What can we do to remove PFAS from our drinking water sources?

TEAM 3: PFAS REMOVAL PERFORMANCE TESTING

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NORTH CAROLINA PFAS Testing Network

NC PFAS Testing (PFAST) Network, a research program funded by the NC Policy Collaboratory

Team 3 Investigators

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UNC, Chapel Hill

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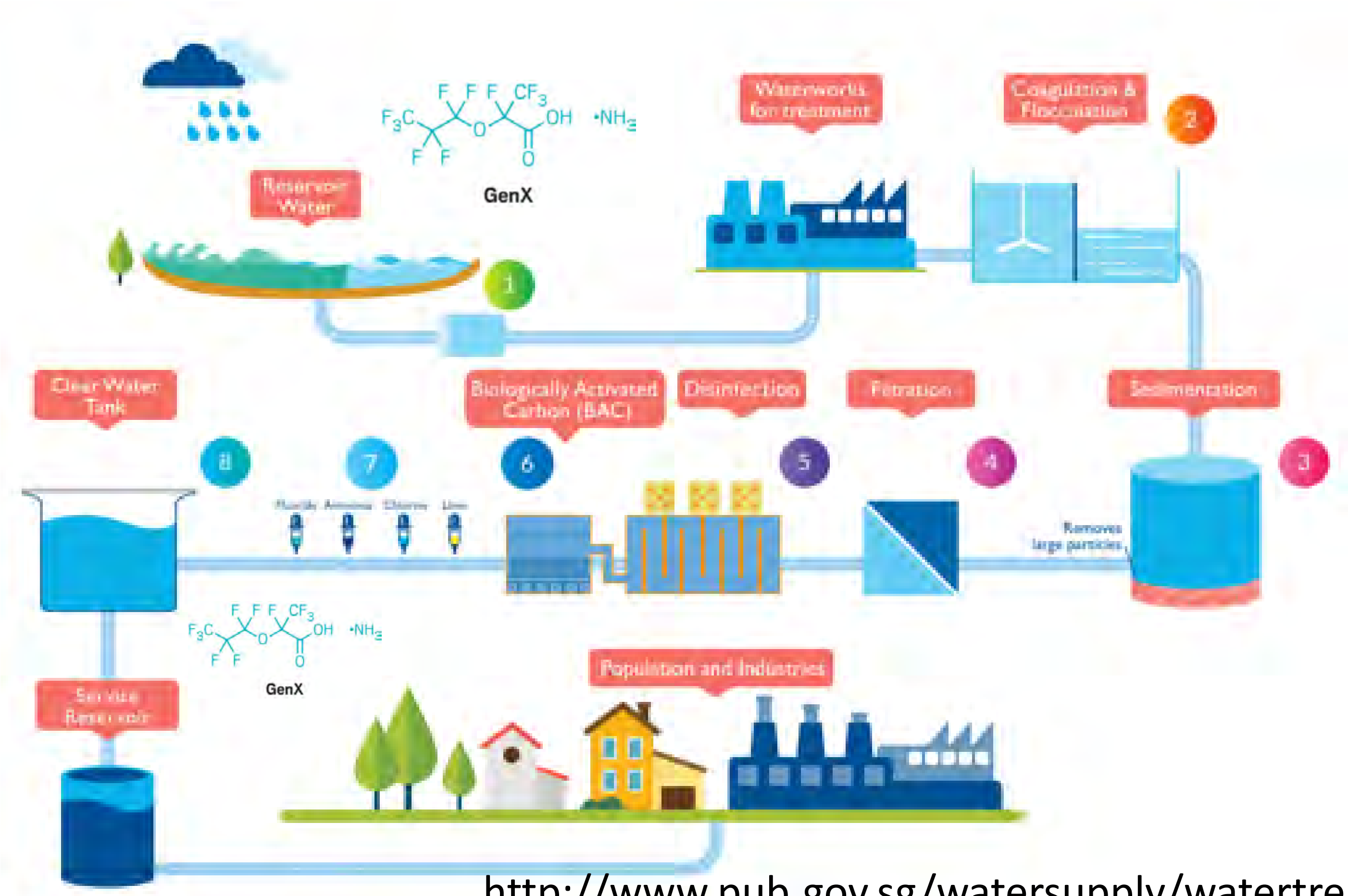
Assistant Professor
UNC, Charlotte

Detlef Knappe, PhD
Professor
North Carolina State University

Frank Leibarth, PhD
Assistant Professor
UNC, Chapel Hill

Heather Stapleton, PhD
Associate Professor
Duke University

The Problem: How do we remove PFAS from drinking water sources?



http://www.pub.gov.sg/watersupply/watertreatment

Can we remove PFAS with water filters in our home?

Research Questions Addressed by Team 3

- What is the best option to remove PFAS from drinking water among commercially available materials, such as activated carbons (AC), ion exchange (IX) resins, and membrane filters?
- What do we do with the waste streams containing PFAS?
- Are there promising novel PFAS removal methods we can develop?
- How successful are the household filters in removing PFAS from tap water?




Preliminary Results

PFAS Removal by High-Pressure Membranes

The quantity and scope of studies evaluating PFAS rejection by high-pressure membranes is limited.

Motivation

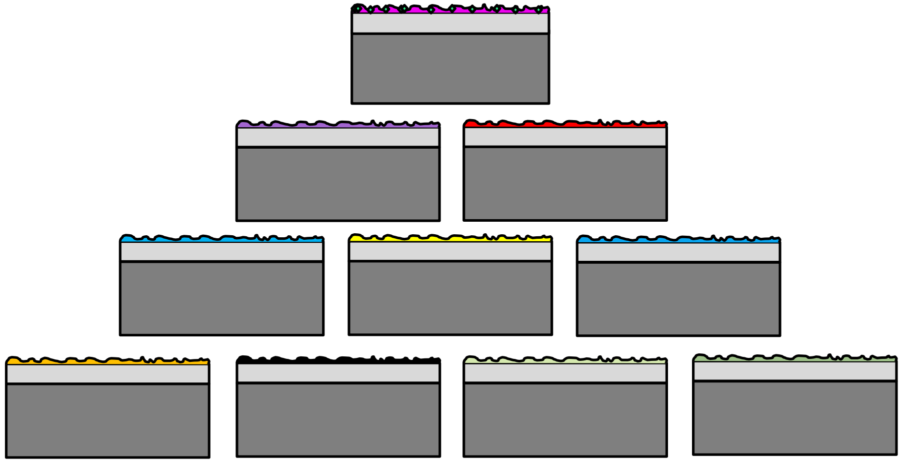
Objective

Evaluate the impacts of membrane type, PFAS physico-chemical characteristics, and membrane fabrication modifications on PFAS removal by high-pressure membranes

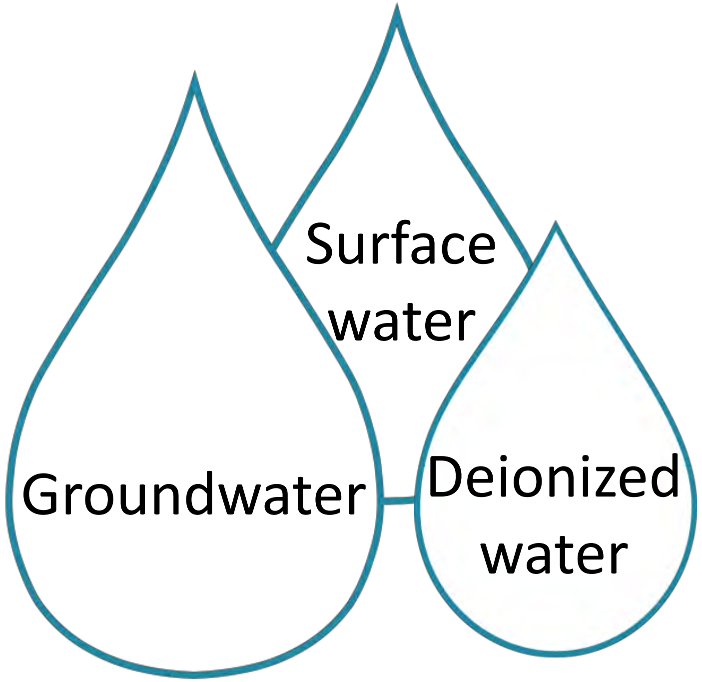
Experimental Design

29 types of PFASs

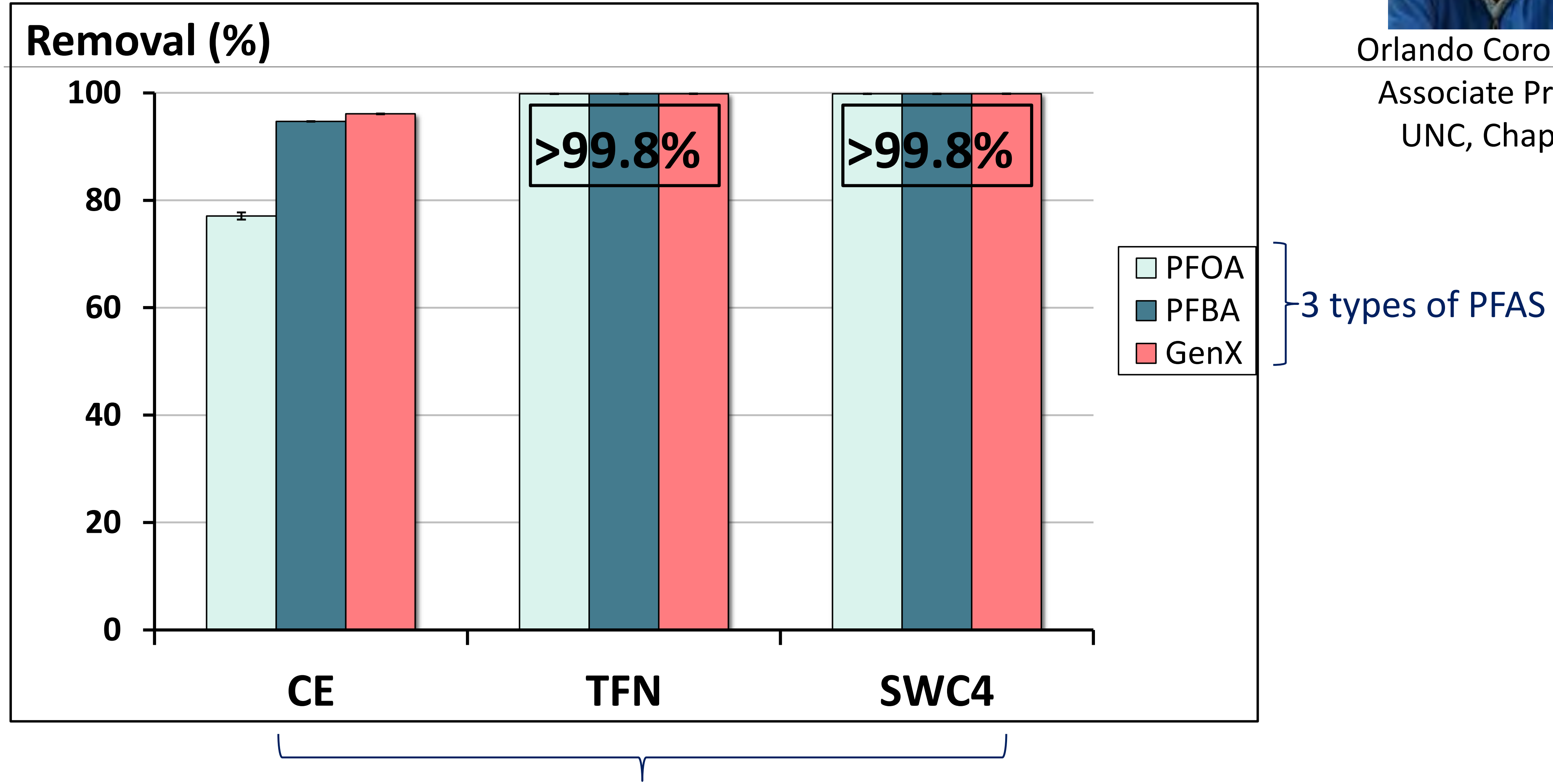
10 types of high-pressure membranes



3 types of water



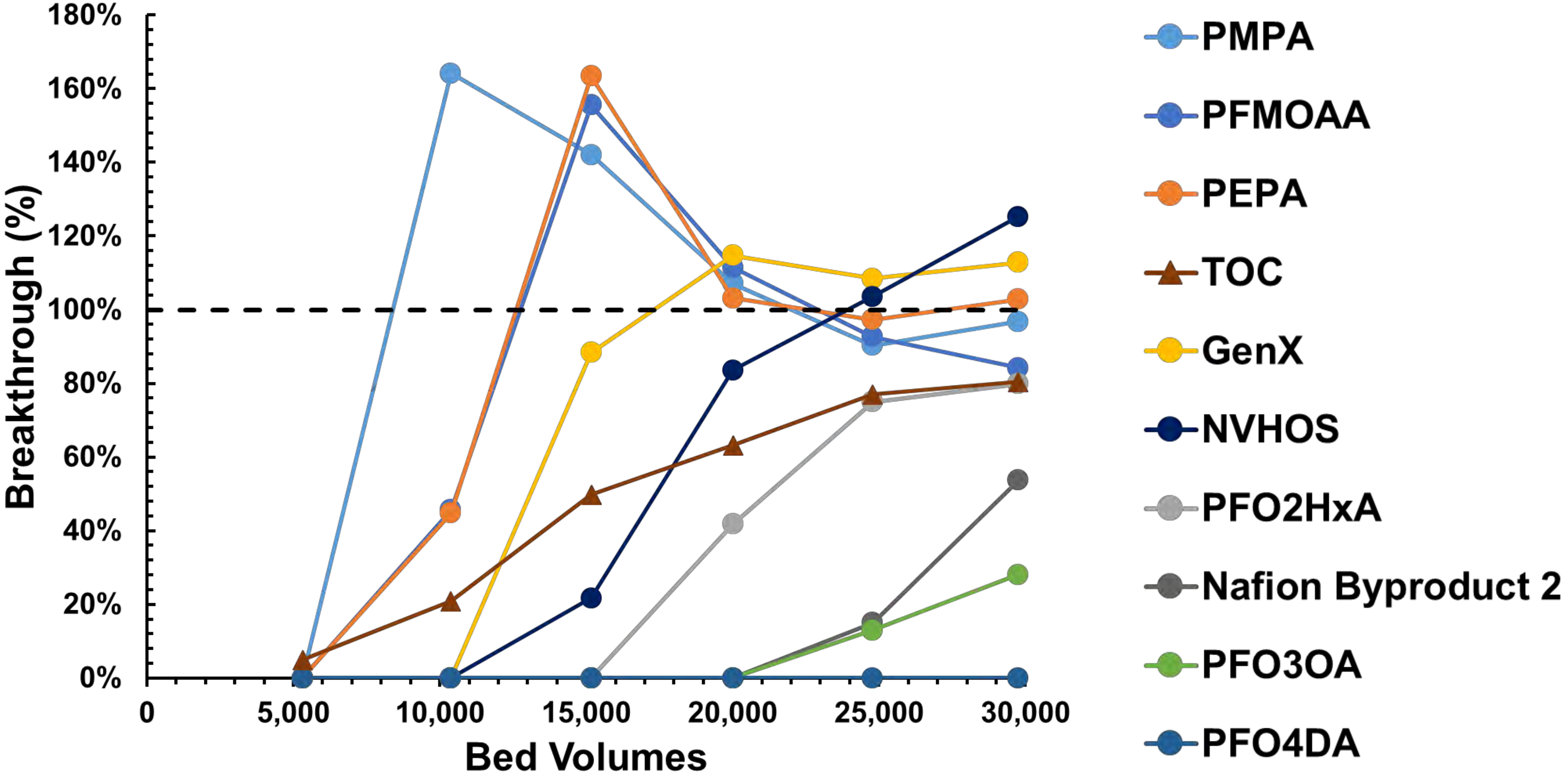
Preliminary Results



Orlando Coronell, PhD
Associate Professor
UNC, Chapel Hill

Effectiveness of granular activated carbon for PFAS removal increases with increasing PFAS chain length

Rapid small-scale column test:

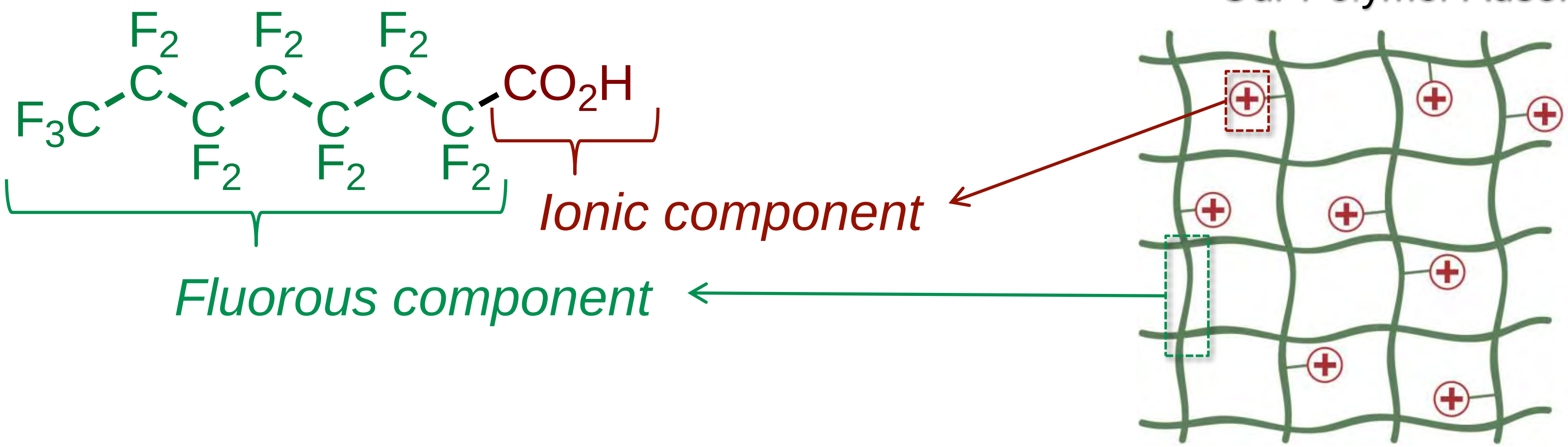


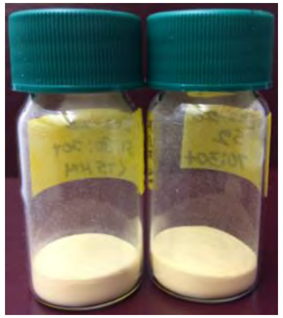
Zack Hopkins, PhD student
CCEE, NCSU

Ionic Fluorogels for PFAS Adsorption

Ionic Fluorogels combine both adsorption ion exchange capabilities to create a sorbent that is selective for PFAS over other organic contaminants.

Our Polymer Adsorbent Design:

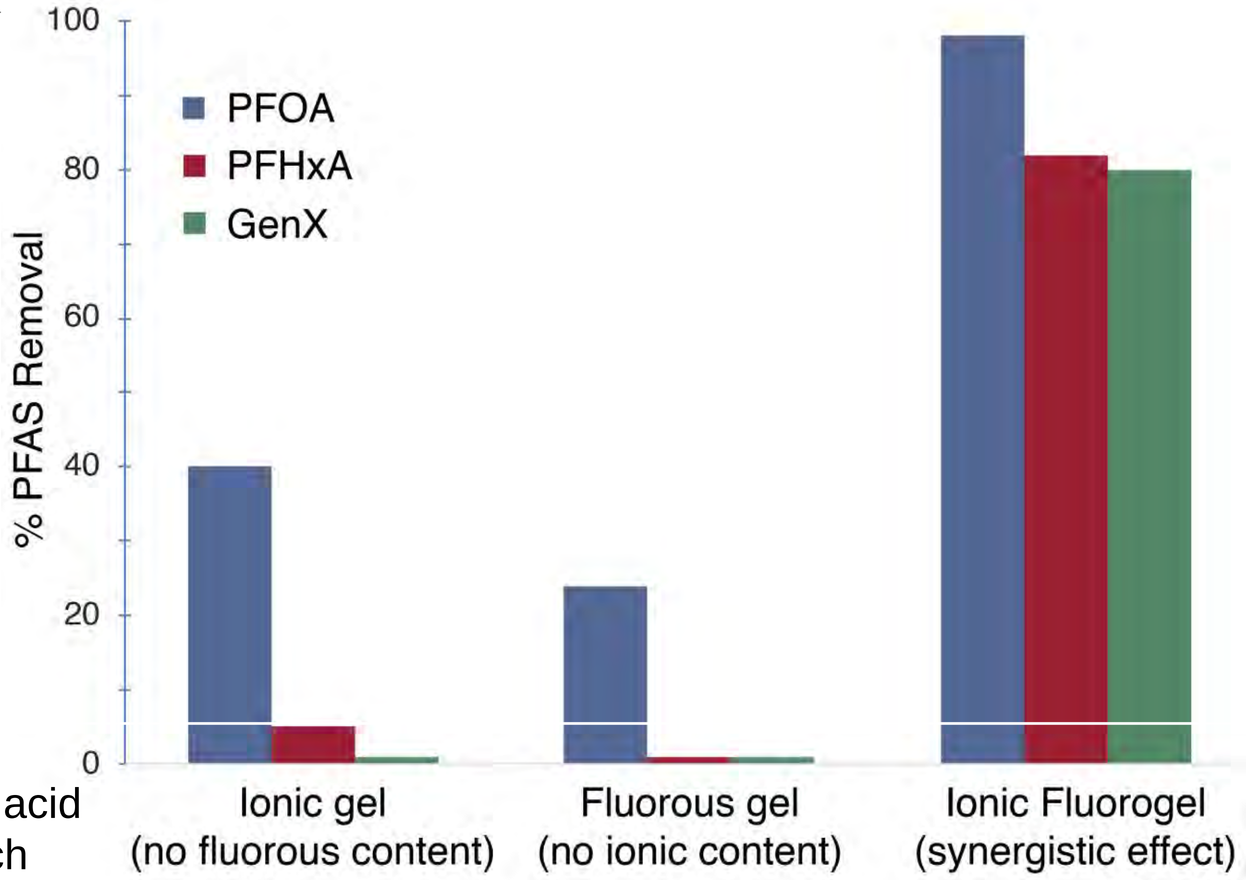




The **Synergistic Combination** of ionic and fluorous components within the granular Ionic Fluorogel resin result in a high capacity and selective PFAS absorbent

GenX Adsorption at Environmentally Relevant Concentrations

Frank Leibfarth, PhD
Assistant Professor
UNC, Chapel Hill

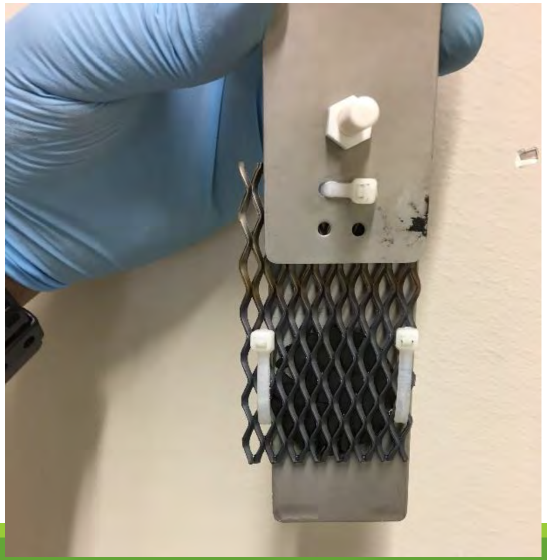


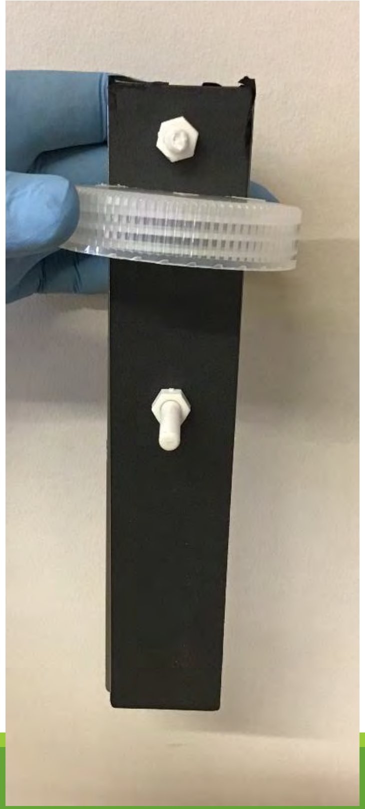
Conditions:
Challenge: 200 ppm NaCl + 20 mg/L Humic acid
Ionic Fluorogel: 10 mg/L ; PFAS : 1 μg/L each
Equilibrium adsorption after 21 h
Average of 3 trials

Electrochemical Mineralization of PFAS

Electrode materials tested

- Ruthenium oxide coated Titanium (Ti/RuO_2)
- Ebonex Plus (a commercial monolithic Ti_4O_7 ceramic material)
- Graphene membrane





Electrochemical Mineralization of PFAS

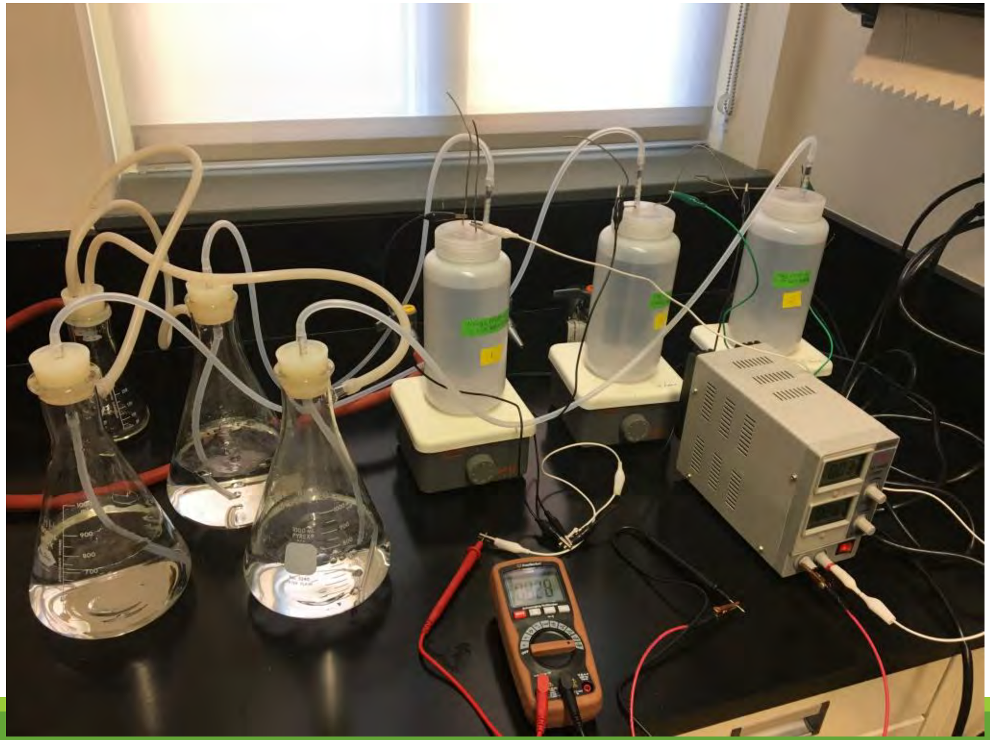
Mei Sun, PhD
Assistant Professor
UNC, Charlotte

Preliminary results:

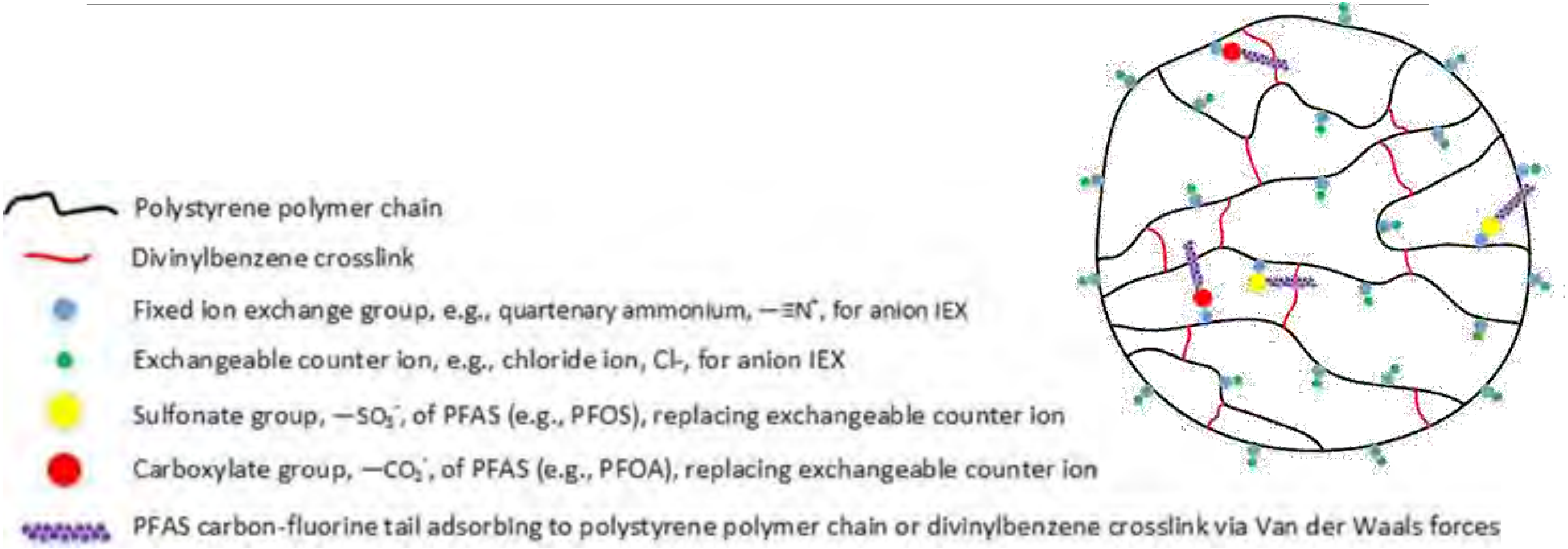
- 93% PFOA removal achieved using the Ti/RuO_2 electrode at 30 mA/cm^2

Ongoing work

- Identify degradation products
- Test degradation at lower current densities
- Test degradation of other PFAS

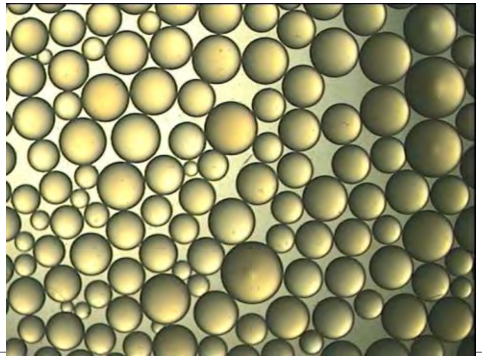
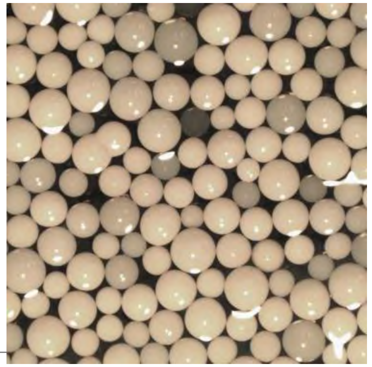


PFAS Removal by Ion Exchange (IX)



Remediation Journal, Volume: 27, Issue: 3, Pages: 19-27, First published: 07 June 2017, DOI: (10.1002/rem.21515)

Research Plan

Screening tests for the most effective resins

- 5 DOW resins, 3 Purolite resins and 2 IXOM resins based on literature review

Water matrices

- groundwater from Fayetteville
- Surface water from Wilmington

Ongoing and future studies

- PFAS removal efficiency
- PFAS removal kinetics
- PFAS sorption isotherms
- Effects of other constituents in water on PFAS removal
- Breakthrough curves
- Resin regeneration

Preliminary Results: PFAS removal by In-Home Water Filters

Nicholas Herkert, PhD
Post-doc; Duke University

Refrigerator Filter

Pitcher Filter

Reverse osmosis

Analyte	Refrigerator Filter	Pitcher Filter	Reverse Osmosis Filter
GenX	56%	46%	100%
PFBA (4 carbon)	47%	36%	100%
PFHxA (6 carbon)	60%	43%	100%
PFOA (8 carbon)	73%	69%	100%

Expected Timeline and Products

- Targeted date to complete research: January 2020
- Expect to produce several research reports with information on:
  - Recommendations on the types of materials to use in large scale water treatment plants to optimize the removal of PFASs in NC waters
  - Information on approaches for degrading PFASs from waste streams
  - Recommendations for home water filtration systems to remove legacy and emerging PFASs in NC drinking water
- Communicate and discuss findings with relevant stakeholders in 2020
  - NC Legislature
  - NC DEQ
  - Water utilities

Thank you for your attention!

Questions?

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NORTH CAROLINA
PFAS
Testing Network