

Selective Electrocatalytic Destruction of PFAS using a Reactive Electrochemical Membrane System

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Challenge

Per- and polyfluoroalkyl substances (PFAS) is the umbrella term for a group of fluorinated compounds that have many commercial and industrial uses, and are now ubiquitous in the environment due to their wide-use and persistence to degradation. Research has shown that exposure to some PFAS may be linked to harmful health effects in humans and animals, even at exceedingly low concentrations.¹ The current state-of-the-art for PFAS removal in water is adsorption by granular activated carbon, ion exchange, or reverse osmosis, however, these methods do not destroy the compounds and generate a PFAS-laden waste stream that requires subsequent disposal. Methods that remove and completely destroy PFAS compounds are needed.

Research Approach

This project will investigate the technical/economic feasibility of utilizing a titanium-based (Ti_4O_7), nanoparticle electrocatalyst for simultaneous adsorption and destruction of PFAS in wastewater (see the Figure below). To that end, the research approach is as follows:

1. Electrocatalysts will be doped on selective PFAS adsorbents and deposited on a reactive electrochemical membrane (REM) support.
2. These materials will be thoroughly characterized and refined through computationally guided synthesis.
3. The synthesized materials will be screened at the bench-scale, and the most promising materials will be extensively studied for their reactivity, selectivity, and longevity in real and synthetic reverse osmosis and ion exchange concentrates.
4. Based on these results, a techno-economic analysis (TEA) and impact assessment will be conducted to compare this work to other treatment options and to identify efficient paths for technology scale-up.

Impact

Successful completion of this project will overcome technical limitations of existing PFAS destruction technologies by improving selectivity for PFAS destruction, minimizing toxic byproduct formation, and limiting short-chain PFAS formation. Furthermore, this work will demonstrate that PFAS can be separated and destroyed, in-situ, using two-orders of magnitude less energy than other technologies (e.g., electrochemical oxidation), and generating an effluent with PFAS concentrations below California's Response Level. The knowledge gained from this work will provide a greater understanding of PFAS reaction mechanisms, which will allow more efficient technologies to be developed to combat this widespread problem.

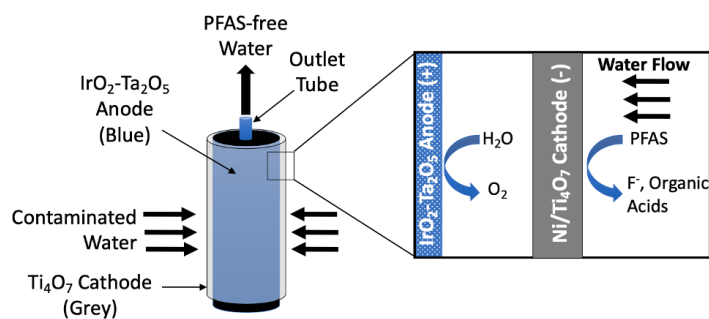


Figure 1. Schematic of a cylindrical REM used for the treatment of PFAS. Reductive defluorination reactions occur on the Ni/Ti₄O₇ reactive electrochemical membrane cathode, and oxidation of water to oxygen gas occurs on the IrO₂-Ta₂O₅ mesh anode.

RESEARCH PARTNERS

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REFERENCES

1. <https://www.epa.gov/pfas/pfas-explained>.