2024 ND PFAS CONFERENCE

Characterization and Electronically Mineralization of Per- and Polyfluorinated Substances (PFAS) in Wastewater

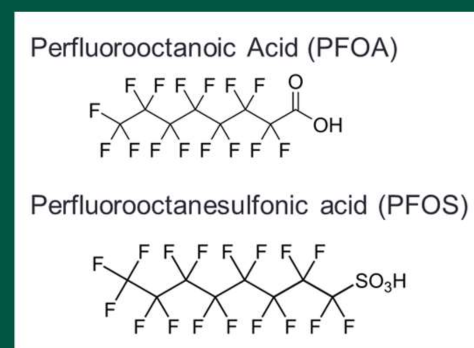
Jiale Xu, Ph.D.
Assistant Professor in Environmental Engineering
North Dakota State University

Perfluorinated Contaminants Source and Regulation

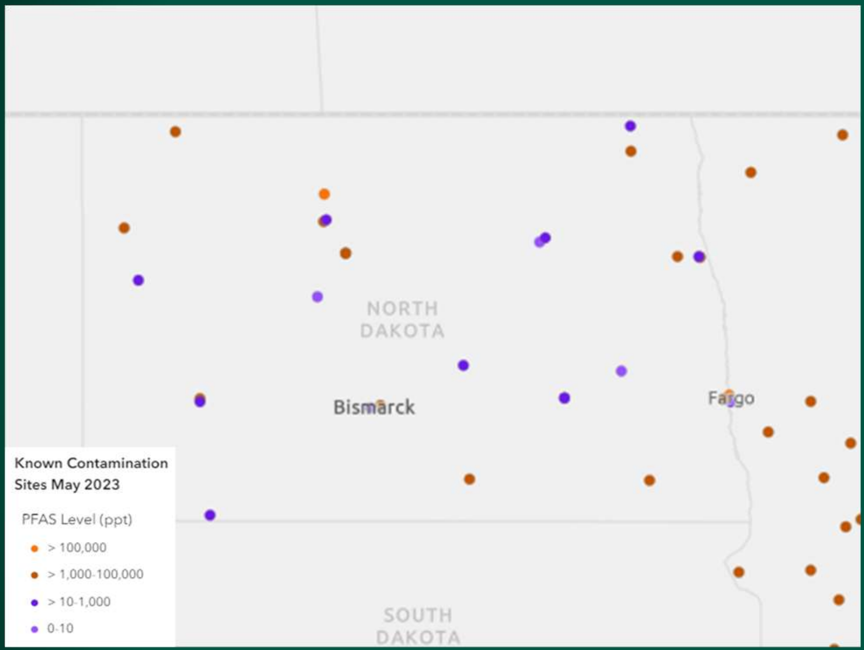
- Sources
  - Main source: aqueous film-forming foams (AFFF) and industrial wastewater
  - Other sources: landfill leachate; wastewater effluents

- Toxic at low levels
- EPA proposed MCLs

  (PFOA 4 ng/L and PFOS 4 ng/L)



PFAS in ND Water



PFAS Sites and Community Resources

https://experience.arcgis.com/experience/12412ab41b3141598e0bb48523a7c940/page/Page-1/?views=Known-Contamination

Air Force Base Groundwater:

PFOS 35000 - 440000 ng/L

PFOA 20000 - 40000 ng/L

Landfill Leachate:

PFOS 7.4 - 580 ng/L

PFOA 78 - 1700 ng/L

Municipal Wastewater Effluents:

PFOS 3.6 - 29 ng/L

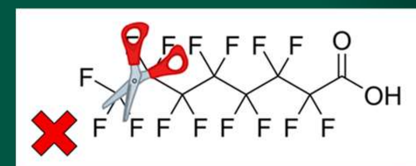
PFOA 6.3 - 35 ng/L

NGB Camp Grafton Drinking Water:

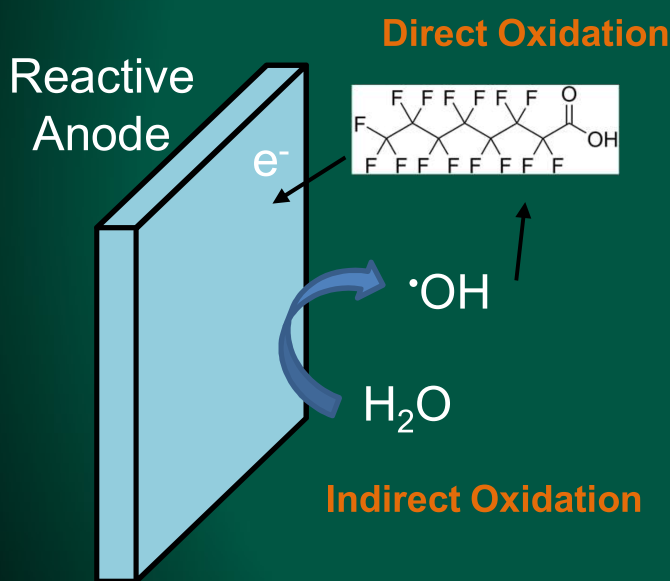
PFOA 6 ng/L

Electrochemical Advanced Oxidation Processes (EAOP)

- **Resistant to traditional treatment: strong carbon-fluorine bond**



- **EAOP mechanism for PFAS degradation**



Limitation of current anodes

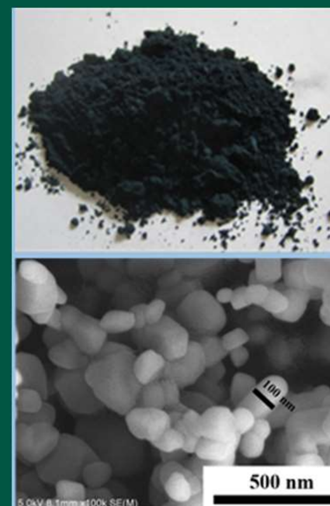
- Boron-doped diamond (BDD): costly (> $10000/m^2$)
- PbO_2 electrode: release toxic Pb
- Ti/SnO_2-Sb: unstable short lifetime

Preparation of Stable Ti_4O_7 Ceramic Electrode

TiO_2 powder

Reduced by H_2 at 950 ° C

High Purity Ti_4O_7 Nano-Powder



Ti_4O_7 ceramic electrode

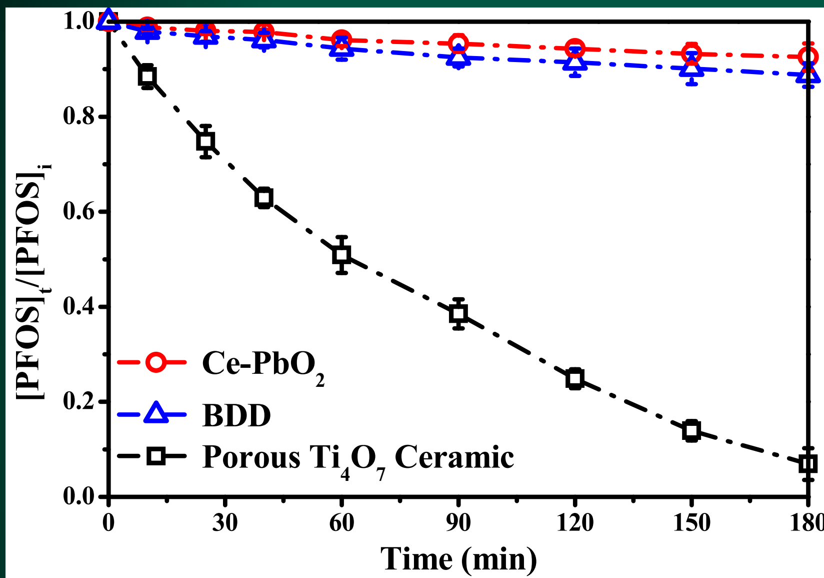
Mixed with polyacrylamide/polyvinyl alcohol
Dried and pressed at 60 MPa for 5 min
Sintered at 1350 ° C in a vacuum for 11 h

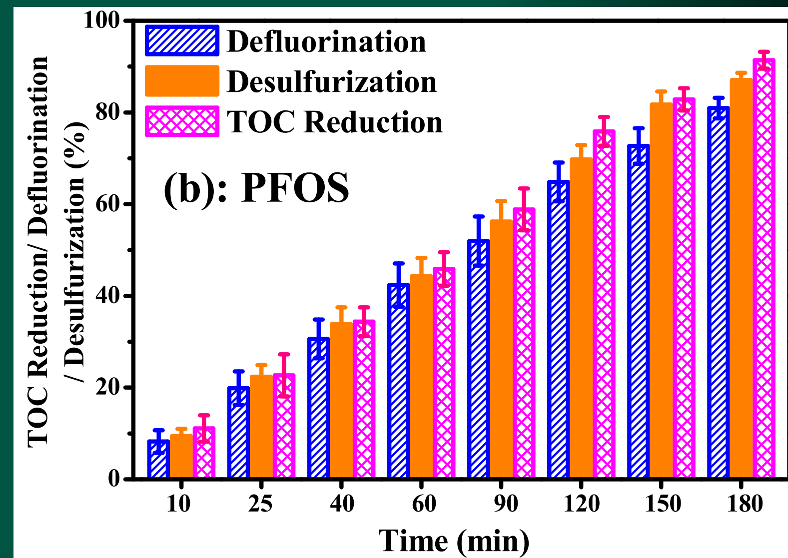
Expected service lifetime:

Ti_4O_7	Ti/SnO_2-Sb
26 years	**0.28 years**

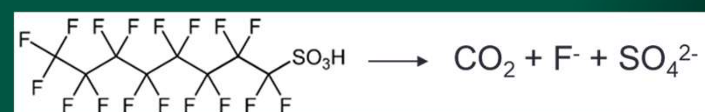
Xu et al. *Electrochim. Acta*, 2020
H. Lin*, **J. Xu***, et al. *Water Res.*, 2021

Degradation and Mineralization of PFOS





Experimental conditions
0.5 mM PFOA and 0.1 mM PFOS in 20 mM $NaClO_4$
stir at 800 rpm; current density of 5 mA/cm^2

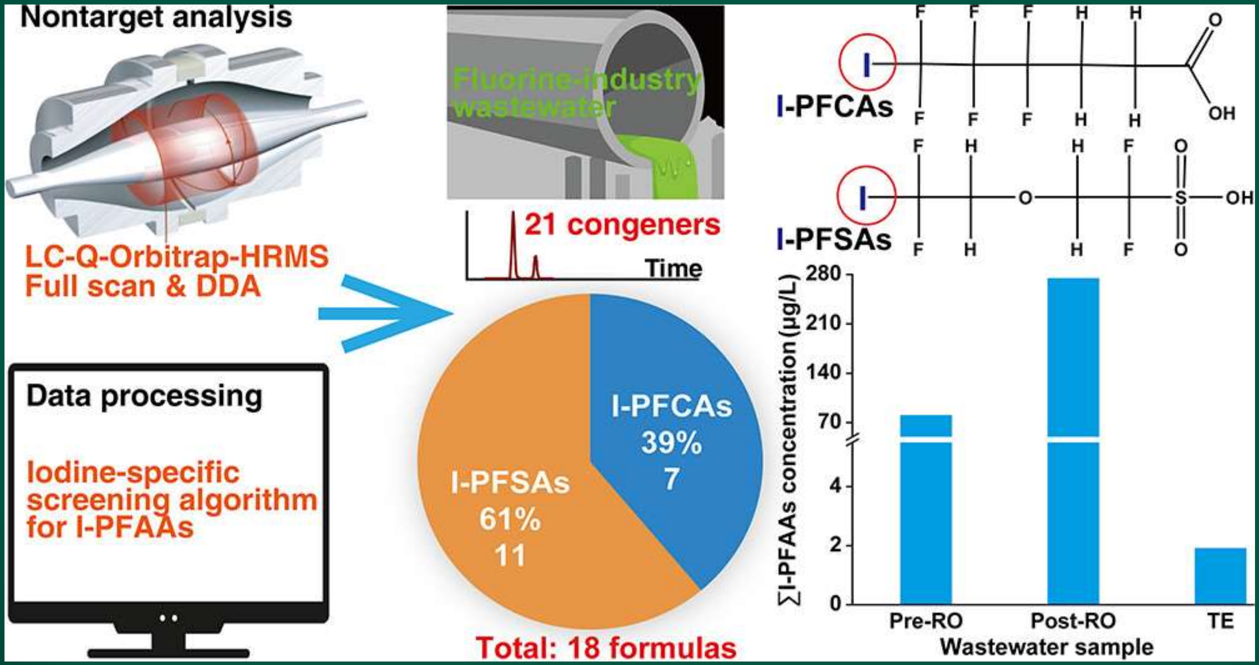


Ti_4O_7 ceramic electrode provided excellent degradation of PFOS

Lin et al. *Chem Eng Technol*, 2018; H. Lin*, **J. Xu***, et al. *Water Res,* 2021; X. Xie, **J. Xu**, et al. *Electrochim Acta*, 2023; H. Peng, **J. Xu**, et al. *ACS ES&T Water*, 2023; W. Li, **J. Xu**, et al. *Water Res,* 2022; K. Yang, **J. Xu**, et al. *J. Hazard. Mater.*, 2022

Emerging Iodinated PFAS in Wastewater

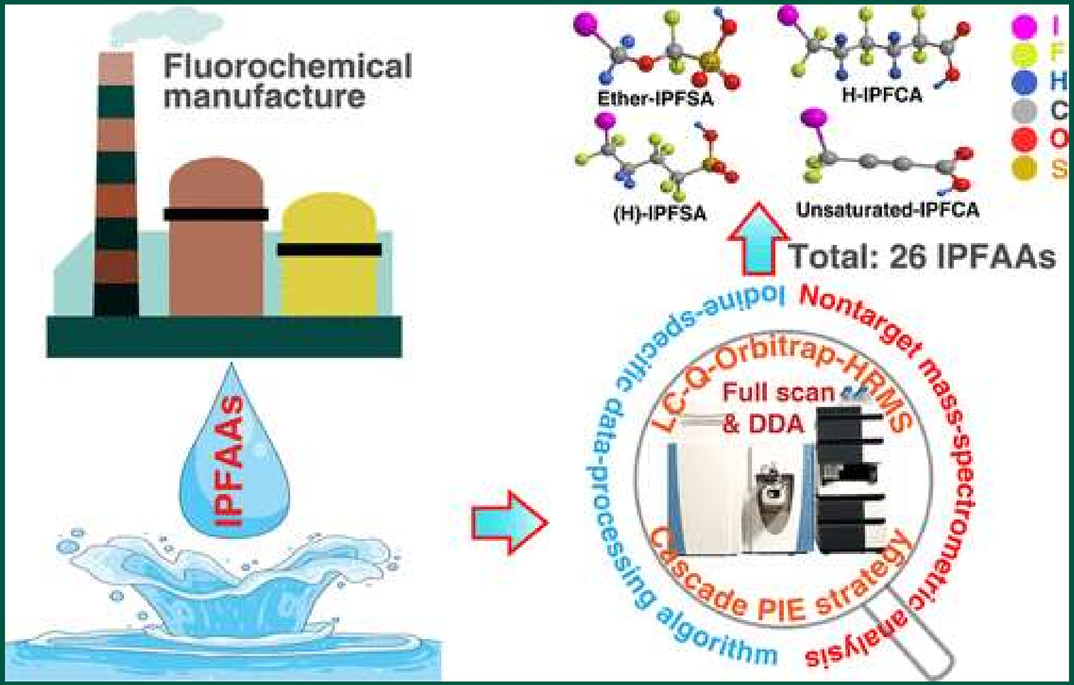
Iodinated per- and polyfluoroalkyl acids (IPFAAs) – more toxic



C. Tang, **J. Xu** et al. *Environ Sci Technol*, 2023a

Emerging Iodinated PFAS in Wastewater

Fluorochemical industry treated wastewater **160 – 285520 ng/L**
Contaminated river water **150 – 170 ng/L**

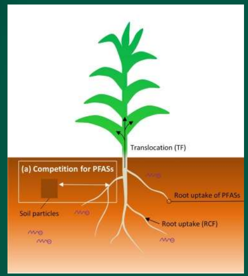


C. Tang, J. Xu et al. *Environ Sci Technol*, 2023b

NDSU NORTH DAKOTA STATE UNIVERSITY

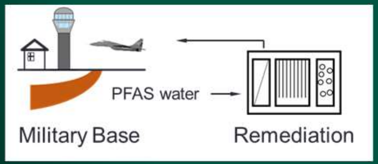
Ongoing Research

Ag: Nutrients effects on PFAS uptake by crops

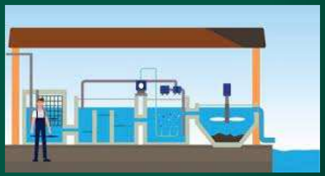


Source: PFAS leaching from construction and other industries

Treatment: Electrochemical technologies



Utility: Fate and source of PFAS in water treatment utilities



Acknowledgement and Contact

Funding Sources

Collaborators:

Shahidul Islam, Assitant professor, NDSU
Ying Huang, Professor, NDSU
Kalpana Katti, Professor, NDSU
Dinesh Katti, Professor, NDSU
Hui Lin, Associate professor, Dongguan University of Technology, China

Students: Tajrin Alom Nizhum and Md. Atik Fayshal

Email: jiale.xu@ndsu.edu
Tel: (701) 231-6393