

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

Ross Livingston,¹ Peter A. G. Cormack,¹ R. Sebastian Sprick¹ and Filipe Vilela²

1. Department of Pure & Applied Chemistry, University of Strathclyde, 295 Cathedral Street, Glasgow, G1 1XL

2. School of Engineering and Physical Sciences, Perkin Building, Heriot-Watt University, The Avenue, Edinburgh, EH14 4AS

Email: ross.livingston.2019@uni.strath.ac.uk

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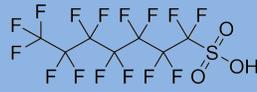
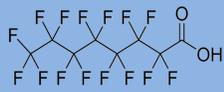


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Introduction

- 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.¹
- 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

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

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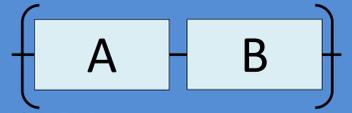
The Guardian

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

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Polymer Design

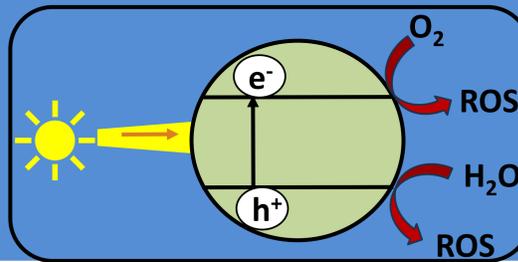
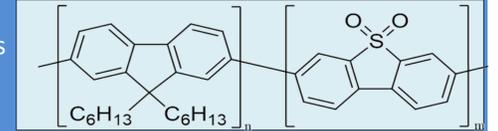
Polymers are highly modular and scalable and can be designed to have non-covalent and/or covalent interactions with PFAS.



Monomer "building blocks" provide tuneable:

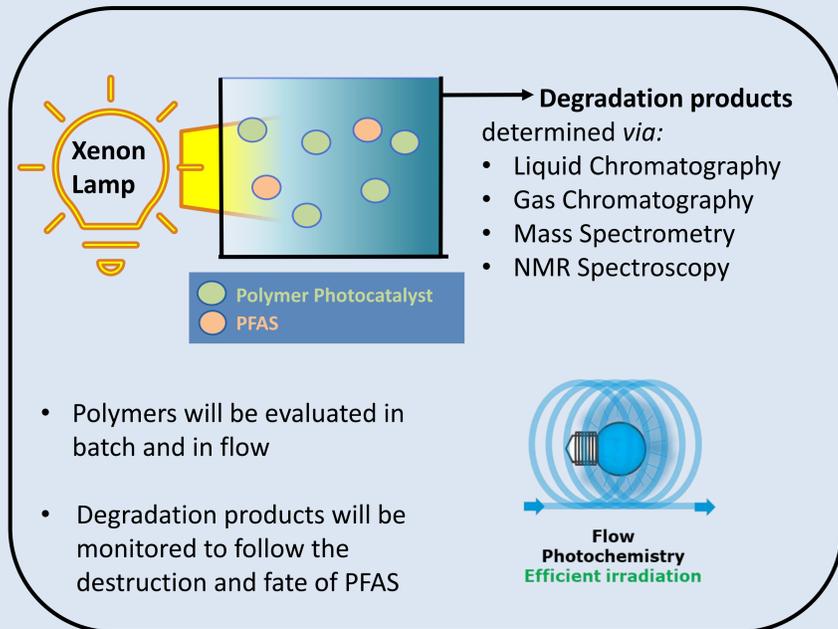
- Affinity for PFAS
- Photocatalytically active properties
- Internal surface area

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



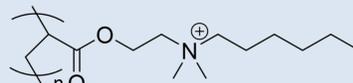
- Solar light absorbed by photocatalyst
- Electron-hole pair generated
- Reactive oxygen species (ROS) formed
- ROS destroy PFAS

Methods

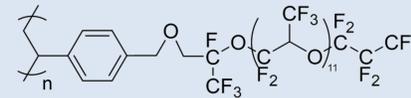


- Polymers will be evaluated in batch and in flow
- Degradation products will be monitored to follow the destruction and fate of PFAS

Binding Groups



- Anion-exchangers allow ionic interactions



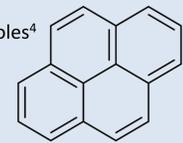
- Perfluorinated side-chains²

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.³

Photocatalytically Active Groups



- Thiaziazoles⁴
- Sulfones⁵



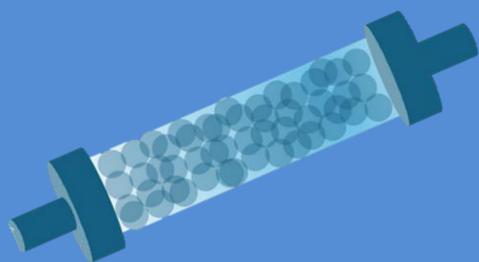
- Pyrenes⁶

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 incorporated⁷

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University of
Strathclyde
Glasgow

