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MEMetic - Exquisitely selective bioinspired membranes

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Separating molecules from water is a fundamental challenge across sectors, from wastewater treatment to blood dialysis. Current filtration technologies rely on sequential separation steps based on the properties of the molecules, sometimes up to a dozen. However, biology has evolved a solution to this, developing proteins that sit within membranes to selectively transport a specific molecule across it. MEMetic embeds these specific biological transporters in sustainably produced plastic membranes to create bioinspired membranes capable of selectively removing a specific molecule, such as antibiotics, heavy metals and nutrients, from water in a single step. Additionally, MEMetic's membranes can concentrate the molecules of interest, making it perfect for recovering valuable resources from water, like phosphate and lithium. The technology could also, for example, be used in low-energy desalination or to remove toxic contaminants.

<u>Speakers' bio:</u>

Dr Matt Derry is a Senior Lecturer in Chemistry at Aston University, founding member of the Aston Institute for Membrane Excellence (AIME), and co-founder and Chief Technology Officer of MEMetic. He leads a team of PhD and postdoctoral researchers who are developing new polymer materials for a range of applications including energy storage, data storage and water filtration.

Tom Stephenson is a Visiting Professor at Aston University and presumptive Chief Executive Officer of MEMetic. He is a Non-Executive Director of Marsh Industries Ltd, a wastewater treatment plant manufacturer, and an Advisor to Bluemethane Ltd, a Net Zero startup. Tom has over 40 years' experience of technology development for the water sector, including membranes and biological processes.

Bioremediation of Elastane Within Textiles – Gymshark collaboration

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In 2022, the global textile market reached a record 116 million tonnes, with less than 1% derived from textile-to-textile recycling and approximately 57% being fossil-based virgin fibres. Lack of component recovery results in ~85.5% of textile waste in the US ends up in landfills or incinerators (66.4% and 18.9%, respectively).

Elastane fibres, composed of at least 85% poly(urethane-urea) copolymer (commonly polyether-polyurethane), are often incorporated into textile blends to enhance elasticity and tensile strength, typically as core or covered yarn (with e.g., polyester, cotton, or nylon). In 2022, global elastane production reached 1.2 million tonnes, with only ~2.8% being derived from recycled sources, in contrast to ~14% for polyester fibres.

Although ~20% of recyclable textile waste contains elastane, current repurposing methods are either too inefficient or not cost-effective for industrial application, especially in comparison with the low cost of fossil-based virgin fibres. Mechanical separation methods fail to fully separate elastane fibres, which contaminate downstream processing, resulting in materials with sub-par properties and/or preventing further reprocessing. Furthermore, existing chemical processing and recycling methods typically employ harsh conditions and high energy requirements, often not being environmentally friendly or cost-effective. Consequently, elastane is rarely recycled - typical repurposing methods for polyurethane (PUR) are downcycling or energy recovery via incineration, highly polluting techniques using non-renewable fossil-based fibres are not a long-term solution.

Bioremediation of polymers typically operates under mild reaction conditions and low energy input, being successfully applied to polyester at an industry-level scale. Although most petrochemical polymers are designed for durability and non-biodegradability, PUR is still susceptible to biodegradation by microbes and enzymes - a strategy that has not yet been applied to elastane fibres. Using enzymes responsible for degradation, from microbes, can reduce degradation times from up to 2 years to just 2 weeks.

This research aims, for the first time, to develop a process for the enzymatic degradation of elastane to facilitate textile recycling. The project will identify and evaluate active enzymes, develop a robust degradation method, optimise reaction conditions, and incorporate pre-treatment strategies to improve conversion yields. Advanced analytical techniques will be employed to characterise degradation products and elucidate underlying mechanisms. This novel approach is expected to provide a foundation for industrial applications within existing waste streams or chemical separation processes, thereby driving a circular textile economy.

<u>Speaker's bio:</u>

Lewis Yandle is a PhD researcher at the Energy & Bioproducts Research Institute (EBRI), Aston University, specialising in biotechnology and polymer biodegradation. With a background in biochemistry, his research focuses on the bioremediation of elastane (polyurethane) in textiles, using expertise in microbiology, polymer characterisation, and analytical chemistry. His previous research experience includes optimising brewer's yeast for industrial applications (SuperYeast, MeMBrane project) and developing cell spray burn treatments, along with medical laboratory work at Birmingham Children's Hospital. He is also an active member of The Biochemical Society.

Greener HPLC: Sustainable Solvent Innovation Through Aston University – AstraZeneca Collaboration

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High-Performance Liquid Chromatography (HPLC) heavily relies on acetonitrile, a petrochemical solvent associated with significant environmental and supply chain concerns. The majority of used acetonitrile is incinerated, contributing to harmful emissions.

In collaboration with AstraZeneca, our research focuses on replacing acetonitrile with ethyl lactate, a biorenewable, biodegradable and less toxic alternative. Our findings demonstrate that ethyl lactate delivers comparable chromatographic performance for detecting and quantifying antibiotics of technological importance, including tetracycline, chloramphenicol, trimethoprim, and sulfamethoxazole, while significantly reducing the environmental footprint of HPLC analysis.

This project aligns with global sustainability goals and AstraZeneca's commitment to green chemistry, highlighting the potential for industrial adoption of greener solvent systems. It also exemplifies the power of academia-industry collaboration in driving sustainable innovation in analytical chemistry.

<u>Speaker's bio</u>

Dr Vesna Najdanovic is the Head of the Chemical Engineering and Biotechnologies Department and a member of the Energy and Bioproducts Research Institute (EBRI) at Aston University. Her research focuses on the development and application of green solvents for industrial separation processes, catalytic reactions and sustainable analytical techniques, with a strong emphasis on improving efficiency and reducing environmental impact.

Examples of her work include using biorenewable solvents for a range of industrial applications, including removing pharmaceutical pollutants from water, extracting high-value antioxidants from waste biomass and recovering biomolecules from fermentation broths. Additionally, her research explores carbon dioxide utilisation as a feedstock for fine chemicals and solvent production. In her recent work, she developed a method for analysing pharmaceutical formulations using biorenewable solvents as a sustainable alternative to the hazardous organic solvents traditionally used in the pharmaceutical industry.

With a track record of over 70 peer-reviewed publications and 3,698 citations (h-index 33, January 2025), her work is widely recognised in the field. Over the past 13 years, she has secured over £800,000 in research funding from UK Research and Innovation (UKRI), the Portuguese Research Funding Agency, industry partners and charitable organisations.

HAROW and REvAR Projects – Fuel Gases from Organics in Contaminated Water

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Our consortium will be presenting our work on two related projects looking at producing fuel gases (hydrogen and methane) from water with organic contamination via aqueous phase reforming (APR). The work is based on research at Aston University. HAROW (Hydrogen via Aqueous-phase Reforming of Wastewater), was funded by the BEIS H2BECSS programme to investigate the conversion of aqueous waste glycerol from biodiesel production to produce hydrogen. REvAR (Renewable Energy via Aqueous-phase Reforming) is our current ongoing project. REvAR is one of the winners of the OFWAT Discovery Challenge and we are looking at methane and hydrogen production from sewage sludge and AD digestate. The REvAR project also aims to produce clean water. In both cases, catalytic reaction conditions had previously been developed in batch reactors at Aston. The projects have enabled us to transfer these reactions into custom-built continuous flow systems to examine the potential for further scale up. Concept plans have been developed for the deployment of a containerised system at 5-10x scale.

<u>Speakers' bio:</u>

Dr Malcolm Glendenning is a material scientist who has spent over 25 years working on innovation in a range of industries including glass, nuclear, oil and gas, biomaterials and medical products. In 2018 he helped set up the UK arm of ICMEA specialising in process scale -up with an emphasis on renewables.

Dr Jude Onwudili is a Reader in Chemical Engineering at Aston University, Birmingham (UK) and a Fellow of the Royal Society of Chemistry. He is an expert in advanced thermo-catalytic conversion (e.g., pyrolysis, hydrothermal processing, and catalytic upgrading) of biomass and biomass-derived feedstocks produce gaseous and liquid fuels and chemical feedstocks. Dr Onwudili is a Director of Aston's Energy and Bioproducts Institute (EBRI), leading on industrial research engagements.

Industrial Decarbonisation with Biochar and Bio-products

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The Energy and Bioproducts Research Institute at Aston University has expertise in pyrolysis able to transform waste and residue materials into commercially viable projects with pyrolysis. While it is known that pyrolysis products such as biochar have the potential to provide significant opportunities for decarbonisation, realisation of these opportunities have been elusive. Applied research at EBRI in partnership with a cluster of UK companies and funded with £3m by the WMCA and Innovate UK has developed an approach which is providing promising results. The team is now looking for organisations interested in collaboration to exploit existing technologies and partner in the development of new opportunities.

Speakers' bio:

Tim Miller has over 15 years board level experience in technology companies, specialising in technical and commercial management, research marketing and consultancy. This has included very early stage internet development and founding one of the first Internet Service Providers in the UK. Tim has worked with government bodies on business incubation, science park management and technology commercialisation. This include leadership of business accelerators. Tim's experience covers start-ups through to large companies, international membership organisations, the public sector and universities. Working along side top academic and research teams Tim helped found the Energy and Bioproducts Research Institute at Aston University.

Steve Harrison has a wealth of technical and managerial experience across a wide range of industries. After serving in the RAF for 11 years in propulsion engineering, he has worked for some of the UK's most well-regarded military/aerospace and civil engineering companies such as Ultra Electronics, Froude Hoffman, Dunlop Aircraft Tyres Ltd, Cosworth and Dytecna Systems Engineering. Steve ran his own consultancy, working on renewable energy projects such as waste to energy, solar concentration systems, waste digestion systems, water pollution recovery systems, gas compression and biogas upgrade. Clients have been major international companies and entities such as BAe Systems, Boeing, US DoD, Perkins, Bentley, British Airways, UK MoD, R-R, Agusta.