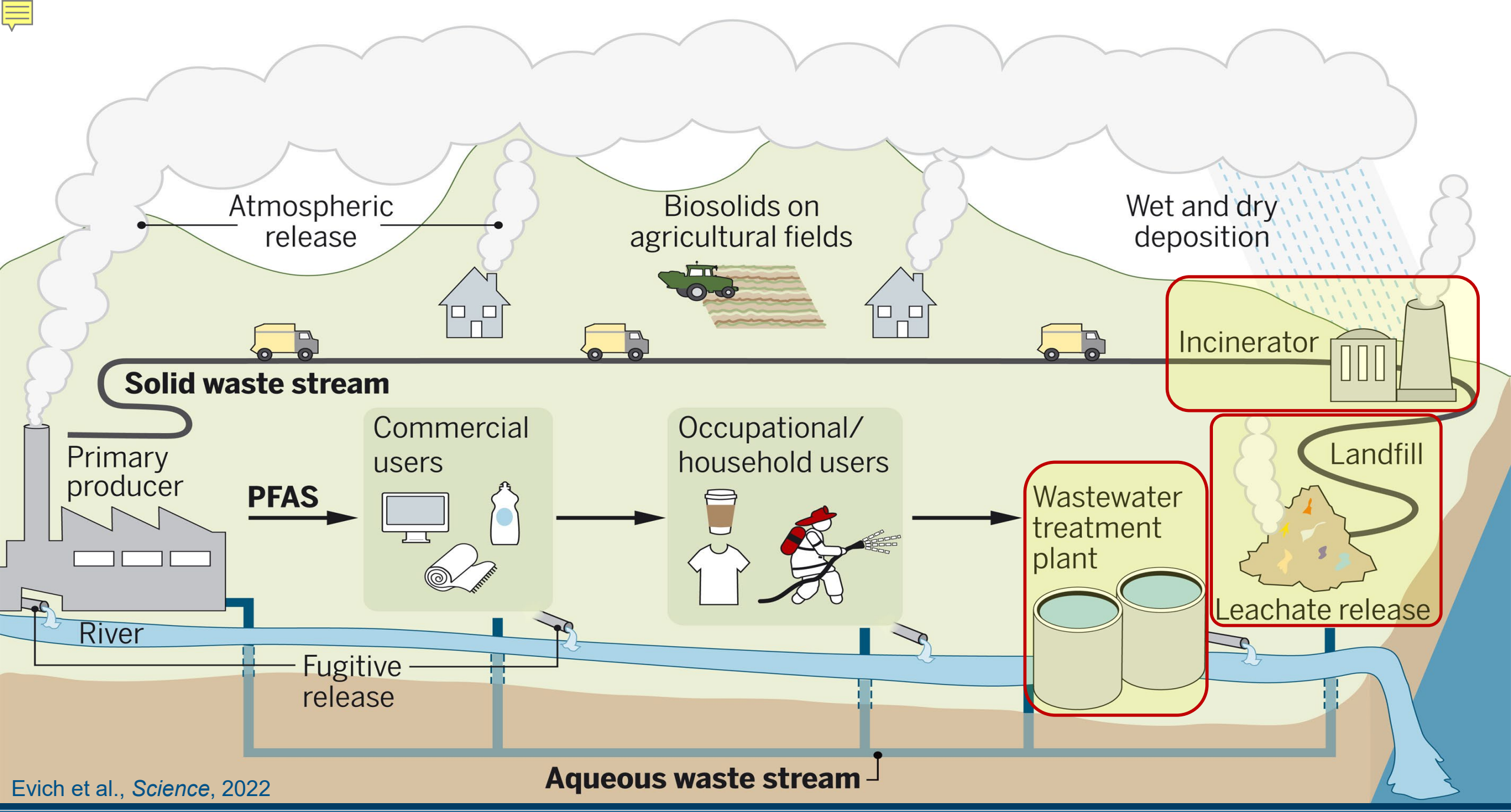


C&EN Volume 97, Issue 12





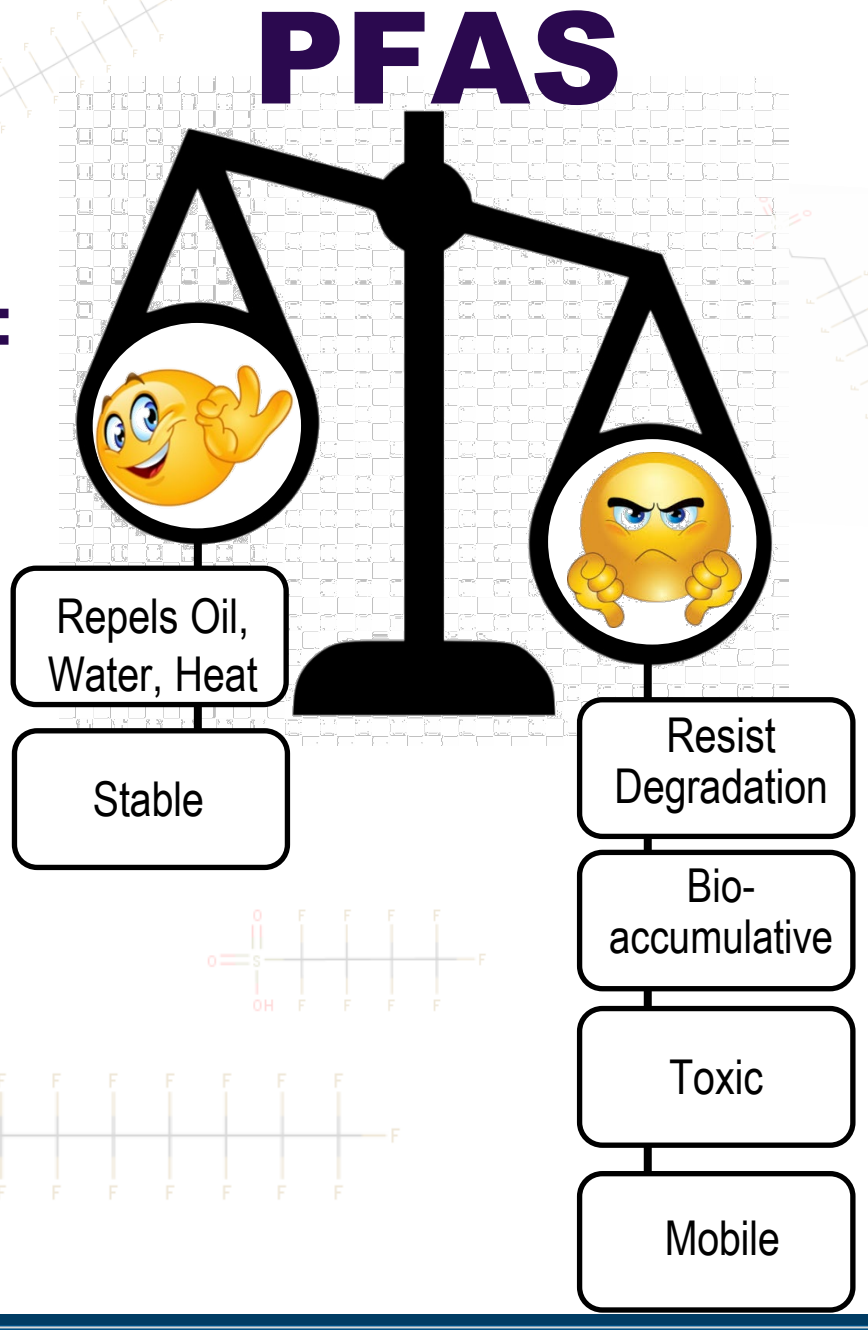
Evich et al., *Science*, 2022



Evich et al., *Science*, 2022

Major Issues with PFAS Removal/Degradation:

- Over 10000 chemicals in the market.
- Highly water soluble
- Low concentration, when compared to other background constituents in water.
- C-F bond is shortest and strongest bond in nature.



- STATE DEPARTMENT OF PUBLIC HEALTH

Degradation

Fungal / Enzymes

Sonolysis

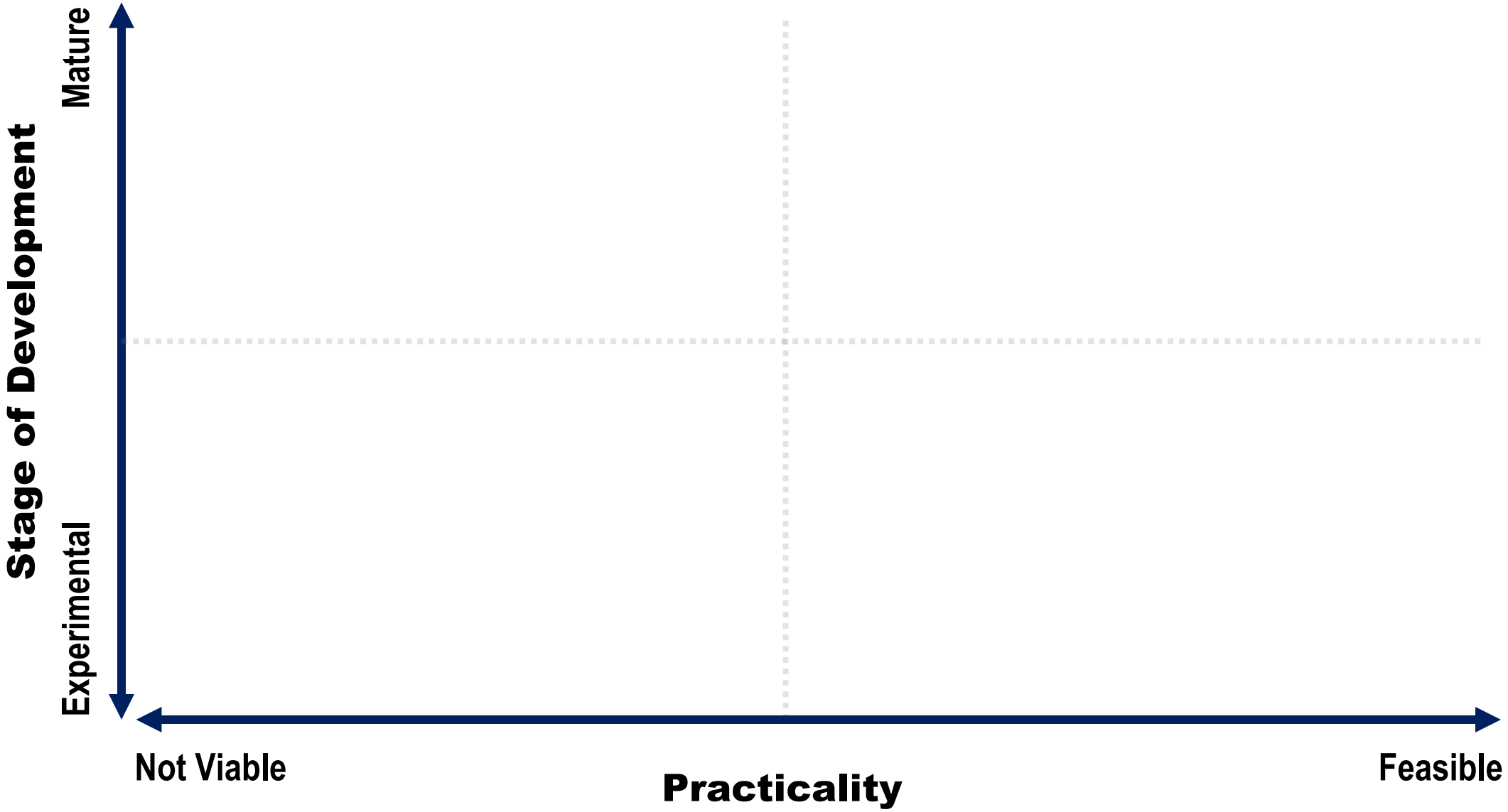
Incineration

Electro-chemical Oxidation

Photocatalysis

Plasma

Activated Persulfate



Separation

RO/NF

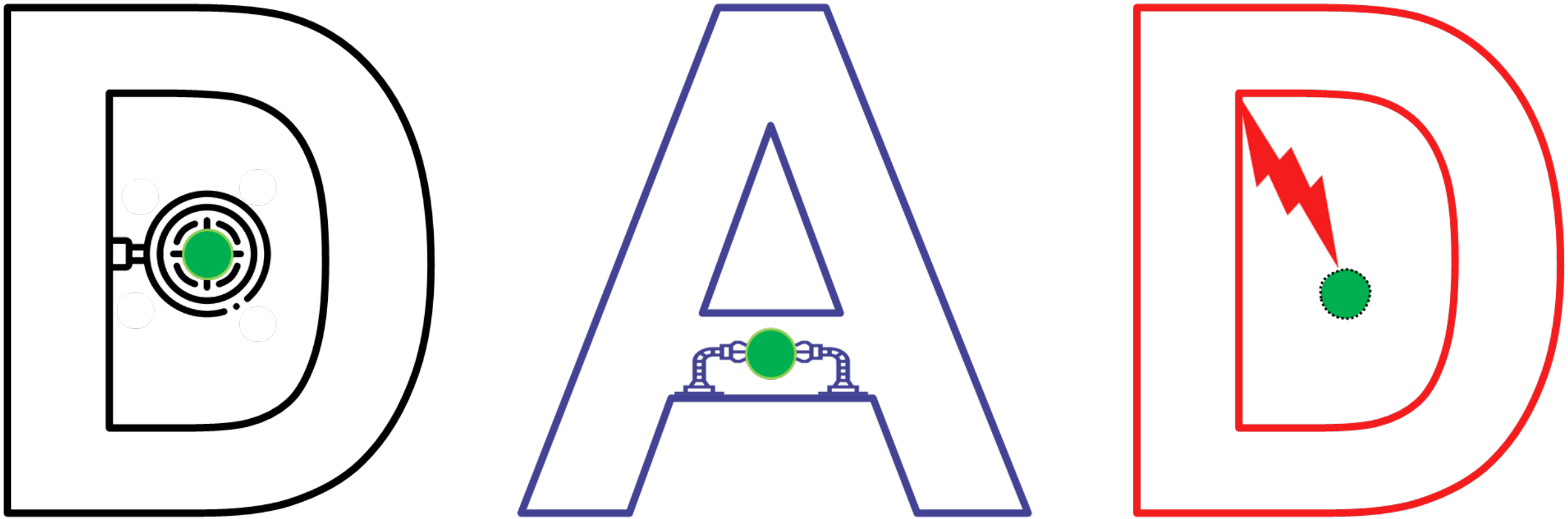
Activated Carbon

Ion Exchange

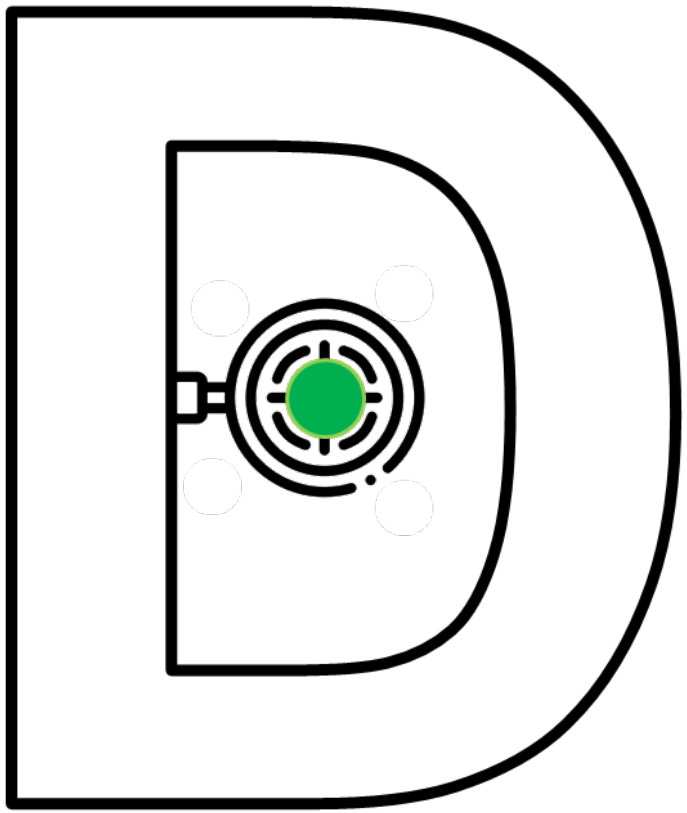
Polymers

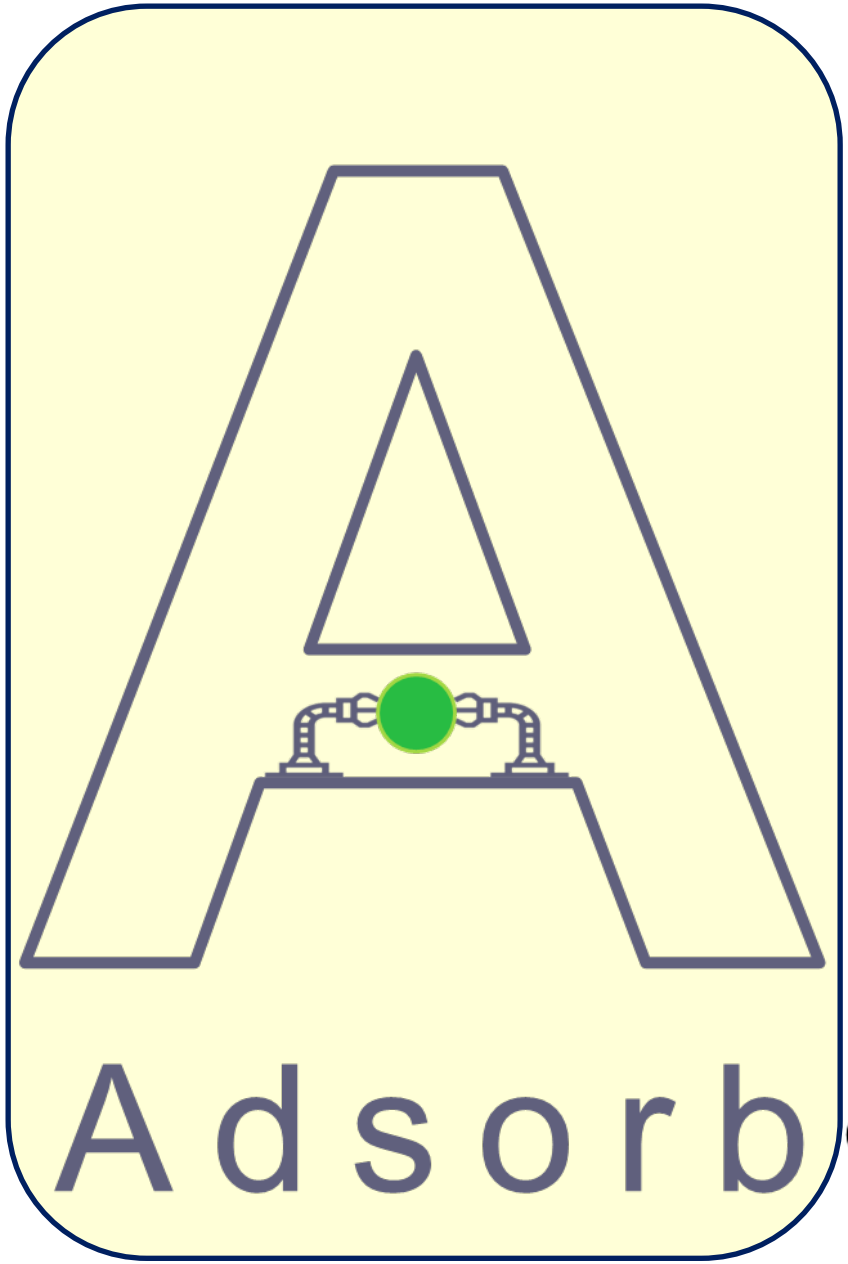
Foam Fractionation

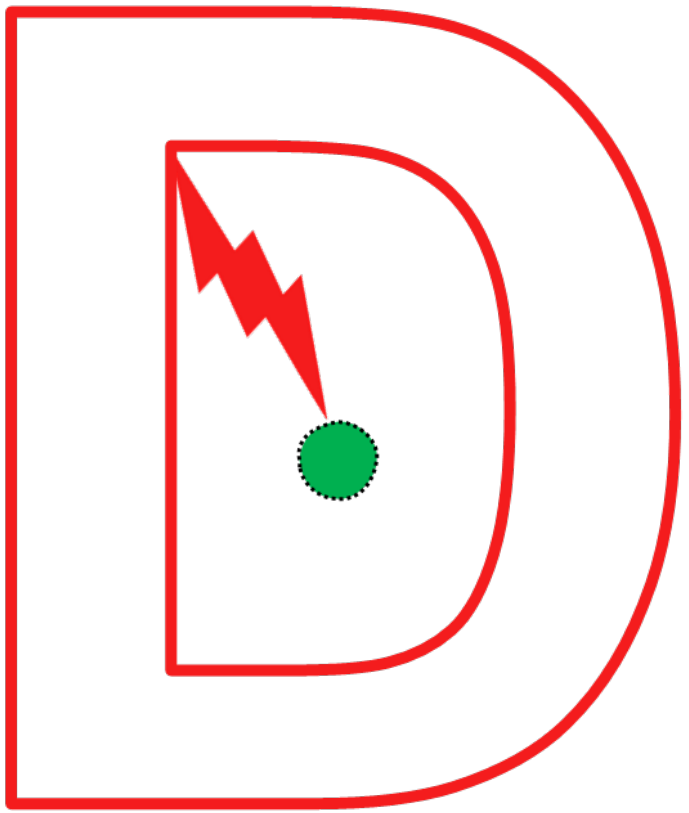
Electro-coagulation



Detect • Adsorb • Destroy







Detect • Adsorb • Destroy

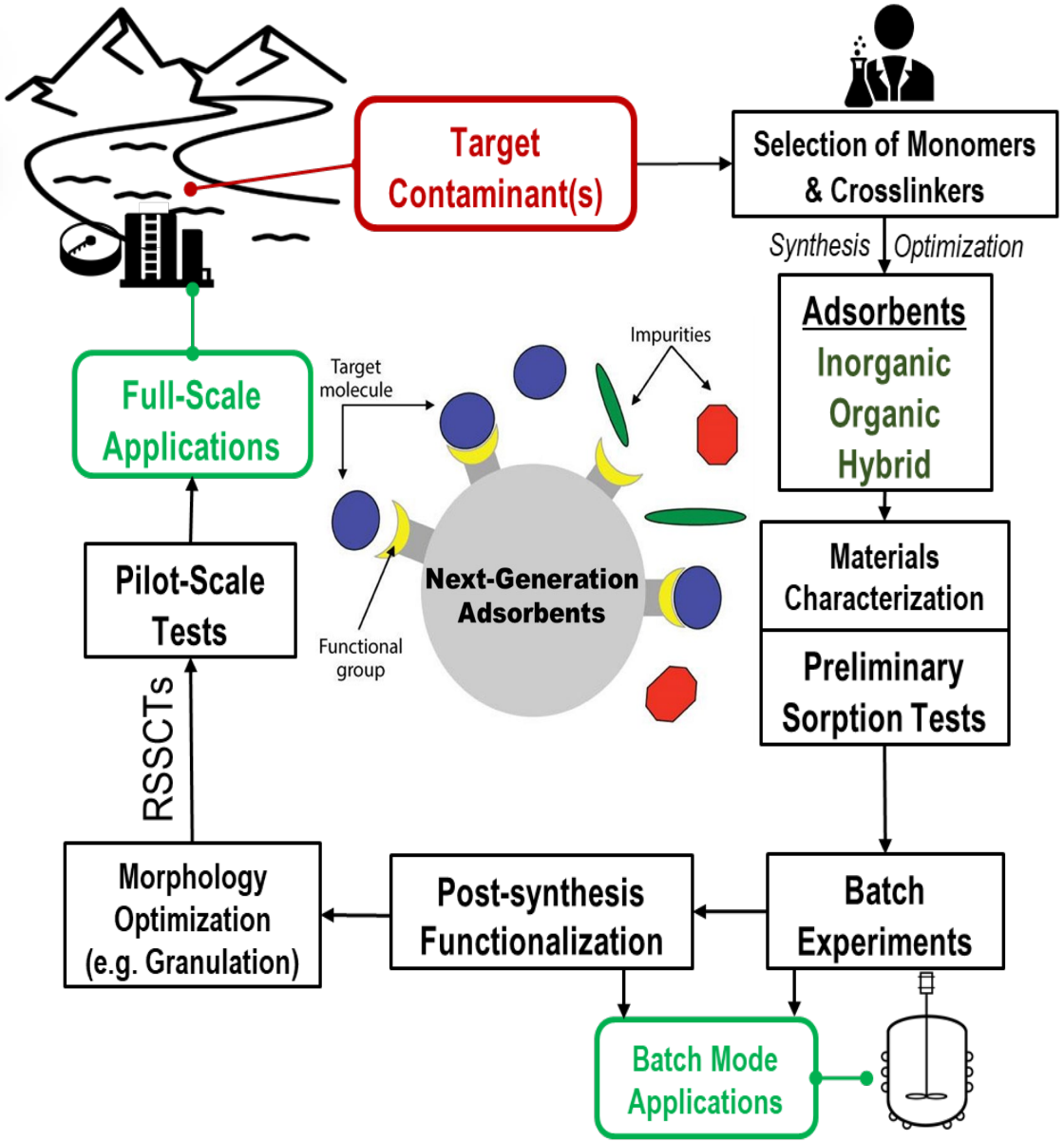
ACS MATERIALS LETTERS

www.acsmaterialsletters.org

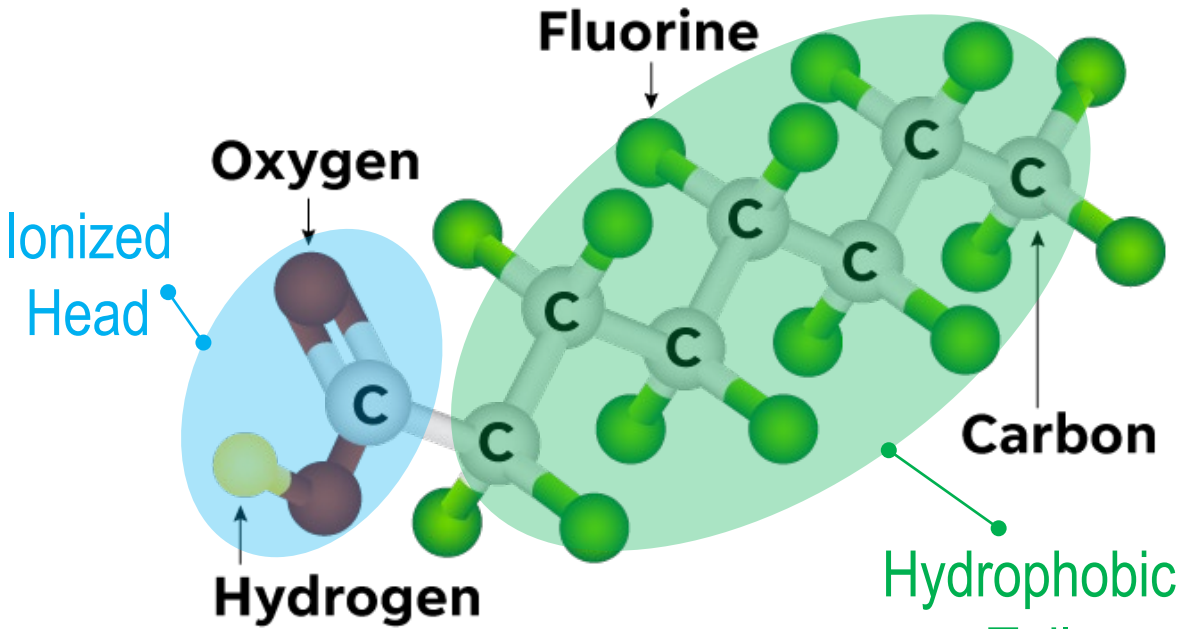
Best Practices for Evaluating New Materials as Adsorbents for Water Treatment

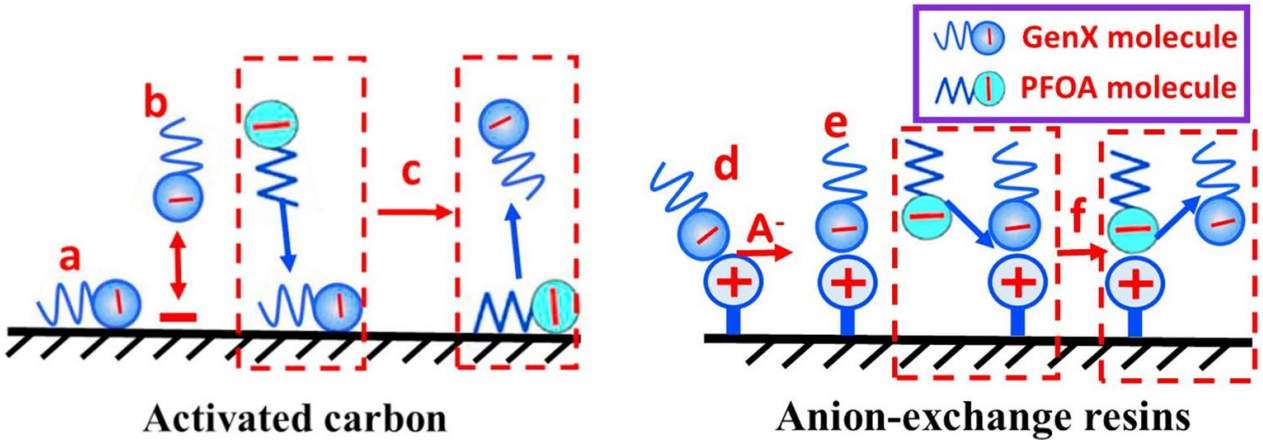
Mohamed Ateia,* Damian E. Helbling, and William R. Dichtel*

Cite This: ACS Materials Lett. 2020, 2, 1532−1544 Read Online



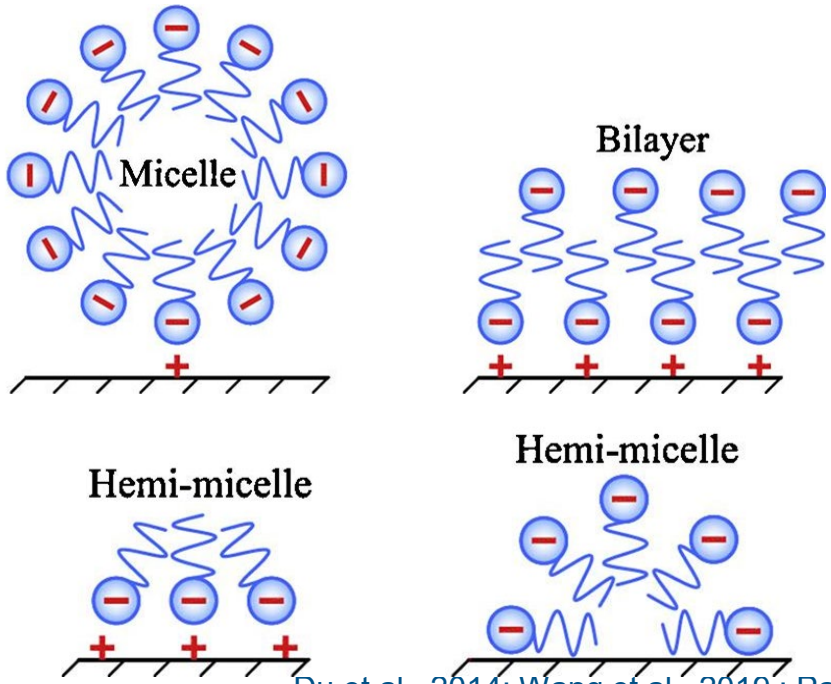
Adsorption mechanisms of PFAS





Factors that affect PFAS removal:

- Hydrophobic interactions.
- Electrostatic interactions.
- Pore size & structure.



Du et al., 2014; Wang et al., 2019 ; Park et al., 2020

Environmental Science & Technology Letters

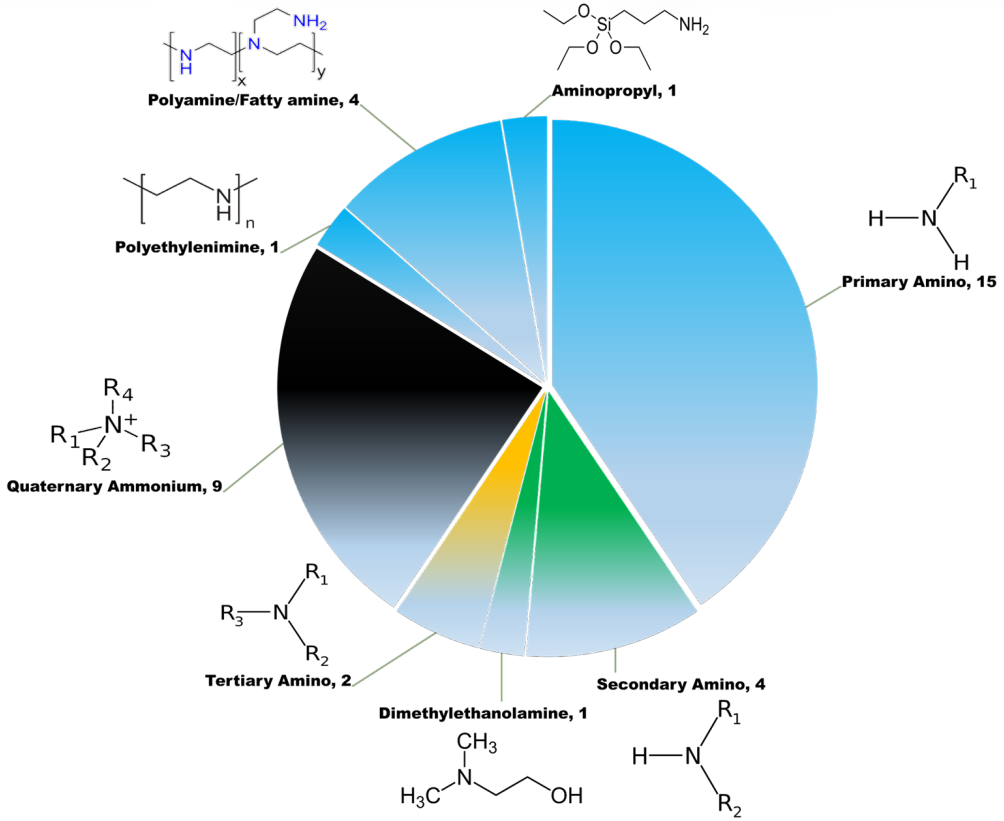
Review

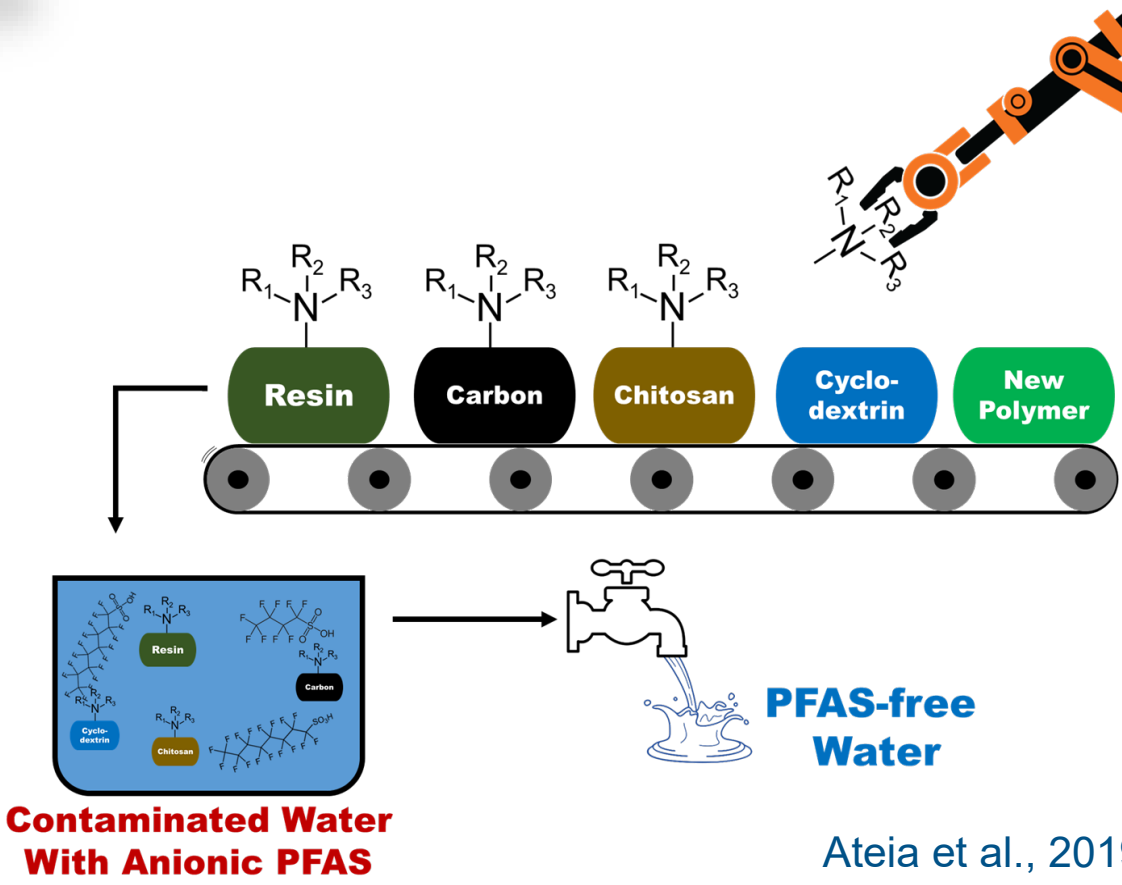
Cite This: Environ. Sci. Technol. Lett. 2019, 6, 688−695

pubs.acs.org/journal/estlcu

Efficient PFAS Removal by Amine-Functionalized Sorbents: Critical Review of the Current Literature

Mohamed Ateia,*[,†,‡,∥] Alaaeddin Alsbaiee,[§,∥] Tanju Karanfil,[†] and William Dichtel[‡]

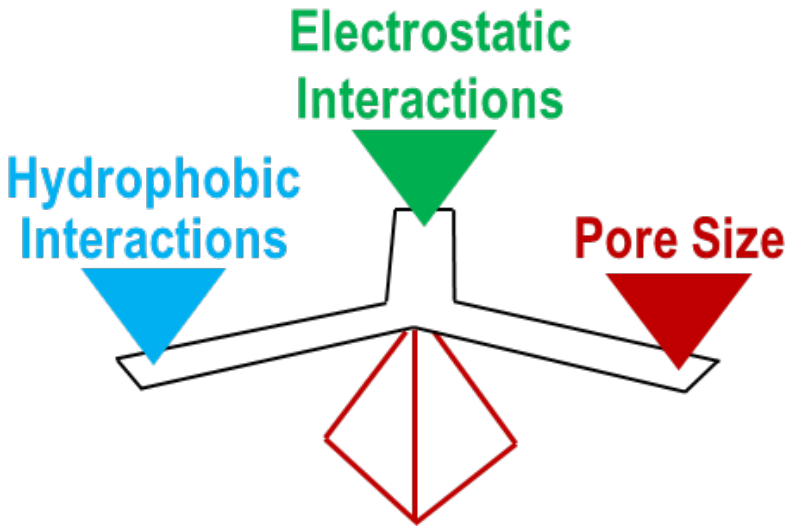




Ateia et al., 2019

Q: Why are amine-containing sorbents efficient for PFAS removal?

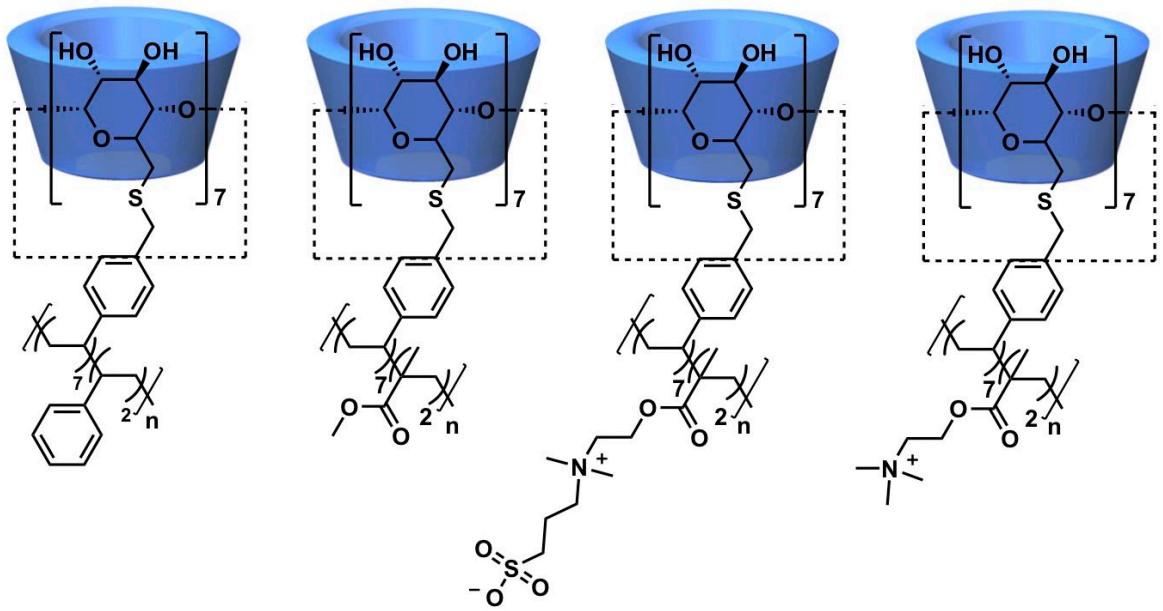
A: The interplay between electrostatic interactions, hydrophobic interactions, and pore size.



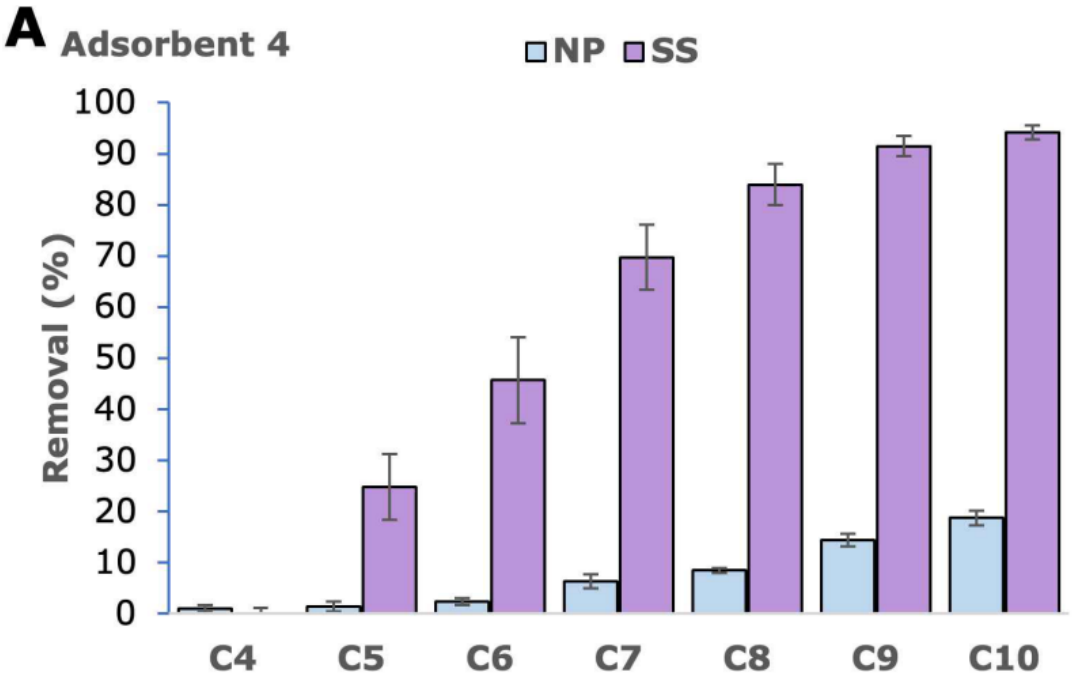
Ateia et al., 2019;
Ateia et al., 2018

New Optimized Cyclodextrin Adsorbents

Stydex/Styrene Stydex/MA Stydex/Z Stydex/+



✓Hydrophobic ✓Hydrophilic ✓Zwitterionic ✓Cationic



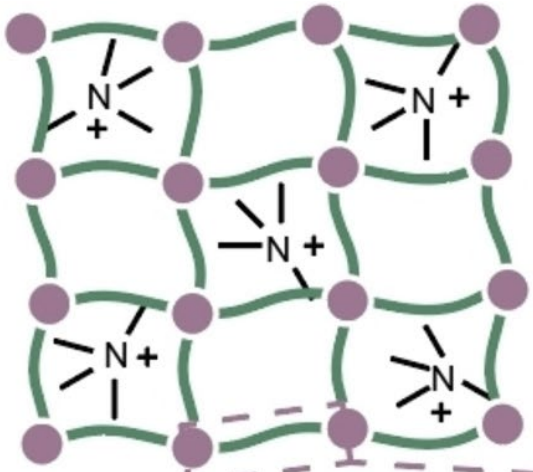
- ✓ **High yield >85%**
- ✓ **High surface area >300 $m^2 g^{-1}$**
- ✓ **Modular Synthesis**

Prof. Will Dichtel

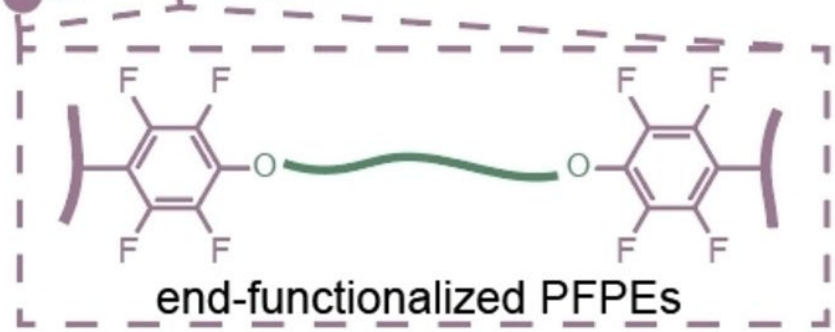
Zhi-Wei Lin

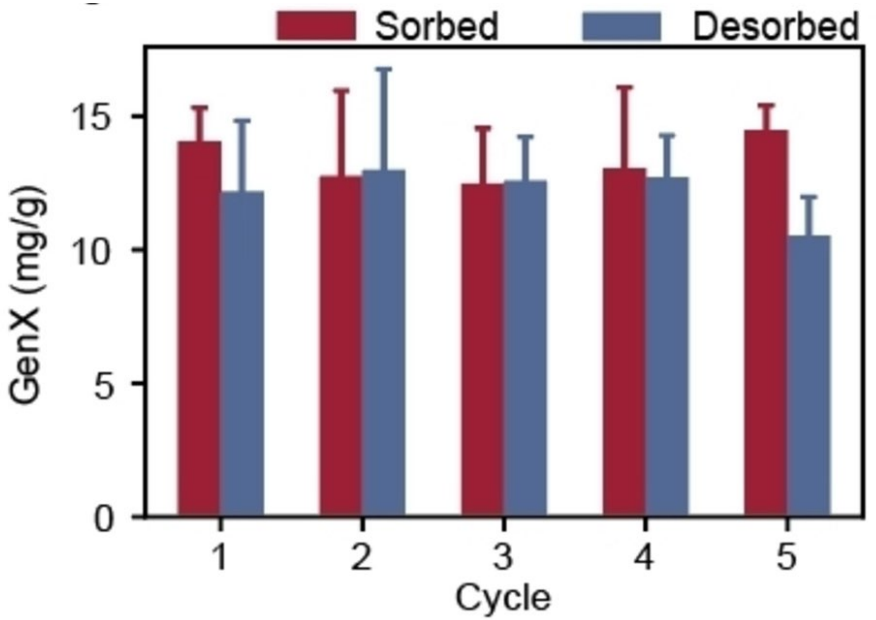
Wang et al., *ACS Central Science*, 2022

New Optimized Ionic Fluorogels



- *One-step monomer synthesis*
- Selective PFAS removal
- Regenerable *in green solvent*
- Efficient in real N.C. water
- *Quantitative PFAS removal in column tests*
- *Hydrolytically stable*



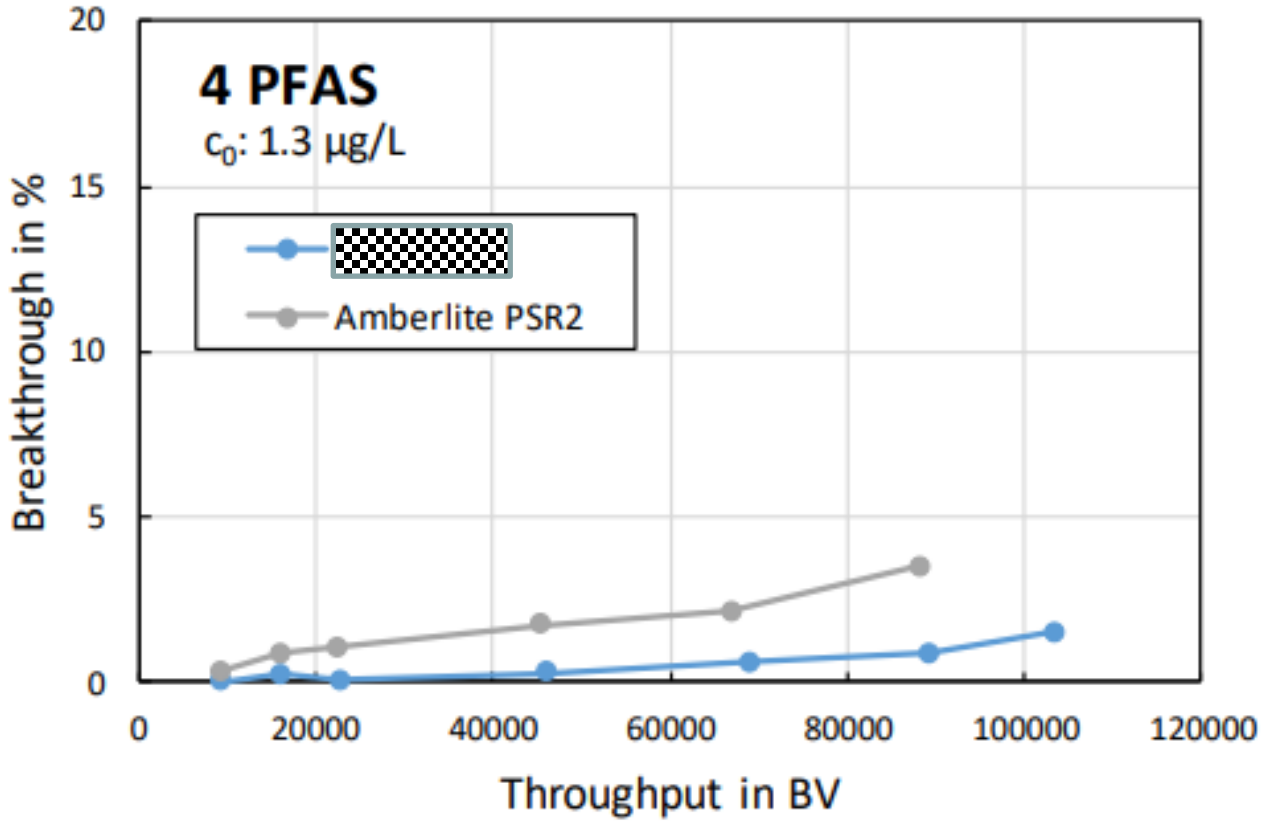


Prof. Frank Leibfarth

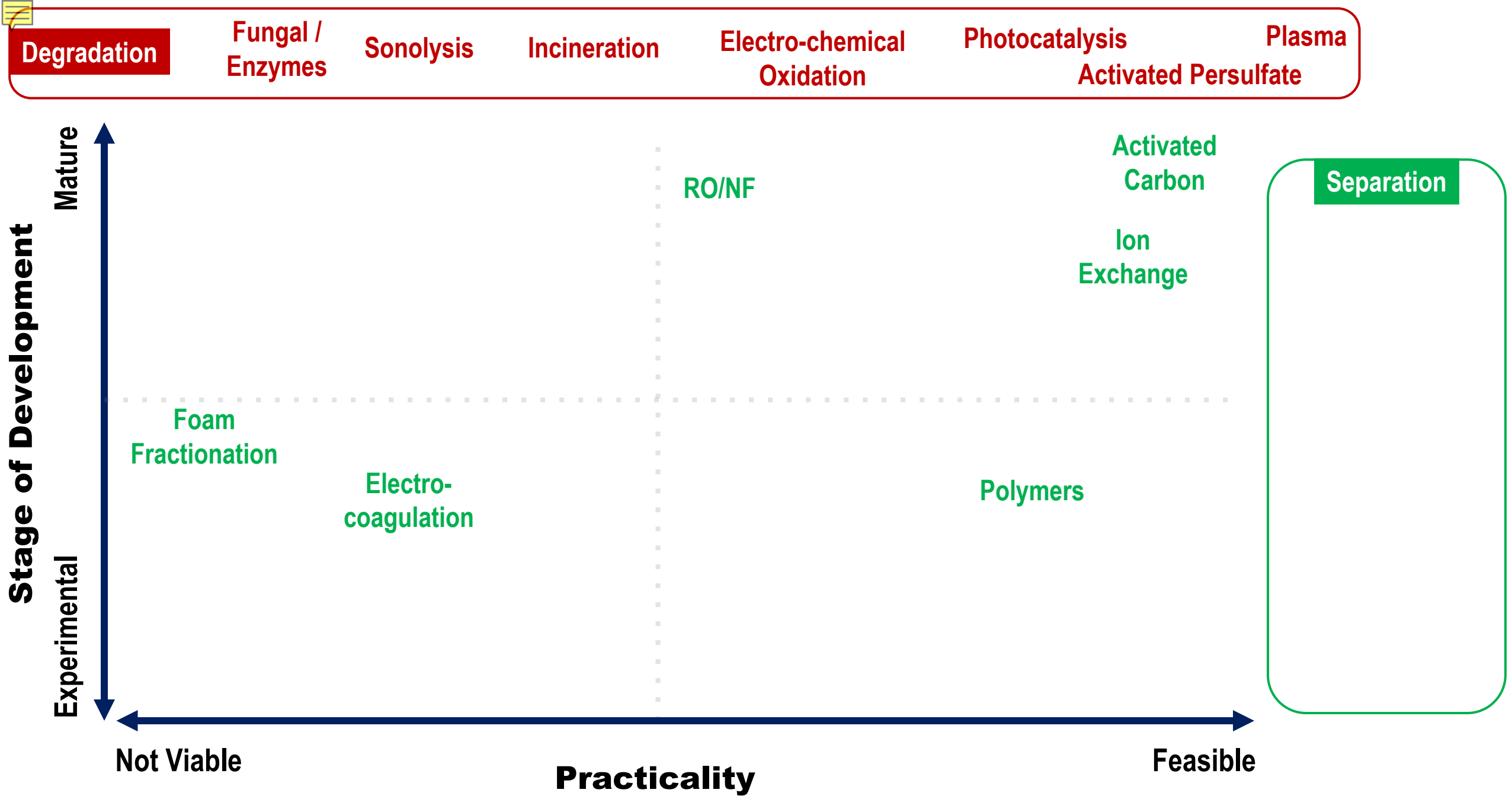
Irene Mulloy Manning

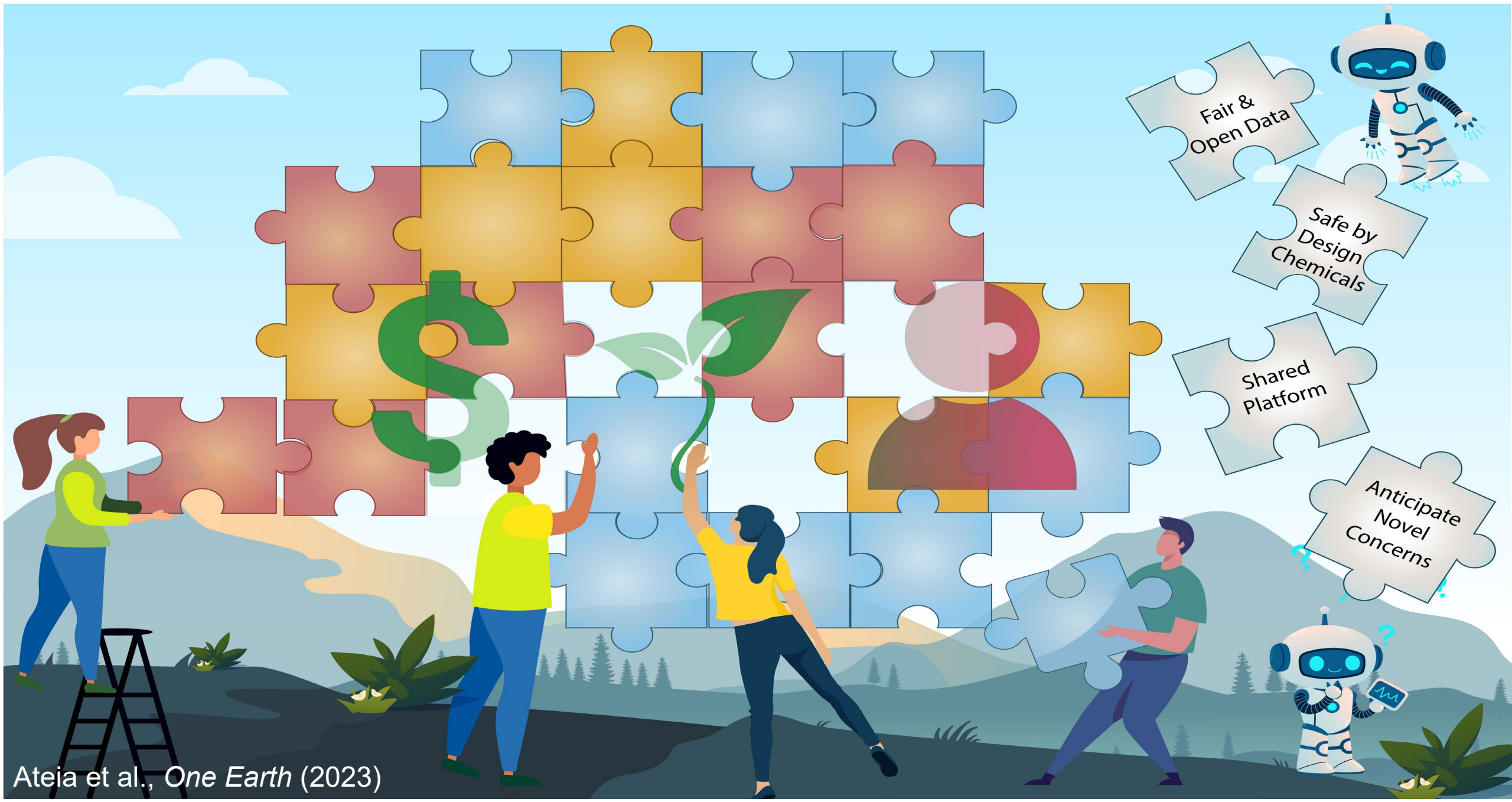
Manning et al., *Angewandte Chemie 134.41 (2022)*

New Optimized granular adsorbent



Not EPA data – Results were provided by the company form a third-party evaluation.


Degradation
Fungal / Enzymes
Sonolysis
Incineration
Electro-chemical Oxidation
Photocatalysis
Plasma
Activated Persulfate
Separation
Activated Carbon
RO/NF
Ion Exchange
Foam Fractionation
Electro-coagulation
Polymers
Stage of Development
Mature
Experimental
Not Viable
Practicality
Feasible



Ateia et al., *One Earth* (2023)

⬅ TWO Postdoc Positions

Thank you!

Contact: ibrahim.mohamed@EPA.GOV