

# New Materials for the Capture and Photocatalytic Destruction of "Forever Chemicals"

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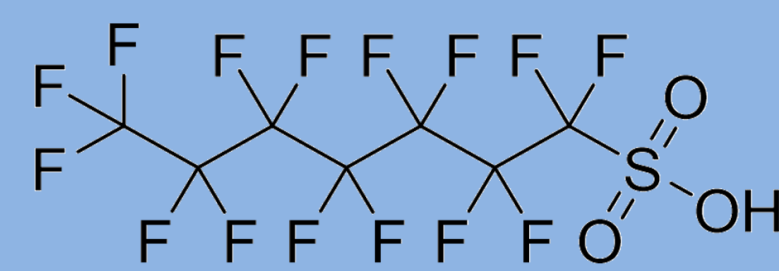
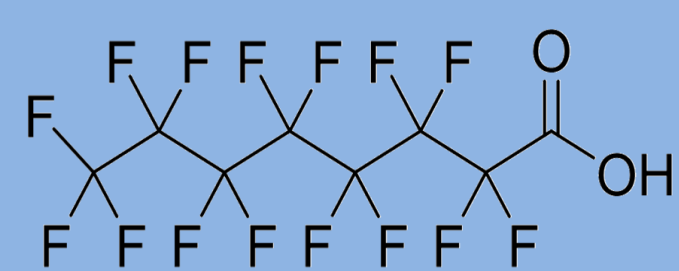


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## Introduction

- PFAS – Perfluoroalkyl and polyfluoroalkyl substances exist in the environment. There are over **10,000 different PFAS**. They enter into the environment in many ways including from runoff and industrial sites.
- PFAS do not degrade in the environment and are linked to adverse effects on human health, even at low levels.<sup>1</sup>
- PFAS pass through conventional water treatment processes untouched.
- PFAS are pollutants of significant and widespread **global** concern.



BBC  
NEWS

Toxic 'forever' chemicals found in excessive levels in global groundwater, study says

By Sandee LaMotte, CNN

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Experts call for tighter limits on 'forever chemicals' in water

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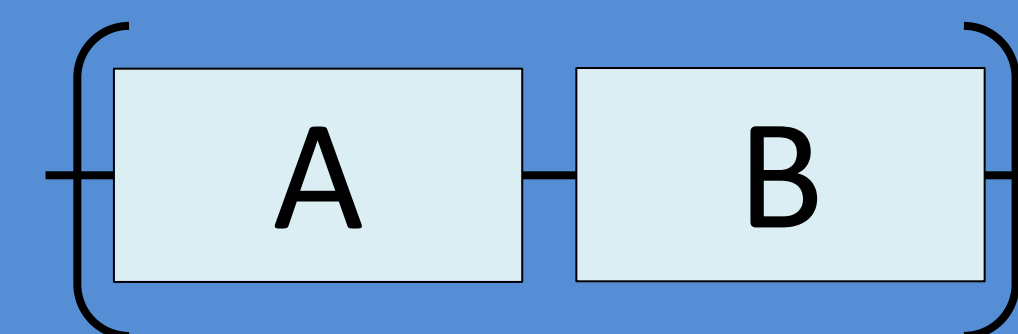
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Guardian

'Forever chemicals' outlast any government - all the more reason for dealing with them now

Mon 21 Oct 2024 17:23 BST

## Polymer Design

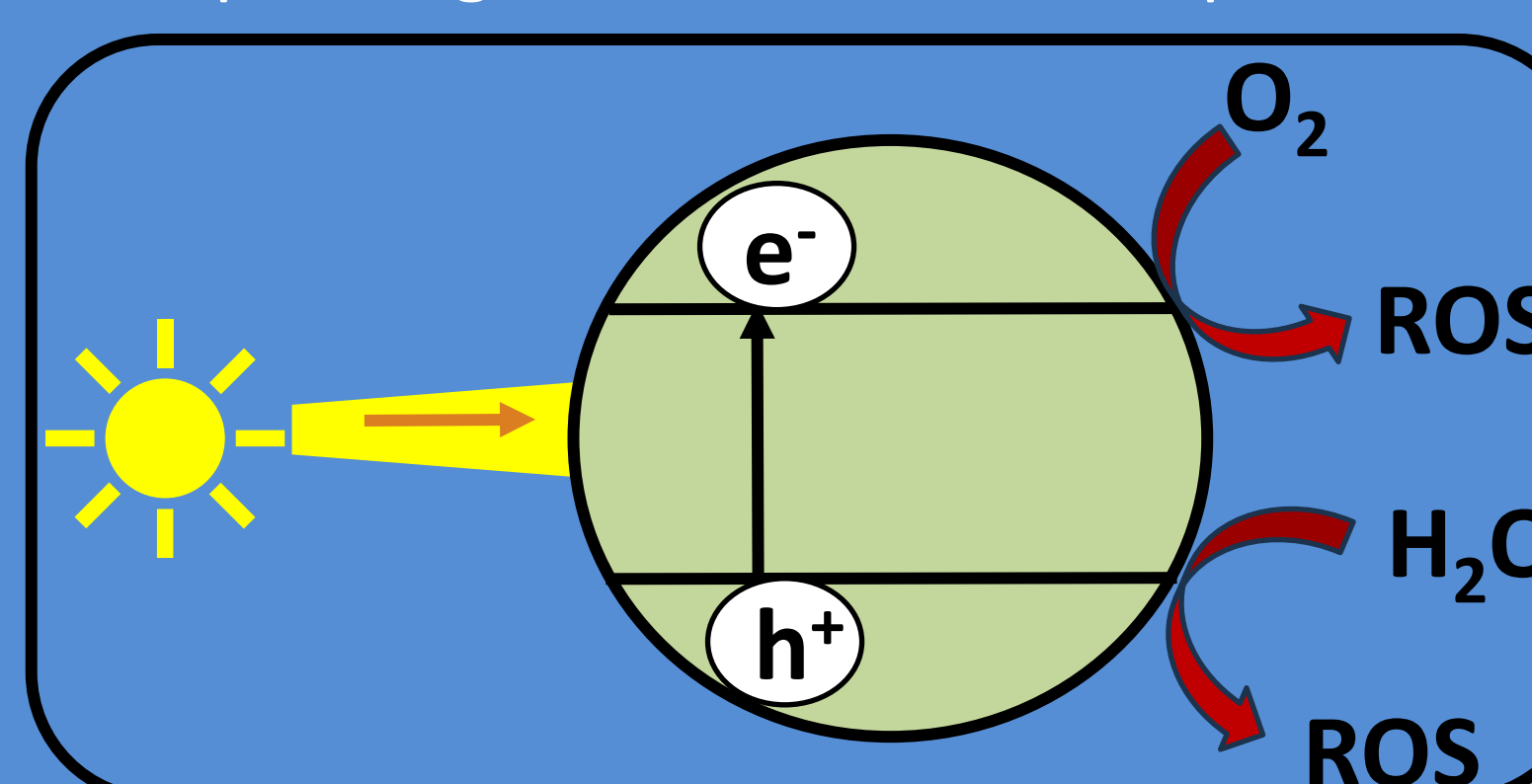
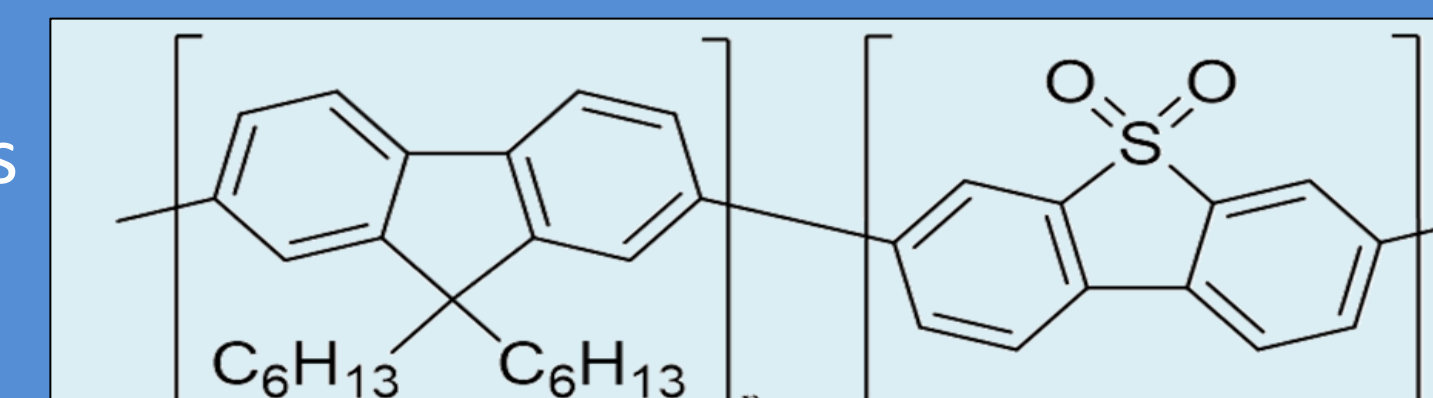
Polymers are highly modular and scalable and can be designed to have non-covalent and/or covalent interactions with PFAS.



Monomer "building blocks" provide tuneable:

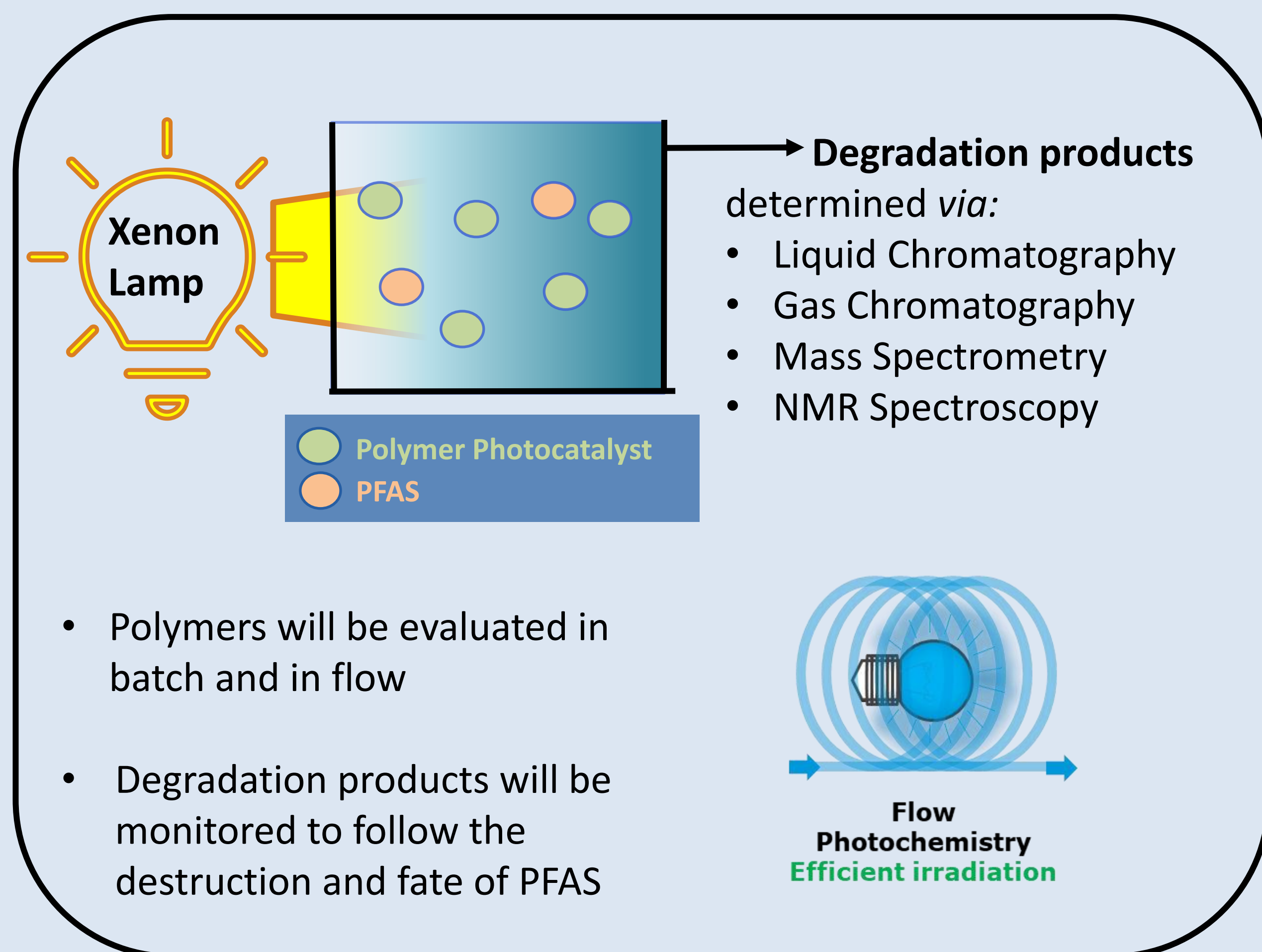
- Affinity for PFAS
- Photocatalytically active properties
- Internal surface area

The properties can be optimised depending on the needs of the photocatalysis

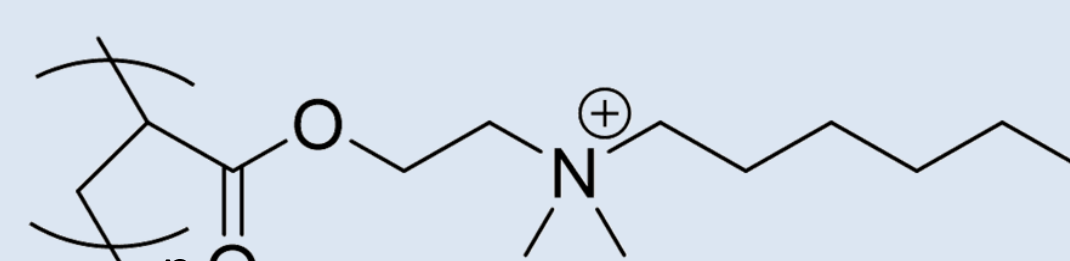


- Solar light absorbed by photocatalyst
- Electron-hole pair generated
- Reactive oxygen species (ROS) formed
- ROS destroy PFAS

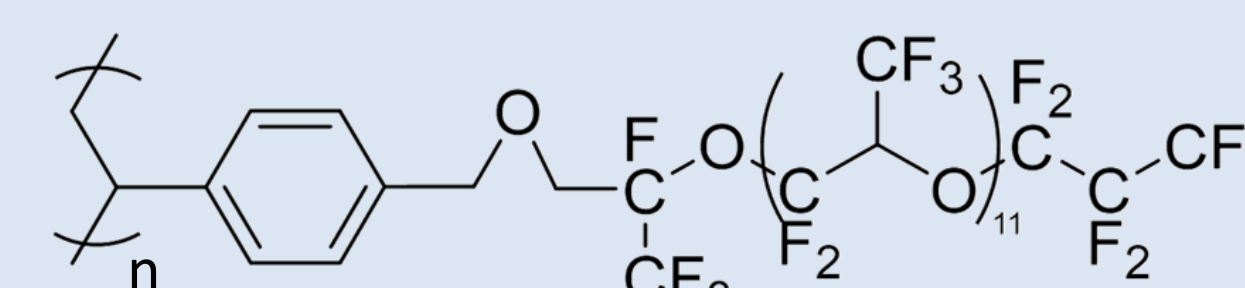
## Methods



### Binding Groups



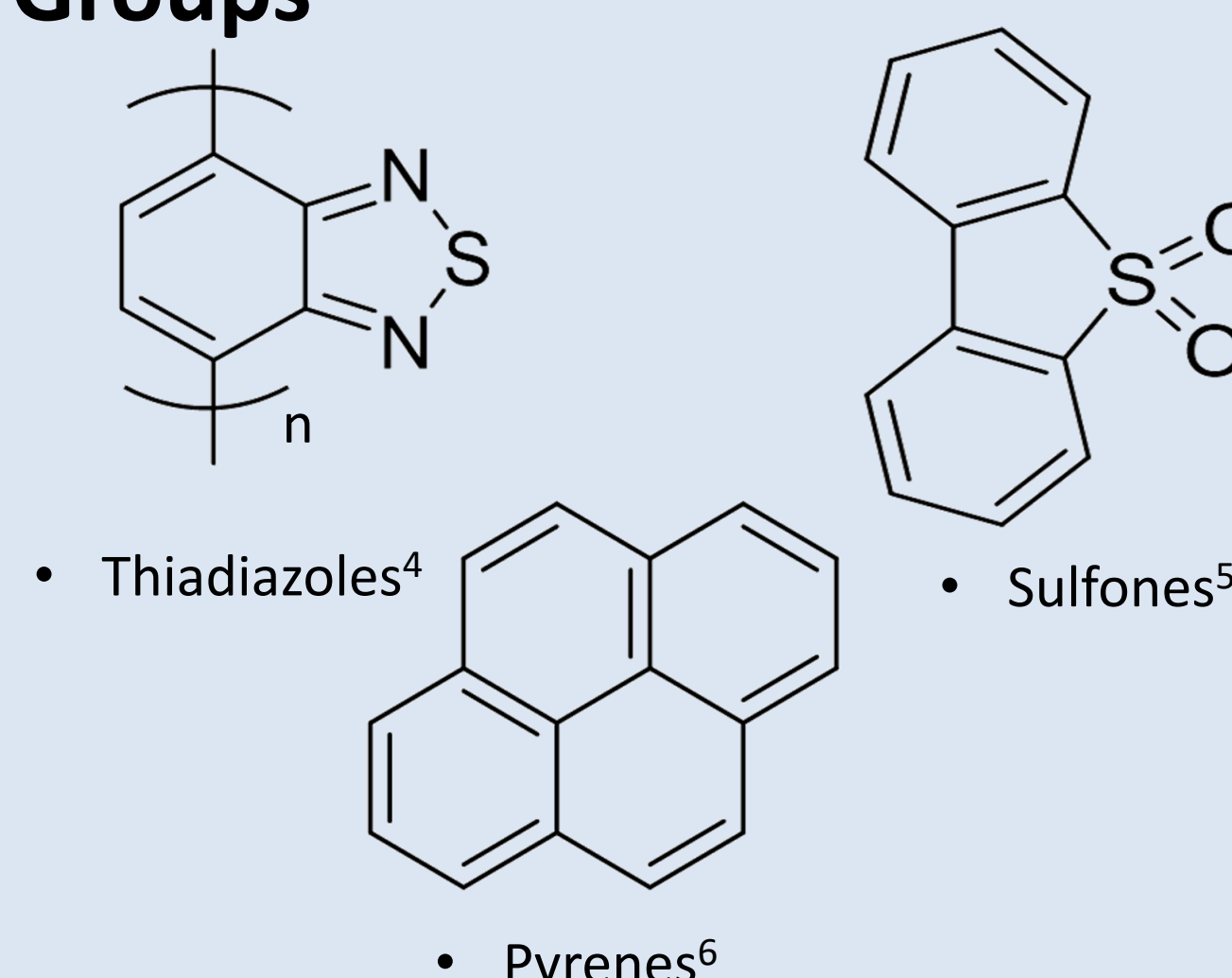
- Anion-exchangers allow ionic interactions



- Perfluorinated side-chains<sup>2</sup>

Charged groups (1) can bind to anionic PFAS while perfluorinated chains (2) have weaker affinity towards fluorinated PFAS backbones and can help preconcentrate PFAS on the photocatalytic polymers.<sup>3</sup>

### Photocatalytically Active Groups

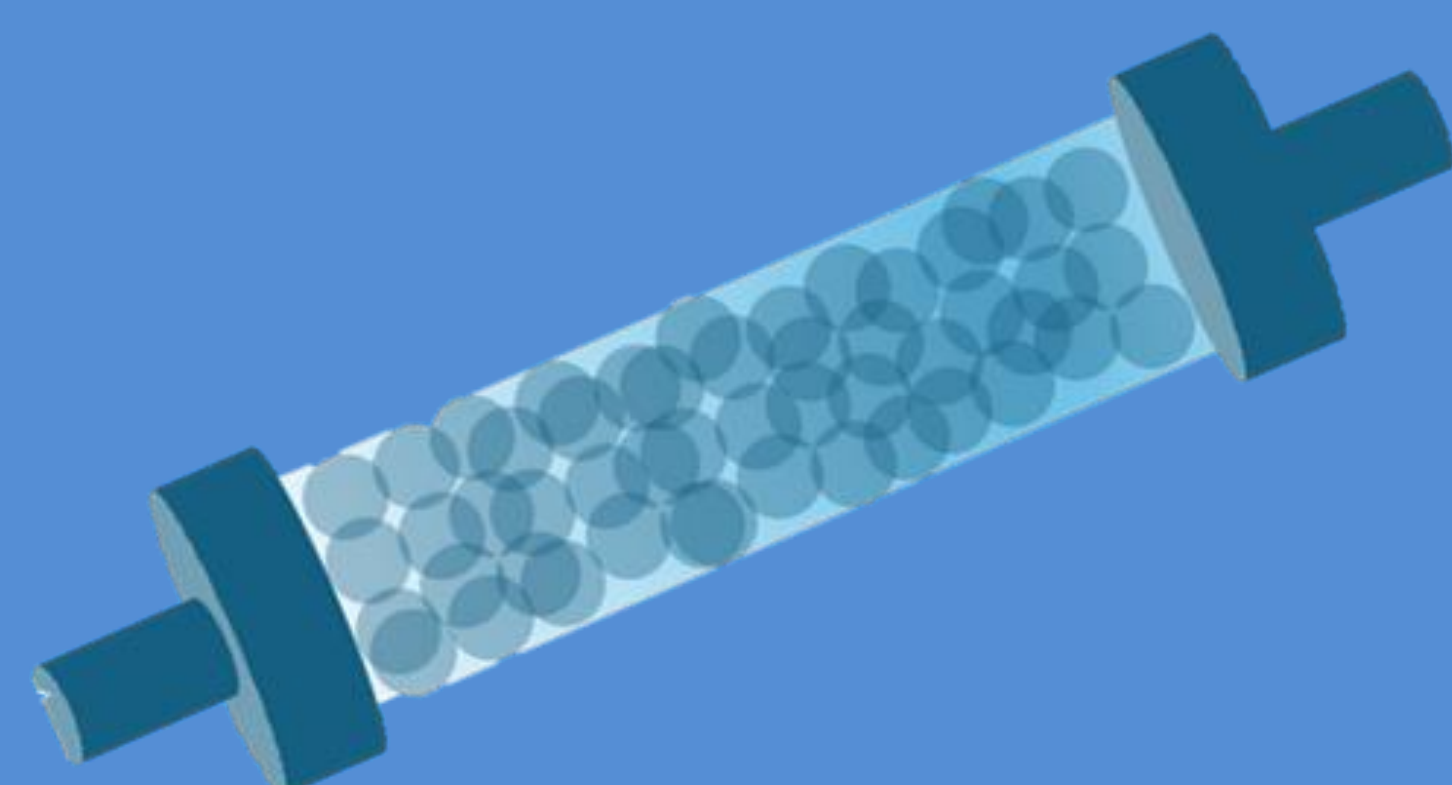


Photocatalytic groups incorporated into polymers.

Absorb visible light to produce ROS.

## Research Programme

- Synthesis of libraries of photocatalytically active polymers
  - Variables include chemical structure, porosity and format (beads, membranes, gels etc.)
  - Structure-property relationships established
- Use of photocatalytic polymers to destroy PFAS present in water
  - Range of PFAS targeted
  - Different water sources, including wastewater
- Showcasing of scalability
  - Fluidic devices
  - Polymer extrusion
  - Polymer 3D printing



## Scale-up

- Free radical polymerisation used on an industrial scale
- Chemistry in flow
- Polymers 3D printable
- Real time monitoring of photocatalytic processes



Swollen polymer gel with photocatalyst incorporated<sup>7</sup>

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