

HELLO TOMORROW

Faculty of Science and Engineering

POSTGRADUATE RESEARCH

Department of Materials

Postgraduate Research Conference

14th & 15th May 2025

Programme of Events

HELLO TOMORROW

Faculty of Science and Engineering

POSTGRADUATE RESEARCH

Contents

Welcome Statement p3

Conference Overview p4

Presentations

Presentation Schedule p5

Presentation Abstracts p12

Posters

Poster Numbers: Year 1 p94

Poster Abstracts: Year 1

Poster Numbers: Year 3 p166

Poster Abstracts: Year 3

Materials Conference 2025

Date: Wednesday 14th - Thursday 15th May

Conference Location: Nancy Rothwell Building

Welcome Statement

Welcome to the Department of Materials PGR conference 2025.

Our Postgraduate Research community has over 500 PhD and MPhil researchers, contributing enormously to research excellence, social responsibility, and teaching delivery - as well as making the Department such a vibrant place to work and to learn.

Our research spans material science, engineering, textiles and fashion management & marketing. These may appear diverse topics, but the power of interdisciplinary exchanges for generating innovation and sharing best practice is exemplified by the range of talks and speakers.

We are very much looking forward to hearing and seeing all your interesting research projects.

Please enjoy the conference, ask plenty of questions, and engage with other participants to draw inspiration for your future research and careers.

We have invited two excellent speakers to open the conference in the Plenary session. Dr Jack Coffin who's talk focuses on how to encompass equality, diversity and inclusion in your PhD research, and Dr Beatriz Mingo, who's talk focuses on her development as a researcher and tips for post-PhD careers. Both talks promise to be inspiring and helpful for your research and future careers.

Dr Rosy Boardman

(Head of PGR)

Drs Courtney Chrimes, Chamil Abeykoon, Alec Davies

(Deputy Heads of PGR)

Conference Overview

Day 1 14th May 2025

10:30AM-11:30AM	Plenary session
11:30AM-12:30PM	Lunch
12:30PM-2:00PM 2:00PM-2:15PM	Year 1 poster session Year 1 poster prizes
2:15PM-3:15PM	Year 2 oral presentations #1
3:15PM-3:45PM	Tea, Coffee & Cake
3:45PM-5:15PM	Year 2 oral presentations #2

Y1 Poster Presenters should arrive from 9:30 to register & display their posters in advance of the plenary session.

Day 2 15th May 2025

09:30AM-10:00AM	Tea, Coffee and Pastries
10:00AM-11:00AM	Year 2 oral presentations #3
11:00AM-11:15AM	Short Break
11:15AM-12:15PM	Year 2 oral presentations #4
12:15PM-1:00PM	Lunch
1:00PM-2:30PM 2:30-2:45PM	Year 3 poster session Year 3 poster prizes

Y3 Poster Presenters should arrive between 9:30am-12pm to register and display their posters

All catering will be hosted in Nancy Rothwell's Ground Floor Event Space.

Day 1: Oral Presentation Sessions (Wednesday 14th May)

Session Theme(s): Metallurgy & Corrosion		
Wednesday 14 th May, 14:15 – 17:15 Building/Room: Nancy Rothwell_3A.012		
Chairs: David Champness , david.champness@postgrad.manchester.ac.uk Philipp Frankel , philipp.frankel@manchester.ac.uk		
Break: 15:15– 15:45		
14:15	Saleh Mohammed S Al Awadh	Model Development for Localized External Corrosion of Buried Pipelines
14:30	Miles Cooke	Examining the combined effects of irradiation and microsegregation on the microstructure and mechanical properties of low alloy steel welds
14:45	Avijit Das	Lead in Drinking Water: Understanding Scale Evolution
15:00	Andrew Evans	Structural controls on critical mineral mobilisation and fluid flow within the Cornubian Batholith: Insights from the Cligga Head Granite, Cornwall
Break: 15:15– 15:45		
15:45	Chijioke Godwins	Corrosion Inhibition by DDTMAC: Impact on Siderite Scale Formation in Oil and Gas Pipelines
16:00	Aiden Ha	A phase-field approach to understanding the development of abnormally coarse grain structures during β -annealing of Ti-64: The sequel
16:15	Kaige Liu	Graphene Nanocomposite Coatings
16:30	Szymon Ochenkowski	Microstructurally Informed Modelling of Fragmentation of Metals
16:45	Zichao Zhu	Investigating the Heat Treatment of WAAM'd 300M Landing-gear Steel
17:00	Burcu Eroglu	Corrosion of Stainless Steel in HCl containing Vapour Environments

Session Theme(s): Polymers & Composite and Coating & Ceramics		
Wednesday 14 th May, 14:15 – 17:15 Building/Room: Nancy Rothwell_3A.016		
Chairs: Christina Valles , cristina.valles@manchester.ac.uk Bill Sampson , william.sampson@manchester.ac.uk		
Break: 15:15– 15:45		
14:15	Xiaojing Gu	A Study on dual-responsive physical gel and its drug release performance for injection application
14:30	Dominic Harris- Jukes	Carbon negative polymers in automotive applications
14:45	Md Arif Mahmud	Development of UV-Curable Green Polymeric Materials-Based Biocomposite Structures
15:00	Peng Zong	Microstructural engineering of protective coatings for prolonged lifetime
Break: 15:15– 15:45		

15:45	Francesca Patel-Burrows	Thermally responsive colourimetric sensors made from cellulose/polymer hybrids
16:00	Saleh Soomro	Metrology and Mixing in Plastics Recycling
16:15	Jian Tang	Pyrene-functional multiblock copolymers prepared by sequential RAFT aqueous emulsion polymerisation
16:30	John Vickers	Graphene-enhanced Polypropylene Sustainable Composites for mechanical and electrically conductive monofilament and multifilament Applications.
16:45	Ellie Wilson	Uncovering the Impacts of Realistic Nanoplastics
17:00	Huize Zheng	Synthesis of pH responsive amphiphilic copolymer nanoparticles which have adjustable blue light fluorescence by polymerisation-induced self-assembly

Session Theme(s): Imaging & Characterisation

Wednesday 14th May, 14:15 – 16:45

Building/Room: Nancy Rothwell_3A.029

Chairs:

Ali Gholinia, Ali.Gholinia@manchester.ac.uk

Jane Wood, jane.wood-2@manchester.ac.uk

Abraham Barde, abraham.barde@manchester.ac.uk

Break: 15:15– 15:45		
14:15	Alexander Beale	Extraction of Tritium from the Molten Salt FLiBe
14:30	Joao Bezerra	Machine Learning and Electron Microscopy: Integrating Techniques to Enhance Understanding of Alkaline Electrolysers
14:45	Sethupathi Rangaraj	Understanding the Anisotropic High Cycle Fatigue of AlSi10Mg Produced by LPBF
15:00	Sara Hammoud	Understanding the Behaviours and Factors Influencing Detritiation During Thermal Treatment of Materials
Break: 15:15– 15:45		
15:45	Siguang Meng	The use of advanced electron microscopy to explore the early stages of precipitate evolution in Cu-Cr-Zr alloys
16:00	Sudip Bose	Towards Inline Defect Detection of Pultruded CFRP Composites: A comparative X-Ray Imaging study between Cone-beam X-ray micro-CT and Digital Tomosynthesis
16:15	Seana Youssefi	A Near-Atomic-Scale Study of the Microstructure and Mechanical Properties of Tungsten and Tungsten-based Alloys
16:30	Sem Zaal	Understanding Tritium Behaviour in Plasma-Facing Materials for Nuclear Fusion Applications

Session Theme(s): Fashion Marketing & Management and Textiles & Apparel

Wednesday 14th May, 14:15 – 17:00

Building/Room: Nancy Rothwell_3A.052

Chairs:

Aurelie Le Normand, aurelie.lenormand@manchester.ac.uk

Victoria Stephens, victoria.stephens@manchester.ac.uk

Clare Richardson, clare.richardson-5@manchester.ac.uk

14:15	Wanchu Hou	The role of emotional contagion in consumer interactions with generative AI chatbots
14:30	Xiangjun Ma	Enhancing Consumer Trust in Secondhand Luxury Live-Streaming: A Comparative Study of AI and Third-Party Authentication
14:45	Asyifa Jiniputri	Dressing Heritage: Indigenous Knowledge, Heritage Identity, and the Broader Implications of the Outer Baduy Community's Clothing Practices
15:00	Haoke Liu	Textile Circularity Digitization for Developing Product Digital Passport
Break: 15:15– 15:45		
15:45	Renhao Wang	Establish the Parametric Design Principles and Methods for the Multi-functional Suit-Jacket for the Specific Cultural Contexts
16:00	Dewan Murshed Ahmed	Shaped Woven Panels for Seamless Jeans: A Zero-Waste Approach via Dobby Loom Engineering and Integrated Hemming Techniques
16:15	Xu Wang	Effect of Structure Changes During Wool Textiles Manufacturing and Finishing on Fabric Hand and Comfort
16:30	Xiuju Cui	Tunable Temperature Alarm Sensor for Enhanced Safety in Firefighting Clothing
16:45	Jing Liu	Thermal Management Functional Materials and Wearable Sensors

Session Theme(s): Polymers & Composites and Metallurgy & Corrosion		
Wednesday 14 th May, 14:15 – 17:15		
Building/Room: Nancy Rothwell_3A.057		
Chairs:		
Mark Bissett , mark.bissett@manchester.ac.uk		
Alec Davies , alec.davis@manchester.ac.uk		
Break: 15:15– 15:45		
14:15	Matthew Wray	Investigating Hydrogen-Induced Degradation in Stainless Steels through Electrochemical & Gaseous Charging, Fatigue Testing & 3D Crystallographic Mapping
14:30	Yashi Zheng	Design and Evaluation of fully Sustainable Polymeric Composites for 3D Printing Applications
14:45	Reham Aljedaani	Using Polymer Particles to Increase the Toughness and Stability of Perovskite Solar Cells
15:00	Robbie Clark	Basicity, Aromaticity and Glycolysis: An Exploration of Poly(ethylene terephthalate) Depolymerisation
Break: 15:15– 15:45		
15:45	Ashwaq Alanazi	Using Nanogels to Improve the toughness and Stability of Perovskite solar cells.
16:00	Rawan Alsulami	Influence of heat treatment parameters on secondary phase formation and microstructural evolution in Duplex Stainless Steels
16:15	James Hall	Understanding the materials performance of additive manufactured Ni-base alloy components in high temperature water

16:30	Matthew Williamson	The Influence of Creep on the Initiation of Environmentally Assisted Cracking
16:45	Sydney Coates	Understanding Cold Work Needed for Recrystallization of 316 LPBF Material and its effect on the Material's Performance in PWR Primary Water
17:00	George Livesey	Understanding the Performance of Advanced Gas-Cooled Reactor (AGR) Cladding

Day 2: Oral Presentation Sessions (Thursday 15th May)

Session Theme(s): Coatings & Ceramics and Polymers & Composites		
Thursday 15 th May, 10 – 12.15		
Building/Room: Nancy Rothwell_3A.012		
Chairs:		
David Hall , david.a.hall@manchester.ac.uk		
Chamil Abeykoon , chamil.abeykoon@manchester.ac.uk		
10:00	Peng Tao	Improving the mechanical property of GZO by second phase toughening approach
10:15	Daniel Thomas	Improving the Tetragonality of Yttria Stabilised Zirconia for Thermal Barrier Coatings via Co-Doping
10:30	Jianxi Wen	The development of lead-free potassium bismuth titanate based ferroelectric solid solution
10:45	Yuge Yang	Micromechanical actuation mechanisms in piezoelectric BiFeO ₃ -BaTiO ₃ ceramics
Break: 11.00– 11:15		
11:15	Shuai Zhong	The understanding of toughening mechanisms of high entropy zirconates
11:30	Xiangwei Zhu	Development of Oxidation-resistant Refractory Coating Compositions by High Entropy Approach
11:45	Giulio Mausoleo	pH-responsive silica-based ionic colloidal systems of poly(acrylic acid) water solutions.
12:00	Anirudh Kohli	The Effect of notch geometry on kink band formation

Session Theme(s): Biomaterials and Metallurgy & Corrosion		
Thursday 15 th May, 10am– 12.15		
Building/Room: Nancy Rothwell_3A.016		
Chairs:		
Nicholas Stevens , nicholas.stevens@manchester.ac.uk		
David Champness , david.champness@postgrad.manchester.ac.uk		
Kasey Hatch , kasey.hatch@manchester.ac.uk		
10:00	Lianghui Zhu	The Influence of Impurity Elements on the Corrosion Performance of 6xxx Aluminium Alloys
10:15	Donghuan Yang	Materials for 3D Printed Soft Robotic Phantoms
10:30	Yi-Ching Chen	Investigating the Bioactivity, Degradation Mechanisms, and Structural Properties of Innovamatrix for Chronic Wound Healing
10:45	Yiting Chen	Peptide hydrogels for 3D models of liver regeneration
Break: 11.00– 11:15		
11:15	Lukas Weber	Melt electrowriting of poly-(3-hydroxyalkanoate) scaffolds for rotator cuff repair
11:30	Rachael Tibbitts	Developing a 3D printed skin model to analyse the cellular and epigenetic effects of interleukin-17 inhibitors in psoriasis
11:45	Bhuvaneshwari Anbazhagan	Development of advanced bone biomaterials using cell-derived extracellular matrix and bioactive glasses

12:00	Nayab Raza	Municipal Wastewater as a Resource for Next-Generation Biomaterials: A Circular Bio-Economy
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Session Theme(s): Nano & Functional Materials and Imaging & Characterisation		
Thursday 15 th May, 10am– 12.15		
Building/Room: Nancy Rothwell_3A.029		
Chairs:		
Mohammad Israil Hossain , mohammadisrail.hossain@manchester.ac.uk		
Zeeshan Azam , zeeshan.azam@manchester.ac.uk		
Mia Maric , mia.maric@manchester.ac.uk		
10:00	Debra Bligh-Wall	Graphene based end-effector sensors for teleoperated robotics in extreme environments
10:15	Yang Cao	Nanobody-conjugated graphene based electromechanical biosensors
10:30	Jack Harrison	In situ TEM for understanding of the electrochemical performance of iridium based OER catalysts
10:45	Christian Maddox	Synthesis of Photoluminescent 3 and 4-Metal Sulfide Nanoparticles towards Development of High Entropy Quantum Dots
Break 11:00-11:15		
11:15	Zibo Zhou	Enhancing Electrode Stability via Dual Cation Pre-Intercalation in Vanadium Oxide for Calcium-Ion Battery
11:30	Atut Septiana	High Selectivity 2D-Layered Double Hydroxide Hybrid Membranes for Redox Flow Batteries Application
11:45	Jianbo Xu	Self-assembly of cellulose nanocrystals in geometrical confinement
12:00	Mark Turner	Developing atomic-structural descriptors of the performance of IrOx electrocatalysts

Session Theme(s): Coatings & Ceramics		
Thursday 15 th May, 10:00 – 12:15		
Building/Room: Nancy Rothwell_3A.052		
Chairs:		
Jane Wood , jane.wood-2@manchester.ac.uk		
Daniel Scotsman , daniel.scotson@manchester.ac.uk		
Ahmet Hilmi Paksoy , ahmethilmi.paksoy@manchester.ac.uk		
Break 11:00-11:15		
10:00	Hareem Zubairi	Optimisation of Lead-Free Sodium Bismuth Titanate Ferroelectric Ceramics for Enhanced Energy Discharge Performance and Stability
10:15	Rielle Jensen	Processing of SiC Ceramic Matrix Composites
10:30	Tess Knowles	MXene based functionalisation of ceramic coatings produced by plasma electrolytic oxidation of light alloys
10:45	Chuyang Li	Degradation mechanism of ytterbium based EBCs by CMAS and steam
Break 11:00-11:15		
11:15	Tiantian Liao	Fibrous Silica Sealing Post-treatments for Corrosion Protection of Anodised A1050

11:30	Runqi Liu	Development of ceramic coatings on AZ31 magnesium alloy by the Aerosol Deposition (AD) method
11:45	Finley Lloyd	A Cheap, Simple and Scalable Technique for the Production of Ceramic Coatings
12:00	Xiyue Mao	The Effect of Tungsten-Precursor Addition on the Thermoelectric Properties of Nbdoped SrTiO ₃ Ceramics

HELLO TOMORROW

Faculty of Science and Engineering

POSTGRADUATE RESEARCH

Presentation Abstracts

Model Development for Localized External Corrosion of Buried Pipelines

Name: Saleh Al Awadh

Email: saleh.alawadh@postgrad.manchester.ac.uk

Research Theme: Metallurgy and Corrosion;

Year of Study (Presentation Type): Year 2 (Presentation)

Abstract body text; Times New Roman, Size 12; Left Justified; Max. 200 words; No figures or tables to be included.

Corrosion is big challenge that affects everything from government infrastructure and industrial facilities to private property. For buried pipelines in particular it can lead to environmental contamination, down time and extensive repair costs. Industry data shows that for transmission pipelines, external corrosion far more prevalent than internal corrosion. Additionally, uniform corrosion is essentially a non-factor when it comes to buried pipelines. It is localized corrosion that causes failures. The main mechanism driving localized corrosion in soil is differential aeration where one part of the pipeline has a higher oxygen concentration than an adjacent part. Although there have been many attempts to model corrosion by industry and academia, external corrosion was largely overlooked in favor of more aggressive environments. Therefore, this project aims to build a model capable of predicting the external corrosion behavior of buried pipelines using information about the external environment (soil). The presentation will cover an update to my progress so far including an overview of the experimental approach and recent results.

Examining the combined effects of irradiation and microsegregation on the microstructure and mechanical properties of low alloy steel welds

Name: Miles Cooke

Email: miles.cooke@postgrad.manchester.ac.uk

Research Theme: Metallurgy and Corrosion;

Year of Study (Presentation Type): Year 2 (Talk)

Changes to the design of pressure water reactor pressure vessels (RPVs) could see a switch to SA508 Grade 4N low alloy steel, as well as changing the welding method to electron beam welding (EBW). This welding method induces changes to the microstructure and properties of SA508 Grade 4N steel. Notably, microsegregation has been identified in the as-welded fusion zone.

When exposed to radiation, RPV steel undergoes an increase in hardness and becomes more brittle. This occurs due to the formation of precipitates and grain boundary segregation. It is understood that the composition of the steel influences the response to radiation, including grain boundary segregation and precipitate formation. As the EBW fusion zone exhibits a variation in composition due to microsegregation, it is hypothesised that regions of solute enrichment will show greater precipitation and grain boundary segregation, and therefore worse hardening and embrittlement.

Three heat treatment cases have been performed on the EBW SA508 Grade 4N, these treated EBWs have been proton irradiated and shall be compared with their non-irradiated forms in future. This is planned to be done by nano-indentation and TEM. The definitive aim is to attempt to identify the optimal heat treatment required for EBW SA508 Grade 4N.

Lead in Drinking Water: Understanding Scale Evolution

Name : Avijit Das

Email : avijit.das@postgrad.manchester.ac.uk

Research Theme : Metallurgy and Corrosion

Year of Study : Year 2 (Talk)

The lead burden on human health is of ongoing global concern as according to WHO, lead is considered one of the ten topmost chemical hazards. Lead in drinking water is mainly due to the degradation of lead-based water networks caused by general and/or galvanic corrosion.

Typically, these networks are made of galvanized wrought iron and steel, lead, and copper together with brass joints. This research aims to develop a predictive framework of lead solubility in water based on the electrochemistry of scale formation and dissolution.

Accordingly, the objectives are (i) formation of scales to understand the release of dissolved lead in a reference drinking water system (ii) prediction of plumbosolvency and its routes, and (iii) elucidating the structure and chemistry of the scales. Towards this end, the first-year research progress summary includes (i) the development of scales in a reference drinking water (ii) initial characterisation of scales developed in the reference drinking water with the help of SEM, XRD, and XPS, and (iv) an initial understanding of the evolution of the Pb scales formed over a period of 70 days. Finally, lead solubility modelling in the reference drinking water was also done using the aqueous geochemical software PHREEQC.

Talk title: Structural controls on critical mineral mobilisation and fluid flow within the Cornubian Batholith: Insights from the Cligga Head Granite, Cornwall

Name: Andrew Evans

Email: Andrew.evans-5@postgrad.manchester.ac.uk

Research Theme: I don't fit into any research theme. The closest would be **Metallurgy and Corrosion**

Year of Study: Year 2 – Oral presentation

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The transition towards green technologies has led to a substantial increase in demand for several resources, including lithium (Li). Li demand is projected to exceed supply within the next ten years, and although new deposit types (e.g. sedimentary hosted) are being explored, extraction of Li from unconventional sources need to be considered. With rising Li costs, and the requirement for securing Li resources for geopolitical security, countries are exploring domestic Li potential.

The Cornubian granite batholith has the highest Li concentration in the UK, in addition to other critical mineral potential. To ensure sustainable extraction from brines associated with the Cornubian Batholith, determining the effect of fluid flow within crystalline granites is crucial to understanding the impact of geothermal fluid extraction.

Field fracture analysis of the Cligga Head granite has allowed me to develop a temporal model for the evolution of fractures and veins observed in the exposed granite. Furthermore, these observed fracture trends align with regional scale lineations providing valuable insights into broader regional fluid flow dynamics.

The following work will examine permeability and conductivity in granite types, as well as investigating lithium leaching from silicate phases under natural conditions—both critical to the long-term viability of lithium-brine extraction.

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Word count: 200/200

Corrosion Inhibition by DDTMAC: Impact on Siderite Scale Formation in Oil and Gas Pipelines

Chijioke Godwins

Chijioke.godwins@manchester.ac.uk

Metallurgy and Corrosion

Year 2

This research explores the efficacy of dodecyldimethylammonium chloride (DDTMAC) as a corrosion inhibitor in both strong acids (hydrochloric acid, HCl, and sulfuric acid, H₂SO₄) and weak acids (bicarbonate, HCO₃⁻, and acetic acid, CH₃COOH). By comparing DDTMAC's inhibition performance across various acidic environments, the study aims to optimise its application in industrial systems. Electrochemical techniques such as Linear Polarisation Resistance (LPR), Potentiodynamic Polarisation (PDP), and Open Circuit Potential (OCP) were employed to evaluate its protective capabilities on carbon steel. Additionally, the critical micelle concentration (CMC) of DDTMAC was determined to understand its surface activity, and X-ray Photoelectron Spectroscopy (XPS) was used to probe the adsorption behaviour and elucidate the molecular-level mechanisms underpinning its protective action at different acid concentrations. This study was sponsored by the **Petroleum Technology Development Fund (PTDF)** of Nigeria.

**A phase-field approach to understanding the development of
abnormally coarse grain structures during β -annealing of
Ti-64: The sequel**

Name: Aiden Ha

Email: aiden.ha@postgrad.manchester.ac.uk

Research Theme: Select one of the following and delete the rest:

[Metallurgy and Corrosion;](#)

Year of Study (Presentation Type): [Year 2 \(Talk\),](#)

Recent phase-field simulations were used to investigate the growth-reversal behaviour that occurs during β -annealing of hot-rolled Ti-6Al-4V: highly misorientated γ -fibre grains first expand discontinuously inside a rotated-cube sub-grain matrix, then get consumed as that sub-grain matrix coarsens. Here we extend the model to the “Goldilocks” grains which are misorientated 20–30 ° away from the rotated-cube texture. Unlike γ -fibre grains, Goldilocks grains continue to coarsen discontinuously, producing abnormally coarse grains (ACGs) near the mid-plane of wrought products, which may undermine mechanical performance and service life.

Discontinuous grain growth for FCC structures was described by Humphreys mean field model through ratios of boundary energy, mobility and grain size. However, our phase-field model for BCC titanium assigns boundary properties directly from misorientation-dependent energy and mobility curves. These functions have been calibrated so that Goldilocks grains may continue to grow, while γ -fibre grains still undergo the previously observed texture reversal.

In addition, thermomechanically processed alloys often develop clusters of similarly oriented grains, which is believed to enhance the survival and growth of Goldilocks grains by conferring an initial size advantage. To examine this, we generate orientation clusters in our microstructural realisations using a Markov-chain Monte-Carlo (MCMC) algorithm and track their influence on subsequent texture evolution.

Graphene Nanocomposite Coatings

Name: Kaige Liu

Email: Kaige.liu@postgrad.manchester.ac.uk

Research Theme: Metallurgy and Corrosion

Year of Study (Presentation Type): Year 2 (Talk)

Recently there have been many reports in the field of graphene nanocomposite coatings, predominantly focused on approaches to improve the dispersion of graphene and thus the corrosion protection performance of composite coatings. There are, however, few studies examining the influence of other key factors, such as the size, shape and loading of nanofillers, and moreover, there is a lack of in-depth research on the protection mechanism of composite coatings. This project designed a series of experiments based on this research gap and selected a two-component water-based epoxy coating provided by Allnex as the polymer matrix. In the first year of research, it was found that the curing conditions had a significant impact on the corrosion protection properties of the epoxy coating. Coatings prepared under higher humidity and temperature seemed to have better corrosion protection performance, which may be attributed to the better cross-linking reaction conditions provided under high humidity and high temperature.

Microstructurally Informed Modelling of Fragmentation of Metals

Name: Szymon Ochenkowski

Email: szymon.ochenkowski@postgrad.manchester.ac.uk

Research Theme: Metallurgy and Corrosion

Year of Study (Presentation Type): Year 2 (Talk)

The effects of energetic events such as blast, impact, and explosion are frequently reported in current conflicts. Costly and time-consuming trial and error experiments are conducted to understand the performance potential of these threats. However, due to cost and availability, conclusions must be made using a limited dataset, which does not cater for the variability caused by differences in micro/macro-scale properties or threat manufacture. Modelling and Simulation plays a key role in predicting how materials will respond to these dynamic events. However, although sophisticated, such models generally rely on simple empirical descriptions of material behaviour that do not account for material variability. This inevitably requires assuming a worst-case scenario and introducing empirical safety factors, leading to underutilisation of materials and/or over-engineering of structures. This project will incorporate the material behaviour in a physical way, which accounts for inherent material variation, allowing statistical predictions and removes the limitations previously discussed.

Investigating the Heat Treatment of WAAM'd 300M Landing-gear Steel

Name: Zichao Zhu

Email: zichao.zhu@postgrad.manchester.ac.uk

Research Theme: [Metallurgy and Corrosion](#).

Year of Study (Presentation Type): [Year 2 \(Presentation\)](#)

300M steel is a kind of landing gear steel that has received a lot of attention because of its good mechanical properties. However, its application is limited by the fact that it is difficult to process, and the process is environmentally unfavourable due to the waste of resources. WAAM is a processing method that has the potential to solve these problems. Therefore, in this research, hot forged 300M steel and WAAM'd 300M steel were selected and they were subjected to conventional heat treatment (austenitising-quenching-tempering) to investigate the effect of the WAAM process on the 300M steel, including the mechanical properties (such as hardness, toughness), as well as the microstructure. Dilatometry is being used to investigate the effect of different cooling rates in quenching (after 870°C 1h austenitizing) on the microstructure of forged and WAAM'd 300M steel. CCT diagram of forged and WAAM'd 300M steel were also prepared based on the change in sample length during austenitizing and quenching.

Corrosion of Stainless Steel in HCl containing Vapour Environments

Burcu Eroglu¹, Ben Clowes², Dirk Engelberg¹

*1 Metallurgy & Corrosion, Department of Materials, The University of Manchester,
Manchester, M13 9PL, United Kingdom*

2 Sellafield Ltd., Sellafield, Seascale, CA20 1PG, United Kingdom

Nested type 316L austenitic stainless-steel cans are used for the storage of a range of nuclear products. The internal environment of the nested can design features low oxygen concentrations (<10 ppm) and low relative humidity (<10% RH) where corrosion is unlikely, yet reaching elevated service temperatures (80–100°C) and potential chloride contamination in the form of HCl vapour, originating from thermal decomposition of PVC packaging material. This condition might cause localized corrosion (pitting) or stress corrosion cracking (SCC) to occur. This project, therefore, investigates the corrosion behaviour of type 316L stainless steel in HCl-containing vapour environments as a function of oxygen concentrations and controlled RH to predict the lifetime of storage cans. A custom experimental setup was designed to enable the control of oxygen concentration and continuous monitoring of relative humidity (RH), with oxygen levels regulated through nitrogen gas purging of the exposure cell. After HCl exposure, all surfaces were characterised by XRD. The effect of oxygen in forming corrosion products in this set-up will be discussed. To assess the nature of the surface film, potentiodynamic polarization tests of type 316L stainless steel were conducted in HCl electrolyte using localized electrochemical scanning techniques, complemented by correlative Scanning Kelvin Probe Force Microscopy (SKPFM) measurements.

Email: burcu.eroglu@postgrad.manchester.ac.uk

Research Theme: Metallurgy and Corrosion

Year of Study (Presentation Type): Year 2 (Talk)

A Study on dual-responsive physical gel and its drug release performance for injection application

Xiaojing Gu

Xiaojing.gu@manchester.ac.uk

Polymers and Composites

Year 2 (Talk)

Stimuli-responsive microgels (MGs) form physical gels when the MGs are swollen and there is insufficient space for the particles to move past one another. Traditionally, such gels are composed of a single type of microgel. In this study, we blend a pH-responsive MG (poly(ethylacrylate-co-methacrylic acid-co-divinylbenzene) (PEA-MAA-DVB) with a temperature-responsive MG (poly(N-isopropylacrylamide-co-methylene-bis-acrylamide) (PNP-BIS) to form physical gels that are both pH- and temperature-responsive. We will investigate the morphology and rheological properties of the mixed MG gels. The PEA-MAA-DVB MG swelling dominates the gel-forming behavior. We will also investigate the ability to release a model drug and study the effect of temperature. Finally, we will investigate the potential for the mixed gel to provide a new type of injectable gel for future use in intervertebral disc repair.

Abstract Template:

Carbon negative polymers in automotive applications

Name: Dominic Harris-Jukes

Email: dominic.harris-jukes@postgrad.manchester.ac.uk

Research Theme: Select one of the following and delete the rest:

[Polymers and Composites.](#)

Year of Study (Presentation Type): Select one of the following and delete the rest: [Year 2 \(Talk\)](#)

Abstract body text;

Plastics are ubiquitous in the modern era, permeating all elements of modern life, from electronics to skincare and cosmetics. For certain industries, e.g., automotive, the advent of engineering plastics has enabled manufacturers to reduce production costs, vehicle weight, and therefore improve vehicle efficiency. However, these automotive plastics are almost entirely petrochemically derived with limited end-of-life (EoL) options, contributing to the pervasiveness of plastic waste that's had a profound effect on our modern landscape, and contributing to broader climate change. To address this, in collaboration with Polestar, this project aims to identify functional carbon negative or low-carbon alternatives to the most common automotive grade plastic, talc-filled polypropylene (TF-PP). This will be achieved, either through identifying appropriate alternative polymer matrices to Polypropylene (PP), or through identifying alternatives to the talc filler. This talk will discuss the work focused on improving the processability of the most common polyhydroxyalkanoate (PHA), polyhydroxybutyrate (PHB), a promising biodegradable biopolymer synthesised from microorganisms. The aim of this work is to identify suitable additives to mitigate against processing induced degradation and damage, to ensure that the promise of the pristine material can be maintained through the processing necessary to create an automotive part.

Title: Development of UV-Curable Green Polymeric Materials-Based Biocomposite Structures

Name: Md Arif Mahmud

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Research Theme: Select one of the following and delete the rest: [Polymers and Composites](#).

Year of Study (Presentation Type): Select one of the following and delete the rest: [Year 2 \(Talk\)](#)

Abstract:

Green polymers are specified as eco-friendly polymers, which are generally bio-derived. These polymers are being preferred for improving sustainability and reducing the toxicity of different petrochemical-based products. On the other hand, photocuring is known as one of the most eco-friendly production processes because of the use of minimal energy, but due to the lack of photocurable green polymers, photocured materials are often considered toxic from different points of view. This research work is focused on developing composite structures based on green polymers, including different polysaccharides and proteins, combined with other green polymers, along with minimal quantities of the least toxic photosensitive polymers, as the final products are expected to have various applications. Results of physical and mechanical tests have shown that low-strength, while flexible, green polymeric materials-based biocomposite structures can be developed using combinations of polymers, and the developed resin can have different applications based on the requirements of the final products.

Microstructural engineering of protective coatings for prolonged lifetime

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Research Theme: Coating and Ceramics;

Year of Study (Presentation Type): Year 2 (Talk)

The aim of this study is to develop durable ceramic thermal barrier coatings (TBCs). Current advanced TBCs are made of either yttria stabilized zirconia (YSZ) or gadolinium zirconate (Gd_2ZrO_7). However, YSZ is vulnerable to attack from calcia–magnesia–alumina–silicate (CMAS) in dusty environments and Gd_2ZrO_7 has low fracture toughness. To overcome these problems, we propose a novel core-shell coating structure in which each microstructural unit comprises a tough, CMAS-resistant shell and a YSZ or Gd_2ZrO_7 core. $GdAlO_3$ is selected as the shell material due to its high melting point, phase stability, fracture toughness and strong CMAS resistance. The core-shell structure is expected to improve the CMAS resistance of YSZ and fracture toughness of Gd_2ZrO_7 , thereby achieving long coating lifespan. The core-shell coating will be realized by first synthesizing core-shell powder using the sol-gel method and then translating the core-shell structure from powder to coating by thermal spray. The CMAS resistance, fracture toughness, thermal stability and lifetime of the core-shell will be tested to validate the microstructural design.

Abstract Template:

Thermally responsive colourimetric sensors made from cellulose/polymer hybrids

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Research Theme: Polymers and Composites.

Year of Study (Presentation Type): Year 2 (Talk)

Abstract: Self-assembled block copolymers (BCPs) are useful platforms for developing biologically compatible materials and nanocomposites. Cellulose nanocrystals (CNCs), extracted from widely abundant biomaterials, exhibit structural colouration through self-assembly in the chiral nematic (cholesteric) liquid crystal phase. This imparts vivid iridescent colours as seen in *pollia condensata* berries (Viglolini et al 2012) with stimuli responsiveness in the solution phase. Colouration through structural mechanisms shows great potential in the food and pharmaceutical industries due to its unique dye-free optical properties (Dumanli et al, 2016). Inspired by naturally photonic materials, this work seeks to fabricate and explore structurally colour-shifting nanocomposite materials using a CNC derivative, self-assembled in the cholesteric phase immersed in a self-assembled physical gel.

The current work successfully combines self-assembled block copolymer nano-objects (synthesized *via* reversible addition fragmentation chain transfer polymerisation induced self-assembly (RAFT PISA)) with hydroxypropyl cellulose (HPC) to create a library of structurally coloured, hybrid gels with tunable mechanical properties and colouration. The gels exhibit pressure and temperature responsiveness, with the BCP component enhancing the mechanical strength without affecting the self-assembly process responsible for structural colouration. Ongoing investigations aim to optimise the hue and explore the temperature-induced colour-shifting capabilities, with potential compatibility with 3D printing for scalable commercial applications.

Metrology and Mixing in Plastics Recycling

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Research Theme: Polymers and Composites.

Year of Study (Presentation Type): Year 2 (Talk)

The increasing demand for plastic products has generated unprecedented amounts of plastic waste. A significant proportion of plastic waste is landfilled, carrying both short and long term physical and chemical risks. To reduce the impact of plastic waste, recycling has emerged as an effective tool to recover waste and lower demand for unsustainable virgin plastics production. Recent recycled content (RC) legislation implemented across the UK, EU and the US has given further precedence for the incorporation of plastic waste in new materials. However, both the metrology and the mixing mechanisms of RC with virgin grade plastic is understudied, despite both being necessary to prevent greenwashing whilst improving performances of recycled materials. This Hyundai funded project first aims to study metrology in recycling by quantifying RC in automotive plastics using 4,4'-bis(2-benzoxazolyl) stilbene (BBS), a fluorescent tag that exhibits distinct fluorescence patterns above threshold concentrations. Subsequently, this project aims to study mixing in plastics recycling by using the variability in fluorescence response of BBS after mechanical recycling in different conditions and with different materials. By understanding how RC mixes and is measured, the use of plastic waste can be incentivised to promote an authentically circular future.

Pyrene-functional multiblock copolymers prepared by sequential RAFT aqueous emulsion polymerisation

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Abstract

RAFT aqueous emulsion polymerization is an effective method for creating high molecular weight multiblock copolymer nanoparticles in water¹. This process allows for low initiator concentrations and uses water-immiscible monomers which polymerise from a RAFT agent-capped water-soluble precursor within swollen micelles. This strategy provides a low viscosity route to high-molecular-weight multiblock copolymers, which may function as thermoplastic elastomer² (TPE) materials. Recently, pyrene R-functional RAFT agents were prepared and demonstrated to successfully allow the synthesis of well-defined water-soluble polymers which acted as effective dispersing agents for graphene nanoplatelets and improved their compatibility with a water-based film-forming latex formulation³. In this work, this pyrene-functional RAFT agent was used during the preparation of tetrablock copolymer nanoparticles via RAFT aqueous emulsion polymerization. Initially, pyrene-end functional and non-functionalised, water soluble, macromolecular chain-transfer agents were prepared. These were subsequently used in binary mixtures to form pyrene-decorated tetrablock copolymer nanoparticles by sequential monomer addition of two hydrophobic methacrylate monomers. The resulting polymer nanoparticles had narrow size distributions, with excellent block control and high monomer conversions. Thus, these pyrene-decorated nanoparticles are being investigated as promising materials for the preparation of a novel nanocomposite TPEs.

(1) Clothier, G. K. K.; Guimarães, T. R.; Thompson, S. W.; Howard, S. C.; Muir, B. W.; Moad, G.; Zetterlund, P. B. *Streamlining the Generation of Advanced Polymer Materials Through the Marriage of Automation and Multiblock Copolymer Synthesis in Emulsion*. John Wiley and Sons Inc: 2024.

(2) Grady, B. P.; Cooper, S. L.; Robertson, C. G. *Thermoplastic Elastomers*. Elsevier: 2013; pp 591-652.

(3) Li, X.; Jamali, M.; Fielding, L. A. *Pyrene-functionalized poly(methacrylic acid) acts as an efficient stabilizer for graphene nanoplatelets and facilitates their use in waterborne latex formulations*. Academic Press Inc.: 2024; Vol. 676, pp 396-407.

Title: Graphene-enhanced Polypropylene Sustainable Composites for mechanical and electrically conductive monofilament and multifilament Applications.

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Research Theme: Polymers and Composites.

Year of Study (Presentation Type): Year 2 (Presentation).

The paper discusses the development of polypropylene monofilament and multi filament composites by incorporating graphene nano platelets (GNP) into polypropylene (PP) to enhance mechanical, electrical conductivity properties. Specifically, the aim is to address the limitations in mechanical strength and electrical conductivity typically associated with thermoplastic composites. While the addition of 1wt. % GNP is typically targeted for improving mechanical properties, while supporting cost-effectiveness, the addition rate of the GNP for electrical conductivity will be within a range of 1wt.% to 10 wt.%.

The production process involves preparing PP/GNP fibres through melt compounding followed by spinning processes. The melt spinning process used to align the GNP within the material, promotes in-plane orientation of GNP, which enhances mechanical and electrical properties.

The research will show that incorporating graphene platelets into polypropylene via melt spinning significantly enhances the mechanical and electrical properties of filament composites. This approach holds promise for creating lightweight and easily recyclable composites with improved mechanical and electrical properties, suitable for various applications, such as safety clothing, aerospace, defence, automotive and space.

Abstract Template:

Uncovering the Impacts of Realistic Nanoplastics

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Research Theme: Polymers and Composites

Year of Study (Presentation Type): Y2 Talk

Nanoplastics, particles of plastics formed through degradation, measuring less than 1000 nm are potentially a larger environmental concern of plastic pollution with profound implications. Prior research suggests that nanoplastics could potentially cross cell membranes due to their small diameters. This area of research is, however, still in its early stages, with most nanoplastics research being dominated by polystyrene nanoparticles made using bottom-up methods. Our research will address this by producing various types of nanoplastic using both bottom-up and top-down methods.

Additionally, due to their small size, nanoplastics are difficult to identify and analyse as most instruments do not have the resolution. Additionally, the presence of other organic colloidal matter in samples can make it very challenging to characterize nanoplastics within a complex media due to aggregation effects, asymmetric flow field flow fractionation will be used to tackle this.

This research will explore the production of nanoplastics and investigate how their exposure to environmental media affects their colloidal stability – enabled using asymmetric flow field flow fractionation to separate and characterise the particles and determine factors that influence aggregation behaviour. Our research will also investigate the toxicity of aged nanoplastics in various field water samples on *Daphnia magna*.

Synthesis of pH responsive amphiphilic copolymer nanoparticles which have adjustable blue light fluorescence by polymerisation-induced self-assembly

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Research Theme: Polymers and Composites

Year of Study (Presentation Type): Year 2 (Talk)

Nano luminescent materials have various excellent features such as, strong light emission intensity, narrow emission wavelength range, high energy conversion and fast response. Recently, many researchers are attempting to offer these shining materials with different functions like bio-imaging, OLEDs, nano sensing and photodynamic therapy via corresponding polymer nanoparticle platforms.

However, organic fluorescent dyes usually spontaneously aggregate into blocks in aqueous environments due to their intrinsic hydrophobicity, that makes it difficult to control the dispersion and affects fluorescent efficiency. Consequently, the utilisation of amphiphilic polymers to stabilise organic dyes in aqueous environments becomes a significant trend in the development of fluorescent materials.

The incorporation of aggregation-induced emission (AIE) motifs into Polymerisation-induced self-assembly (PISA) -derived nanoparticles and subsequent characterisation is the main aim of this PhD project.

The project plans to use 3-sulfopropyl methylate potassium salt (KSPMA) to synthesise PKSPMA macro-CTA through RAFT solution polymerisation. 4-(1,2,2-triphenylvinyl)phenyl methylate, a polymerisable AIE molecule will be synthesised. Subsequently, methacrylic acid (MAA), benzyl methylate (BzMA), and 4-(1,2,2-triphenylvinyl)phenyl methylate will be copolymerised with PKSPMA macro-CTA to form block copolymer nanogels with blue light emission. These nanoparticles are expected to exhibit different morphological, mechanical, and optical characteristics depending on parameters such as copolymer composition and pH.

Extraction of Tritium from the Molten Salt FLiBe

Name: Alexander Beale,

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Research Theme: [Imaging and Characterisation](#)

Year of Study (Presentation Type): [Year 2 \(Talk\)](#)

The extraction of hydrogen isotopes (Q) from the breeder blanket is essential for sustaining fusion reactions in fusion power devices. The technology to efficiently extract and harvest Q can vary depending on the breeder blanket design and breeder selection. This study aims to determine how viable Permeator Against Vacuum (PAV) extraction technology is with the breeder blanket candidate breeder material FLiBe, a fluoride molten salt. The PAV extraction method was chosen to compare to other typical methods of Q extraction, such as the sweep gas method, as it functions as a one-step, fully continuous procedure.

Here, a literature review was conducted to identify the transport properties of Q in different permeator window materials to identify the most suitable window material and investigate how properties such as grain size, defect microstructure, and topography of these materials impact the extraction of tritium. The selected materials for the permeation window are nickel and niobium. They are planned to be exposed to FLiBe to identify how Q permeation could change within the operational environment before being deployed in an active FLiBe PAV system.

Machine Learning and Electron Microscopy: Integrating Techniques to Enhance Understanding of Alkaline Electrolysers

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Research Theme: Imaging and Characterisation

Year of Study (Presentation Type): Year 2 (Talk)

Abstract

Machine learning methods used in electron microscopy often rely on large, manually annotated datasets, making preprocessing a time-consuming task in the dataset preprocessing. This dependency, combined with the lack of model generalization across images with different materials, resolutions, magnifications, and object types, represents a research gap. Existing models typically struggle to maintain high accuracy when deployed on large-scale datasets, with thousands of images, due to human errors propagation after the trained model is applied to analyse new images. To address these limitations, I propose a hybrid approach that combines two complementary methods that reduce human labour in dataset preprocessing while enhancing model generalisation. This approach enables object detection, such as nanoparticles, in different kinds of microscopy images, like HAADF (High-Angle Annular Dark-Field) and BF (Bright-Field) images, with high accuracy. Additionally, I introduce a segmentation pipeline that eliminates reliance on manual annotations, consequently minimising human error and improving the robustness of object delineation. My results demonstrate that this integrated strategy improves the scalability and reliability of automated analysis in electron microscopy workflows.

Understanding the Anisotropic High-Cycle Fatigue of AlSi10Mg Produced by LPBF

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Research Theme: Imaging and Characterisation

Year of Study: Year 2 (Talk)

Abstract: Laser Powder Bed Fusion (LPBF) is a widely researched additive-manufacturing technique renowned for its ability to produce high-precision metallic parts with excellent material efficiency and controlled emissions. However, the complex microstructure and the spatial distribution of defects inherent to LPBF remain active areas of investigation, as a deeper understanding of these features is essential for optimizing processing parameters and improving component performance. In this study, high-cycle fatigue (HCF) behaviour of LPBF-fabricated AlSi10Mg alloy, comparing specimens built perpendicular and parallel to the build direction (BD) were examined. Fatigue cracks predominantly initiate at near-surface defects, which tend to align closely with melt-pool boundaries (MPBs). Although crack-propagation lifetimes were similar for both build orientations, the initiation lifetimes differed significantly. Back-scattered electron and X-ray Imaging (BEX) and electron back-scatter diffraction (EBSD) used to correlate local elemental distributions and grain structure with crack-initiation behaviour. Short, sub-surface cracks were further characterized by X-ray computed tomography (CT) to examine the geometry and position of the crack. Three-dimensional EBSD revealed that local microstructural features at the melt-pool boundaries govern the transition between trans granular and intergranular fracture modes. This study highlights the influence of MPB alignment on the anisotropic fatigue performance of LPBF AlSi10Mg.

Reference:

1. Wu, Z., Wu, S., Kruzic, J.J., Hu, Y., Yu, H., Zhang, X., Li, X., Wang, Q., Kang, G. and Withers, P.J. (2024). Critical damage events of 3D printed AlSi10Mg alloy via in situ synchrotron X-ray tomography. *Acta Materialia*, 282, pp.120464–120464. doi:<https://doi.org/10.1016/j.actamat.2024.120464>.
2. Żaba, K., Snopiński, P., Wałach, D., Kaczmarczyk, G.P. and Rusz, S. (2024). Insight into the fracture behaviour and mechanical response of ECAP processed cast and LPBF AlSi10Mg alloy. *Engineering Fracture Mechanics*, 295, p.109785. doi:<https://doi.org/10.1016/j.engfracmech.2023.109785>.
3. Wu, Z., Wu, S., Bao, J., Qian, W., Karabal, S., Sun, W. and Withers, P.J. (2021). The effect of defect population on the anisotropic fatigue resistance of AlSi10Mg alloy fabricated by laser powder bed fusion. *International Journal of Fatigue*, 151, p.106317. doi:<https://doi.org/10.1016/j.ijfatigue.2021.106317>.

4. S Rangaraj, Ahmed, S.S.I., Davis, A., Withers, P.J. and A Gholinia (2024). Understanding fatigue crack propagation pathways in Additively Manufactured AlSi10Mg. *IOP Conference Series Materials Science and Engineering*, 1310(1), pp.012025–012025. doi:<https://doi.org/10.1088/1757-899x/1310/1/012025>.

Understanding the Behaviours and Factors Influencing Detritiation During Thermal Treatment of Materials

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Research Theme: Select one of the following and delete the rest:

[Imaging and Characterisation;](#)

Year of Study (Presentation Type): Select one of the following and delete the rest: [Year 2 \(Talk\)](#)

Understanding the key factors influencing the detritiation of hydrogen isotopes—deuterium and tritium—from tungsten, a key plasma-facing material (PFM) in fusion devices exposed to high-flux fuel environments is critical to safe disposal of waste. Improving this waste process will enable more cost-effective tritium removal, support the recovery of tritium—a scarce and expensive fuel—and allow for the waste reclassification of tungsten components, thereby reducing disposal costs. In the first year, the work focused on understanding hydrogen isotope behavior in tungsten, emphasizing on retention and permeation mechanisms. Key parameters such as microstructure and temperature were identified as critical in influencing detritiation efficiency. Ongoing collaborative work will examine deuterium, used as a non-radioactive analogue for tritium, retention in irradiated tungsten using two distinct plasma exposure techniques. These samples will be analyzed using thermal desorption spectroscopy (TDS) to evaluate deuterium release kinetics and gain insight into trapping and detrapping behavior. Future work will extend this study to tungsten–rhenium and tungsten–rhenium–osmium alloys, which are relevant to fusion environments due to the formation of rhenium and osmium as neutron-induced transmutation products.

The use of advanced electron microscopy to explore the early stages of precipitate evolution in Cu-Cr-Zr alloys

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Research Theme: [Imaging and Characterisation](#)

Year of Study (Presentation Type): [Year 2 \(Talk\)](#)

Cu-Cr-Zr alloy due to its superior thermal and electrical conductivity is chosen to use in the next generation of fusion reactor. Age hardening can improve its mechanical properties. The crystal structure of second phase precipitate changes during the ageing process.

This study reports the findings of advanced electron microscopy methods on both the microstructure as well as the larger scale dislocation structures occurring in the material. Working out the GND density through SEM-EBSD reveals the dislocation structure and the results show evenly distributed in the energy map. The microstructure analysis is carried out by TEM. STEM-EDS indicates the distributed fine Cr-rich particles (< 5nm) and the relatively large Zr content concentrated. 4D-STEM can provide a VDF image together with the diffraction patterns acquired from each STEM probe position. In specific diffraction patterns, repeated superstructure occurred between sublattices and superlattices.

Some published works have reported the ageing sequence of Cu-Cr-Zr alloys, but the description of precipitate evolution is inconsistent, where this study will provide a deeper understanding of its early stages.

Towards Inline Defect Detection of Pultruded CFRP Composites: A comparative X-Ray Imaging study between Cone-beam X-ray micro-CT and Digital Tomosynthesis

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Research Theme: Imaging and Characterisation/Polymers and Composite

Year of Study (Presentation Type): Year 2 (Talk)

Keywords: In-line defect detection, real-time imaging, fuzz ball, bad-splicing, peel-ply welding, X-ray micro-computed tomography (XCT), digital tomosynthesis, carbon fibre reinforced polymer (CFRP), region of interest (ROI) scan, non-destructive testing (NDT)

Abstract: Wind energy constitutes a significant strategy for greenhouse gas emission reduction. Carbon fibre reinforced polymer composites are critical for efficient turbine blade manufacturing, necessitating stringent quality control as internal defects may initiate catastrophic structural failures resulting in safety hazards and economic losses. This research evaluates digital tomosynthesis as a non-destructive testing methodology for CFRP manufacturing. Compared to conventional X-ray computed tomography, tomosynthesis offers faster three-dimensional visualization with a low-dose X-ray beam, making its inline integration in production environments feasible. The investigation assessed three types of anomaly prevalent in CFRP (bad-splicing, fuzz-ball formation, and peel-ply welding) to evaluate both imaging modalities' efficacy in characterizing meso- and macro-scale structural discontinuities. Optimal visualization with tomosynthesis was realized when defects were positioned at the focal plane. This depth-resolved imaging technique demonstrates superior capabilities versus camera-based surface inspection methods and presents significant potential for integration with artificial intelligence algorithms for automated defect detection on a near real-time basis. High-resolution conventional XCT data which helped establish definitive characterization of defect morphology and probable failure mechanisms can be complementarily used as training datasets for machine learning models to enable inline real-time defect detection with reduced radiographic sampling. (*word count=190/200*)

A Near-Atomic-Scale Study of the Microstructure and Mechanical Properties of Tungsten and Tungsten-based Alloys

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Research Theme: Imaging and Characterisation

Year of Study (Presentation Type): Year 2 (Talk)

Tungsten is the primary candidate for plasma-facing-materials in a fusion power device due to tungsten's exceptional properties. However, their mechanical properties including ductility and fracture toughness, severely degrade under the extreme conditions experienced. Tungsten alloys represent a potential solution: W-K alloy, demonstrates high thermal shock resistance and fracture toughness, whereas nanoengineered W-Ti-Cr alloy offers improved thermomechanical properties and higher resistance to detrimental surface morphology evolution. This study aims to characterise the mechanical properties of tungsten and tungsten-based alloys focussing on grain boundary behaviour, dislocation motion and pile-up under tensile testing. Testing was conducted in-situ of a scanning electron microscope combined with Electron Backscatter Diffraction to observe deformation. High-Resolution Digital-Image-Correlation allowed for the measurement of full-field surface deformations and strains at the nanoscale providing insight into atomistic behaviour during deformation. The results will be discussed with relevance to understanding the deformation behaviour of tungsten alloys under these conditions, predicting and mitigating potential failures during operations, thus enabling of development of new alloys and predictive models thereby enhancing the reliability of W-based materials for future reactors.

Understanding Tritium Behaviour in Plasma-Facing Materials for Nuclear Fusion Applications

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Research Theme: Imaging and Characterisation

Year of Study (Presentation Type): Year 2 (Oral Presentation)

The generation of clean electricity through nuclear fusion is reliant on the fusion of deuterium and tritium, both isotopes of hydrogen. A critical knowledge gap exists in understanding how tritium is retained in materials, and the mechanism surrounding its behaviour in trap sites, particularly regarding those that are induced by low-energy radiation damage. This understanding is critical for predicting and managing fuel retention in fusion reactors, which has both safety and economic implications. This PhD aims to investigate the relationship between surface morphology changes of Eurofer-97 & Grade-91 SS exposed to low-energy deuterium and tritium plasma, near-surface trapping sites and deuterium/tritium retention, as well as any influence of the isotope effect on the morphology changes and trapping. Microstructural and topological characterization was performed on a Grade-91 stainless steel specimen before and after an experimental 'dry run' to verify that any observed changes in surface topology and microstructure could be attributed exclusively to ion implantation/plasma exposure. Additionally, experimental conditions from literature performing similar experiments have been collected to aid the design of initial plasma exposures using the DELPHI-II system.

The role of emotional contagion in consumer interactions with generative AI chatbots

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Research Theme: Fashion Management and Marketing

Year of Study (Presentation Type): Year 2 (Talk)

With the rapid advancement of generative AI chatbot (Gen AI chatbot) technology, which could understand complex human dialogues and communicate naturally, it is being widely used in various consumer scenarios. In particular, the fashion industry increasingly leverages Gen AI chatbots to recognise and respond to consumers' emotional needs, offering personalised service experiences. However, there is still research conflict as to whether consumers have a positive experience after interacting with Gen AI chatbots. While some studies confirm its efficacy, others point out that AI emotion expression may trigger discomfort or mistrust. Especially in research related to emotional contagion, there is still a lack of systematic investigation of the mechanisms of emotional responses triggered by human-robot interactions. In this research, emotional contagion is defined as the corresponding emotional responses that consumers have during interaction with AIs due to their emotional expressions, aims to examine its impact on consumers' perceived empathy, satisfaction, usage intention, and purchase intention. By revealing the mechanisms by which the emotional expression of Gen AI chatbots affects consumers' psychological and behavioural responses, this study is expected to provide theoretical support for the design of emotional AIs and practical insights for optimising consumer experience in the fashion industry.

Enhancing Consumer Trust in Secondhand Luxury Live-Streaming: A Comparative Study of AI and Third-Party Authentication

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Research Theme: Fashion Management and Marketing

Year of Study (Presentation Type): Year 2 (Talk)

As live-streaming commerce emerges as a pivotal channel for secondhand luxury retail, concerns over counterfeit products and the lack of standardised authentication methods remain significant barriers to consumer trust. While third-party human authentication is commonly used, it is often time-consuming and inconsistent. In contrast, AI-powered authentication—utilising machine learning and real-time image recognition—offers a promising alternative by enabling efficient, automated, and highly accurate verification during live-streaming sessions.

Despite the growing application of AI authentication across various industries, its use within secondhand luxury live-streaming commerce remains underexplored. This research addresses this gap by responding to calls for technological innovation that can enhance trust and transparency on secondhand luxury live-streaming. Grounded in Social Exchange Theory (SET), this study examines the comparative impact of AI versus third-party human authentication on consumer trust in both products and retailers, and how this trust influences purchase intention.

The first phase employs an experimental design and a large-scale quantitative survey to test these relationships, incorporating AI literacy as a moderating variable in the trust formation process. The second phase involves qualitative semi-structured interviews to explore in depth how specific features of AI and third-party authentication influence consumer trust in secondhand luxury products and live-streaming sellers.

Dressing Heritage: Indigenous Knowledge, Heritage Identity, and the Broader Implications of the Outer Baduy Community's Clothing Practices

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Research Theme: Textiles and Apparel.

Year of Study (Presentation Type): Year 2 (Talk)

This study examines the interplay between indigenous knowledge, heritage identity, and clothing practices within the Outer Baduy community in Indonesia. Known for their strict adherence to traditional customs, the Outer Baduy express their ecological, spiritual, and cultural values through clothing rooted in their customary law. However, external influences such as tourism and modernisation have introduced tensions between preserving tradition and adapting to change. While previous research has addressed elements such as natural dyeing and cultural symbolism, this study identifies gaps in understanding how clothing practices shift over time and under socio-ecological pressures. Using the Corporate Heritage Identity (CHI) framework and a qualitative life history approach, the research explores generational perceptions, the balance of tradition and modernity, and strategies for maintaining authenticity and sustainability. By focusing on an underrepresented community, this research offers insights into how heritage identity is constructed and negotiated. The research advances the CHI framework by critically adapting it to the indigenous and ecological dimensions of heritage identity depicted on clothing practices. The findings highlight the Baduy community's resilience and role of indigenous knowledge in sustaining cultural and ecological harmony in clothing practices, offering wider implications for sustainability and the evolving role of heritage in a globalised world.

Textile Circularity Digitization for Developing Product Digital Passport

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Research Theme: (Textiles and Apparel) Textile Circularity Digitization for Developing Product Digital Passport Year of Study (Presentation Type): Second Year, Oral presentation

Abstract:

With rapid population growth and evolving consumer preferences, the demand for textiles has escalated, driving significant overproduction. This surge results in excessive goods that are frequently disposed of or incinerated rather than being reused or recycled. The traditional linear model of textile production—processing materials without considering their full lifecycle—leads to substantial losses in functionality, economic value, and environmental quality. In response, this study investigates the relationship between various indicators along the textile product value chain, such as water usage, energy consumption, and material flow, and assesses their cumulative impact on circularity. By systematically analyzing these interdependencies, the proposed theoretical model addresses critical research gaps in sustainable textile practices and provides strategic insights for transitioning toward a resilient, circular economy.

Report PPT abstract

Page 1: Title

Page 2 - 3: Background

Page 4 - 5: Policy and Standard

Page 6 - 7: Fieldwork output

Page 8 - 9: Establishment of circularity model with transitivity

Establish the Parametric Design Principles and Methods for the Multi-functional Suit-Jacket for the Specific Cultural Contexts

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Research Theme: Textiles and Apparel

Year of Study (Presentation Type): Year 2 (Talk)

This study specifically investigates the suit-jacket pattern for the Chinese professional women who commonly use bike-sharing as their primary mode of commuting while adhering to their formal dress code. Traditional suit-jackets are designed with a shaping function and minimal ease allowance at key dimensions, which often leads to fit issues when cycling. Leveraging 3D scanning technology and CAD system, this study explores a parametric drafting method to enhance the functionality of suit-jackets, ensuring they accommodate both professional and commuting needs.

With the development of 3D scanning technologies and apparel CAD software, designers now have access to a wealth of detailed human body measurement data, which capable to enhance conventional pattern theory. This advancement further allows for the creation of a pipeline through parameters settings, linking 3D body scan data with the pattern block entities at a virtual interface. Meanwhile, the parametric approach reveals the underlying numerical nature of the pattern-body relationship, which requires to establish the specific workflow for the jacket development against the traditional apparel design process. It is anticipated that this research will introduce a new theoretical framework to the apparel design industry and pave the way for mass customisation.

(Words count: 192)

Title: Shaped Woven Panels for Seamless Jeans: A Zero-Waste Approach via Dobby Loom Engineering and Integrated Hemming Techniques

Dewan Murshed Ahmed, 11470701

Supervisor: Professor Prasad Potluri

Co-Supervisor: Dr. Wajira Mirihanage

Research Theme: Select one of the following and delete the rest:

Textiles and Apparel;

Year of Study (Presentation Type): Year 2 (Talk)

Abstract:

The global garment industry faces a major sustainability challenge due to high levels of fabric waste, with cutting table losses typically ranging from 10% to 40%. This waste not only contributes to environmental pollution but also undermines efforts toward resource-efficient manufacturing. In response, this study investigates the development of shaped woven fabric panels using dobby loom technology, specifically designed for the production of seamless jeans. By tailoring woven panels directly to garment shapes—featuring integrated elements such as hemming and waist shaping—this approach aims to minimize off-cut waste to below 3%. The research focuses on creating specialized weaving patterns for these shaped panels and conducting a detailed analysis of material savings compared to traditional methods. This zero-waste strategy supports sustainable garment production by eliminating the need for conventional cutting processes, thereby reducing waste generation at the source. Additionally, the shaped panel method offers the potential to streamline manufacturing workflows, lower production costs, and improve overall fabric utilization. By integrating design and manufacturing processes more closely, the project contributes to advancing circular economy principles in the textile sector and highlights innovative pathways toward waste reduction and environmental responsibility in garment manufacturing.

Effect of Structure Changes During Wool Textiles Manufacturing and Finishing on Fabric Hand and Comfort

Name: Xu Wang

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Research Theme: Select one of the following and delete the rest:

Textiles and Apparel

Year of Study (Presentation Type): Year 2 (Talk)

Abstract

This study explores the structural evolution of double-faced semi-worsted wool fabrics (80% wool, 20% Tencel) across manufacturing and finishing stages, and its impact on fabric hand and skin comfort. Twelve fabrics were collected from key stages of the production process - including weaving, milling, raising, shearing, calendering, and decatizing - and were categorized into three groups (early-stage, raised, and post-finishing) based on finishing stages for comparative analysis. These samples were analyzed using Scanning Electron Microscopy (SEM) for structural characterization and the Fabric Touch Tester (FTT) for hand feel and skin comfort assessments. The results indicate that raising stages leads to a significant increase in Fabric Hair Ratio (FHR), producing a thicker surface fibre layer that lowers Q_{max} . Fabric smoothness and softness were improved during the post-finishing stages through calendering and shearing, which aligned and compressed the surface fibres, contributing to a more refined hand feel and skin comfort. These findings provide valuable insights into the relationship between structural modifications and fabric performance, offering guidance for optimizing finishing processes to balance hand feel and skin comfort in wool textiles.

Keywords: Fabric Touch Tester (FTT); Fabric Hand; Textile Manufacturing; Fabric Surface Structure.

Tunable Temperature Alarm Sensor for Enhanced Safety in Firefighting Clothing

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Research Theme: Textiles and Apparel

Year of Study (Presentation Type): Year 2 (Talk)

Firefighting suits with integrated temperature warning functions are crucial for firefighters' safety during fire rescue operations. However, it is still a challenge to detect different critical temperature levels without the use of external processing electronics. This research aims to design and fabricate a flexible core-sheath yarn with adjustable response temperatures by coaxial wet-spinning. Graphene nanoplatelets (GNPs)/nitrocellulose (NC) are used as the core to enable a resistance transition from an electrically insulating state to a highly conductive one under high temperatures. Flame-retardant and strong aramid nanofibres (ANFs) form the protective sheath to optimize flexibility and wearability. By controlling spinning parameters and introducing additives, the resulting yarns can achieve tunable response temperatures (150 °C, 250 °C, 350 °C), fast response times (<5 s), and extended warning durations (up to 120 s). As a proof of concept, these smart yarns will be integrated into firefighting suits to provide multi-level alerts at different temperatures, thus helping firefighters respond to heat exposure more effectively and enhance their safety.

Thermal Management Functional Materials and Wearable Sensors

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Research Theme: Textile and Apparel

Year of Study (Presentation Type): Year 2 (Talk)

Thermal management plays a notable role in emerging wearable electronics, facilitating the enhancement of smart wearables and applications, as the level of integration, multifunction, and human body thermal comfort of such electronics is affected by effective thermal regulation. However, the integration of thermoregulatory function into wearable electronics is challenging due to various issues should be addressed, including thermal, mechanical, performance and ergonomic. Therefore, the investigation of thermal management in wearable electronics becomes urgent, as it would be the key to further improving their performance and integration capacity as well as opening up new applications. Here, I introduce mechanically, electrically, and thermally stable wearable electronics even when they are stretched under sunlight to address these challenges. This achievement is realized by integrating a siloxane nanofibrous cooler and electrical conductors for a fully stable wearable device. The thermally robust architecture of nanofibers, based on their inherent properties as thermoset polymers, exhibits excellent cooling performance through high solar reflection and thermal emission. Additionally, patterned conductors possess ideal properties for wearable electronics.

Title: 'Investigating Hydrogen-Induced Degradation in Stainless Steels through Electrochemical & Gaseous Charging, Fatigue Testing, and 3D Crystallographic Mapping'

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Year of study: second year

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Research Theme: 'Metallurgy and corrosion'

Understanding the interaction between hydrogen and the microstructure of stainless steel is critical for the use of hydrogen as a fuel in future aerospace applications. This talk presents multiple experimental techniques that investigate the phenomena of hydrogen embrittlement in austenitic stainless steels, combining electrochemical and gaseous hydrogen charging methods for desorption analysis, fatigue testing, and advanced 3D crystallographic characterisation.

Fatigue tests performed in both air and gaseous hydrogen over a range of temperatures reveal differences in failure initiation points and crack propagation behaviour under varying hydrogen exposures. Gaseous charging provides a more industrially representative environment for high temperature testing; however electrochemical charging has prevalent use in literature due to ease of operation and degree of control, this research hopes explore how applicable electrochemically charged experiments are to gaseous industrial environments.

To probe microstructural evolution, a combination of Diffraction Contrast Tomography and 3D X-ray Diffraction (3DXRD) was employed. These non-destructive synchrotron-based techniques enable the generation of 3D reconstructions of grain structures and stress tensor fields, before and after hydrogen uptake.

Together, these approaches provide a detailed understanding of hydrogen uptake distribution and mechanical effects across multiple length scales, advancing the development of hydrogen compatible stainless steels for aerospace and energy applications.

Design and Evaluation of fully Sustainable Polymeric Composites for 3D Printing Applications

Name: Yashi Zheng

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Research Theme: Polymers and Composites

Year of Study (Presentation Type): Year 2 (Talk)

Abstract:

The escalating environmental impact of conventional hydrocarbon-based polymers necessitates the development of sustainable alternatives for additive manufacturing. This work aims to develop eco-friendly composites by integrating natural fillers and colours into polylactic acid (PLA) to produce recyclable, biodegradable filaments with enhanced functional and aesthetic properties. Hence, this study systematically investigates the properties and 3D printability of cellulose-based fillers, such as sandalwood and barley grass powder, and compares them with protein-based counterparts. Results revealed that cellulose-based fillers exhibit twice the tensile strength and 4 times the Young's modulus of protein-reinforced composites. Additionally, to enhance aesthetics, natural materials were incorporated into the filaments to obtain natural colours by allowing a fully sustainable system. The manufactured composites were then evaluated through mechanical, thermal, rheological, degradability, and morphological tests. Based on these evaluations, patient-specific orthopaedic devices were designed, exemplified by a customised arm brace for fracture recovery. The brace was developed through 3D scanning and reverse engineering, and then it was modelled, followed by fabricating the structure using sandalwood-reinforced filament via a 3D printer and structurally optimised through a finite element analysis and a topology optimisation. Results showed that an optimized brace with a hexagonal design with a 3 mm thickness exhibited 0.9 mm displacement and 0.4 MPa stress, outperforming other topological shapes while offering balanced mechanical strength, lightweight design and biocompatibility. Overall, this work addresses critical environmental challenges by reducing reliance on fossil fuel-based polymers, lowering production costs, and mitigating pollution. By bridging material innovation with sustainable manufacturing, this research advances the development of multifunctional, eco-conscious materials for biomedical and industrial applications, thereby offering both academic significance and societal value in combating climate change and resource depletion.

Using Polymer Particles to Increase the Toughness and Stability of Perovskite Solar Cells

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Research Theme:

Polymers and Composites.

Year of Study (Presentation Type): Year 2 (Presentation)

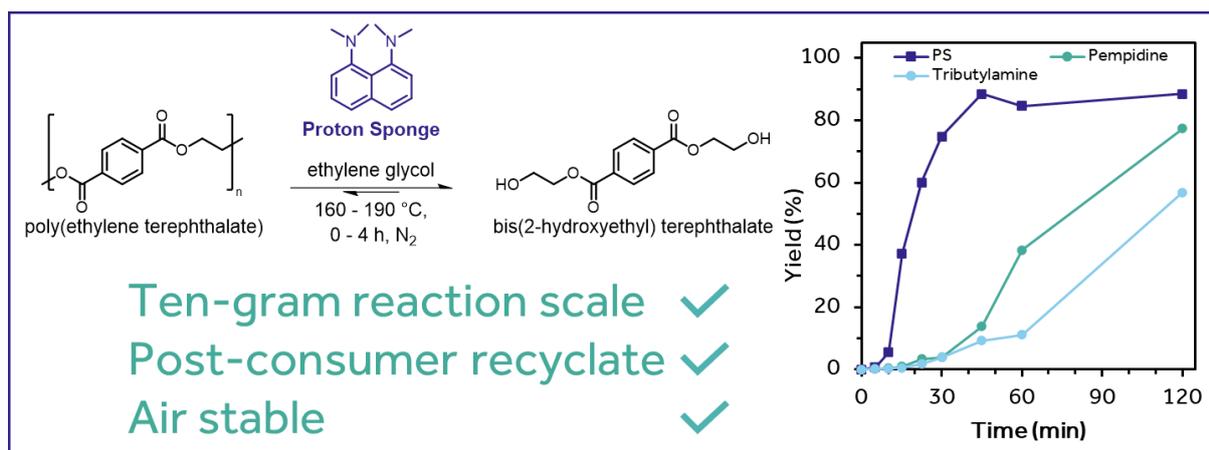
Perovskite solar cells (PSCs) have shown great potential for high-efficiency energy conversion, but their long-term stability, particularly against moisture, remains a critical challenge. In this study, Poly (ethyl acrylate-methacrylic acid- divinylbenzene) nanogels (P(EA-MAA-DVB) NGs) were synthesized using the emulsion polymerisation method to enhance the stability of perovskite films. The microgels were characterised using Dynamic Light Scattering (DLS) and Scanning Electron Microscopy (SEM) analysis. Both MGs were introduced to the perovskite precursor as additives. SEM imaging of the modified films showed smoother, more uniform grains, and an increase in film thickness due to the NGs addition. Contact angle measurements demonstrated improved hydrophobicity, while stability tests indicated enhanced resistance to humidity. These results suggest that P(EA-MAA-DVB) NGs successfully enhance both the morphological properties and moisture stability of perovskite films, offering a promising approach for improving the durability of PSCs.

Basicity, Aromaticity and Glycolysis: an Exploration of Poly(ethylene terephthalate) Depolymerisation

Robbie Clark,^a Ciaran Lahive,^a Michael Shaver^a

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The world faces a growing plastic waste crisis and recycling through chemical depolymerisation offers a part of the solution. Synthetic polymers can be broken down to monomers and then repolymerised, diverting waste and reducing environmental impacts, while maintaining them as pristine materials. This talk explores the activity of 1,8-bis(dimethylamino)naphthalene or Proton Sponge as a catalyst for the glycolytic deconstruction of poly(ethylene terephthalate) (PET), a commonly used packaging polymer. Through parameter optimisation, it is demonstrated that Proton Sponge can effectively and rapidly break down PET, at low catalyst loadings, under an air atmosphere, with scalability and post-consumer recyclate feedstock demonstrated. The activity of glycolysis catalysts generally, is understood by comparison of Proton Sponge to other structurally related compounds. A combination of aromaticity, basicity and other factors lie at the heart of further expanding the growing field of depolymerisation catalysis.



Using Nanogels to Improve the Toughness and Stability of Perovskite Solar Cells

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Research Theme: Select one of the following and delete the rest:

Polymers and Composites.

Year of Study (Presentation Type): Year 2 (Talk)

Abstract.

Perovskite solar cells (PSCs) have attracted significant attention as a promising photovoltaic technology for next-generation solar cells due to their remarkable power conversion efficiency, low-cost manufacturing, and flexibility in device fabrication. However, their stability remains insufficient for large-scale deployment. This project explores the use of polyvinyl caprolactam-co-acrylic acid (PVCL-co-AAc) and polyvinyl caprolactam (PVCL) microgels (MGs) to improve the stability and toughness of PSCs. The MGs were successfully synthesized using a free radical polymerization technique and characterized using dynamic light scattering (DLS) and scanning electron microscopy (SEM). The MG particles were then incorporated into the perovskite precursor solution at different concentrations using an additive engineering method. The results showed that incorporating the MGs enhanced the stability and the device performance compared to the control. More investigation is needed to approve this. This study primarily focuses on optimizing the MG concentration and investigating the effect of these MGs on the morphological, optical, and stability properties of perovskite films and PSC performance.

Influence of heat treatment parameters on secondary phase formation and microstructural evolution in Duplex Stainless Steels

Name: Rawan Alsulami

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Research Theme: Metallurgy and Corrosion.

Year of Study (Presentation Type): Year 2 (Talk)

Duplex stainless steels (DSS) are widely used in structural applications due to their excellent mechanical properties and corrosion resistance. However, exposure to elevated temperatures can lead to the formation of secondary phases, such as sigma (σ) chi (χ) carbides and nitrides, which can degrade mechanical performance and corrosion resistance. Despite their significance, the formation mechanisms of these phases during heat treatment remain poorly understood. This work investigates the evolution of secondary phases under different processing conditions and their impact on DSS microstructure. By varying heat treatment parameters, we aim to understand how temperature, holding time, and cooling rates influence phase transformations. Microstructural characterization using scanning electron microscopy (SEM), electron backscatter diffraction (EBSD), and X-ray diffraction (XRD) will provide insights into phase stability and transformation kinetics. Establishing the correlation between secondary phase formation and mechanical performance will help optimize heat treatment conditions, improving the long-term reliability of DSS in demanding applications.

Name: James Hall

Sponsor: Rolls Royce

Supervisor: Fabio Scenini

Co-Supervisor: Ed Pickering

Department: Materials Science

Research theme: Metallurgy and Corrosion

Title:

Understanding the materials performance of additive manufactured Ni-base alloy components in high temperature water

Abstract:

Austenitic stainless steels and Ni base alloys are extensively used in the primary circuit internals of pressurized water reactors (PWR) due to their high corrosion resistance properties. However, it is also well known that materials processing can have a strong impact on the susceptibility to stress corrosion cracking (SCC) of these materials when exposed in high temperature aqueous environment water coolant under active loading. Historically, components have been manufactured via conventional manufacturing routes, such as forging and welding; however, there is the desire to produce near net shape components via additive manufacturing thanks to the reduce machining costs, more agile manufacturing, and shorter lead times. There is currently insufficient knowledge on the impact of the metallurgical quality of the material produced by such processes on the materials performance. It is critical, therefore, to have a fundamental understanding of the relationship between manufacturing via modern near-to-net-shape manufacturing technologies, such as laser powder bed fusion, so that potential degradation caused by changes to current manufacturing practices can be judged. This, in turn, requires a scientifically-based understanding of the various underlying mechanisms influencing/controlling the environmental degradation and their linking to the end effects.

Name: Matthew Williamson

Supervisor: Timothy Burnett

Year: First

Title: The Influence of Creep on the Initiation of Environmentally Assisted Cracking

Theme: Metallurgy and Corrosion

Abstract:

3rd generation 7xxx series aluminium alloys are used across a wide range of transport applications due to their high strength and low density; however, these alloys are susceptible to Hydrogen embrittlement-related Environmentally Induced Cracking (H-EIC) when exposed to warm humid air. Studies into Environmentally Induced Cracking (EIC) have mostly focused on the propagation of cracks, in part due to the use of notched test specimens that alter the initiation process. However, studies on a variety of metallic alloys have highlighted the impact of prior low temperature creep exhaustion on the crack initiation process. This presentation will explore our current understanding of the effect of creep on EIC in a variety of metals, before discussing current work investigating this relationship in 7xxx series aluminium alloys.

Abstract Template:

Understanding Cold Work Needed for Recrystallization of 316 LPBF Material and its Effect on the Material's Performance in PWR Primary Water

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Research Theme: Metallurgy and Corrosion

Year of Study (Presentation Type): Year 2 (Talk)

As additive manufacturing becomes a more utilized manufacturing process, switching to laser powder bed fusion to create 316 stainless steel structural components for nuclear reactors is considered. However, current post-build HIPping treatments aren't able to erase the as-built laser scanning tracks, resulting in an inhomogeneous microstructure that increases the material's susceptibility to stress corrosion cracking initiation. Because of this, induced cold work with a follow-up solution annealing heat treatment are used to produce an evolution of recrystallized microstructures. These microstructures have currently been analyzed and will have SCC initiation tests done to compare their performance to the as-received material.

Understanding the Performance of Advanced Gas-Cooled Reactor (AGR) Cladding

High-throughput Raman Spectroscopy Mapping

George Livesey¹, Dirk Engelberg¹

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Presenting author: George Livesey (george.livesey@postgrad.manchester.ac.uk)

Advanced gas-cooled reactor fuel, encased within 20%Cr/25%Ni/Nb austenitic stainless-steel cladding, provides a corrosion-resistant barrier to fission product release during storage. Following operational service, the polycrystalline alloy can become sensitised, potentially leading to intergranular corrosion susceptibility. Since the 2018 cessation of THORP reprocessing, spent nuclear fuel requires interim aqueous storage in caustic-dosed ponds (pH 14) until geological disposal becomes viable circa 2075. Initial assumptions regarding deionised water storage proved inadequate when inspections revealed cladding failures within six months. Whilst caustic dosing has demonstrated efficacy for over 25 years, significant knowledge gaps persist and reliance on empirical evidence from initial implementation remains insufficient for robust safety assurance.

The characteristic duplex passive film, comprising an inner chromium-rich oxide layer and outer hydroxide layer, requires stringent monitoring as cladding failure threatens environmental integrity, facility degradation and substantial remediation costs. Spectroscopic methods, particularly Raman spectrometry augmented with computational analysis, present viable non-destructive monitoring solutions for early warning of cladding degradation.

Existing Raman spectroscopic techniques often struggle to reliably identify and assess complex surface chemistries at scale which present challenges when attempting to introduce this technique into existing material health assessment routines. We present a novel approach for Raman spectra decomposition that attempts to address these issues. The algorithm utilises a two-stage ADMM solver with ADAM subproblem handling, applying elastic penalty functions via deviation vectors. Spectra comprised of true Voigt profiles are fitted simultaneously to data in optimisation space. The system maintains physicality via fingerprint databases provides fully automatic multi-material material identification and fingerprint fitting as well as metrics including vectorised deviations for material analysis.

Improving the mechanical property of GZO by second phase toughening approach

Name: Peng Tao

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Research Theme:

Coating and Ceramics;

Year of Study (Presentation Type): Year 2 (Presentation)

6-8 wt.% yttria-stabilized-zirconia (YSZ) is the most widely used commercial thermal barrier coating (TBC) topcoat material in the past decades. However, the main problems of YSZ are insufficient phase stability and accelerated sintering at high temperatures above 1200°C. With an increasing pursuit for higher operating temperature of gas turbine components, great effort has been directed towards identifying promising TBC materials. Rare earth zirconates (REZO) are promising TBC material for its superiority in thermal conductivity to YSZ, among which the gadolinium zirconate (GZO) exhibits the lowest thermal conductivity and the largest coefficient of thermal expansion (CTE). The greatest challenge of GZO lies on its relatively weak mechanical property such as low fracture toughness compared to that of YSZ. In recent years, extrinsic modification method by incorporating secondary toughening phases into matrix TBC material has been proved to be effective on improving the fracture toughness of TBC matrix. The overall aim of this research work is to improve the mechanical property of GZO using second phase toughening approach. The effect of different types of second phase materials on the mechanical property of GZO will be investigated. Furthermore, the toughening mechanism will be discussed based on the best material combination.

Improving the Tetragonality of Yttria Stabilised Zirconia for Thermal Barrier Coatings via Co-Doping

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Research Theme: Coating and Ceramics;

Year of Study (Presentation Type): Year 2 (Talk)

This study explores the co-doping of Yttria-Stabilised Zirconia (YSZ) with titanium, scandium, hafnium, aluminium, and magnesium to enhance tetragonal phase retention and mechanical performance for next-generation thermal barrier coatings (TBCs). A reverse co-precipitation method was used to substitute 2 mol% of yttria with each dopant, followed by conventional powder processing (milling, pressing, and sintering). The sintered pellets underwent isothermal heat treatments at 1350 °C for up to 75 hours, with phase evolution analysed at 25-hour intervals via X-ray diffraction (XRD) and Rietveld refinement. Among the dopants, scandium and magnesium significantly improved tetragonal phase stability, while others promoted monoclinic or cubic phase formation. These findings inform ongoing investigations into synergistic effects of Sc–Mg co-doping and Sc–Mg–Ti systems with varying stoichiometries. Initial results suggest enhanced tetragonal phase retention – outperforming standard 8YSZ – under isothermal ageing at both 1350 °C and 1450 °C. Mechanical properties were evaluated via Berkovic nanoindentation (elastic modulus) and Vickers microindentation (fracture toughness), revealing increased stiffness but a slight reduction in toughness in co-doped systems. Scanning electron microscopy (SEM) confirmed homogeneous dopant distribution and absence of phase segregation. Overall, this work identifies promising co-dopant strategies to optimise the thermal and mechanical resilience of YSZ-based ceramics for demanding TBC applications.

The development of lead-free potassium bismuth titanate based ferroelectric solid solution

Name: Jianxi Wen

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Research Theme: Coating and Ceramics;

Year of Study (Presentation Type): Year 2 (Talk)

The $K_{0.5}Bi_{0.5}TiO_3$ - $BiFeO_3$ has garnered significant interest due to their potential piezoelectric and ferroelectric applications by mimicking of PZT, where electrical properties are optimised with composition around morphotropic phase boundary. However, initial studies have highlighted challenges such as difficulty in achieving over 90% of the relative density and the formation of secondary phases, primarily caused by the volatility of bismuth and potassium at high sintering temperatures. These issues lead to non-stoichiometric compositions and oxygen vacancies, negatively impacting the ferroelectric and piezoelectric properties. In my initial research, the $xKBT$ - $(1-x)BFO$ ($0.6 \leq x \leq 0.9$) system exhibited leakage current contributions, displaying an elliptical shape in the P-E loop due to the flow of charge carriers within the ceramics under an electric field. To address these challenges, the continued work explores the addition of Mn_2O_3 as a dopant to suppress oxygen vacancies, reduce leakage current, and stabilise the electrical properties of the system. The materials are synthesised using the solid-state reaction method and characterised. Additionally, polarization-electric field and strain-electric field measurements are conducted to investigate the ferroelectric and electrostrain behavior. The approach aims to systematically characterise the intrinsic properties of the KBT-BFO system while mitigating extrinsic factors such as non-stoichiometry.

Micromechanical actuation mechanisms in piezoelectric BiFeO₃-BaTiO₃ ceramics

Name: Yuge Yang

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Research Theme: Select one of the following and delete the rest: [Coating and Ceramics](#)

Year of Study (Presentation Type): [Year 2 \(Talk\)](#)

Abstract: Perovskite structured bismuth ferrite-barium titanate (BF-BT) ceramics show excellent potential for applications in electro-mechanical sensors and actuators due their excellent piezoelectric properties and stable performance at high temperatures exceeding 500 °C. In this study, the underlying mechanisms responsible for the electric field-dependent strain behaviour of rhombohedral BF-BT ceramics were evaluated by high-energy synchrotron X-ray diffraction over a range of applied electric field values from sub- to super-coercive levels. The corresponding ferroelectric domain structures before and after electric field application were also compared by SEM observations.

The electric field-induced strain in piezoelectric ceramics is constituted of intrinsic (lattice strain) and extrinsic (domain switching) contributions, which vary for different crystallographic orientations. The total (macroscopic) field-induced strain from diffraction data is calculated through Daymond method, which considers the combined strain of grain families having different crystallographic orientations. The intrinsic and extrinsic contributions for the polar <111> directions over the complete range of azimuthal angles (0 to 90°) are calculated by Jones method.

Abstract Template:

The understanding of toughening mechanisms of high entropy zirconates

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Research Theme:

Coating and Ceramics;

Year of Study (Presentation Type): Year 2 (Talk)

Abstract:

High entropy ceramics (HEC) are advanced ceramics with a highly disordered atomic arrangement. Due to inherent atomic disorder in the cation positions of metallic elements, these ceramics exhibit significant complexity in composition and lattice distortion. Such unique configurational entropies confer superior mechanical, thermal, and chemical properties to HECs, making them more suitable for applications in high-temperature structural materials, coatings, electronic devices, and other fields. However, most studies on HECs have focused on thermal properties, and the toughening mechanism of high entropy itself has rarely been explored. In this work, high entropy pyrochlore zirconate ceramics with fully dense coarse grains (eliminating microstructural effects) and containing 5 and 10 rare earth elements at the A site (the average radius remains the same or like a benchmark ceramic like GZO) were prepared by spark plasma sintering. The sintering reactivity, phase composition, microstructure and mechanical properties of $(\text{Sm}_{0.2}\text{Eu}_{0.2}\text{Gd}_{0.2}\text{Tb}_{0.2}\text{Dy}_{0.2})_2\text{Zr}_2\text{O}_7$ and $(\text{Sm}_{0.1}\text{Eu}_{0.1}\text{Gd}_{0.1}\text{Tb}_{0.1}\text{Dy}_{0.1}\text{La}_{0.1}\text{Nd}_{0.1}\text{Y}_{0.1}\text{Er}_{0.1}\text{Yb}_{0.1})_2\text{Zr}_2\text{O}_7$ were systematically investigated. The fracture toughness of the ceramics was also specifically investigated using nanoindentation and microcantilever beam methods to explore possible toughening mechanisms. It is expected that this work will provide guidance for the preparation of high entropy zirconate ceramics and further the fundamental understanding of the effect of high entropy on fracture toughness and possible toughening mechanisms.

Key Words: Spark plasma sintering (SPS), High entropy pyrochlore ceramics, Mechanical properties, Nanoindentation, Microcantilever, Toughening mechanisms

Abstract Template:

Title: Development of Oxidation-resistant Refractory Coating Compositions by High Entropy Approach

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Research Theme: Coating and Ceramics;

Year of Study (Presentation Type): Year 2 (Talk)

Refractory metals possess a melting point exceeding 2200 °C and maintain a high strength at elevated temperatures (e.g. 1500 °C). These characteristics make refractory metals attractive candidates for high-temperature applications.

However, refractory metals have poor oxidation resistance due to their inability to form protective oxide scales. One viable solution to this problem is to apply oxidation-resistant coatings. Regrettably, commercial coatings like MCrAlY are restricted from direct application onto refractory alloys due to their accelerated oxidation and interdiffusion with the substrate over 1100°C.

This study aims to develop oxidation-resistant refractory high entropy coating compositions. The lattice distortion induced by high entropy is expected to reduce oxygen solubility and slow down oxygen and Al diffusion to facilitate the formation of an exclusive α -Al₂O₃ scale. We use arc melting to blend nine elements (Al, Ti, Cr, Fe, Co, Ni, Nb, Mo and Ta) to produce Al-riched RHEAs (with 50% and 40% Al, respectively, while the other elements have equiatomic ratios). Then, the composition, crystal structure, and phase-specific oxidation behaviour of each phase will be investigated using SEM, FIB, and TEM. Such a methodology provides an efficient and effective way to screen compositions rich in refractory metals capable of growing an exclusive alumina scale.

pH-responsive silica-based ionic colloidal systems of poly(acrylic acid) water solutions.

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Research Theme: Polymers and Composites.

Year of Study (Presentation Type): Year 2 (Talk)

Colloids, owing to their stability, tunability, and interfacial properties, are key to developing functional systems with tailored physicochemical behaviour. Recent interest has focused on stimuli-responsive colloids (i.e. materials capable of adjusting their properties in response to environmental cues such as pH, temperature, or light) opening doors to applications in smart coatings, sensing, and adaptive catalysis. In this context, hybrid colloids, formed by combining polymers with nanoscale fillers, offer enhanced stability, responsiveness, and functionality due to synergistic interactions between their components.

This paper presents a novel pH-responsive hybrid colloidal system based on poly(acrylic acid) (PAA) and silica nanoparticles. Ionic interactions between the polymer and nanofiller enhance interfacial contact, prevent nanoparticle aggregation, and improve overall system performance. The resulting colloid shows enhanced rheological properties, including increased viscosity and thixotropic behaviour not observed in PAA alone. This may be attributed to silica nanoparticles acting as dynamic crosslinks between polymer chains, although further experiments are needed to confirm this mechanism.

Crucially, these ionic crosslinks are reversibly activated by pH changes, providing a dynamic advantage and enabling precise control over material properties. This work introduces a versatile strategy for designing adaptive, multifunctional hybrid colloids with promising applications in advanced materials and technologies.

Abstract Template:

Title : The Effect of notch geometry on kink band formation

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Research Theme:

Imaging and Characterisation;

Polymers and Composites.

Year of Study (Presentation Type): Select one of the following and delete the rest: [Year 2](#)
(Talk)

This study investigates the influence of notch geometry on kink band formation in unidirectional carbon fibre reinforced polymer (CFRP) composites using high-speed synchrotron imaging. Two distinct notch geometries were examined: sharp and square (1mm × 1mm), utilizing phase contrast imaging at 20,000 fps with 0.05ms temporal resolution at the European Synchrotron Research Facility's ID19 beamline. Sharp notched specimens exhibited progressive failure characterized by initial longitudinal splitting at low loads (100-200N), followed by observable fibre rotation and micro buckling before final kink band formation at approximately 700N. In contrast, square notched specimens demonstrated more abrupt failure behaviour, with sudden kink band formation occurring at significantly higher loads (1000N) despite minimal precursor events. The sharp notch produced localized stress concentrations leading to well-defined single kink bands at approximately 30° to the loading axis, while square notches generated more complex failure patterns with multiple kink bands and extensive matrix damage. These findings, supported by in-situ tomography and radiography, demonstrate that notch geometry significantly influences both failure progression and predictability in fibre-reinforced composites. This research contributes to ongoing work on understanding kink band formation using radiographs and DVC, with important implications for structural design and reliability assessment in engineering applications requiring compressive loading resistance.

The Influence of Impurity Elements on the Corrosion Performance of 6xxx Aluminium Alloys

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Research Theme: Metallurgy and Corrosion

Year of Study (Presentation Type): Year 2 (Talk)

The impurity elements contained in aluminum scraps can greatly influence the physical and corrosion properties of secondary aluminium alloy products, especially copper in 6xxx alloys. To systematically study the impacts of copper contents, extruded A6082 alloys consisting of 0.02, 0.1, 0.3, 0.8 wt% copper with both T4 and T6 heat treatments were investigated. It is found that T6 samples have higher intergranular corrosion (IGC) susceptibility due to that grain boundaries are decorated with Cu-containing precipitates, while Cu only has minor effects on penetration depth after long term exposure to corrosive environment. However, higher Cu content clearly increases the crystallographic intragranular corrosion susceptibility due to that Cu enriches on corrosion front, which, subsequently, promotes cathodic reaction. The findings of this study advanced the understanding of corrosion mechanism in AA6xxx alloys and provide a scientific basis for the development of 6xxx aluminium alloys with better impurity tolerance.

Materials for 3D Printed Soft Robotic Phantoms

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Research Theme: Biomaterials

Year of Study (Presentation Type): Year 2 (Presentation)

Image-guided radiotherapy is the latest of tumors treatment method with a good therapeutic effect on tumors such as lung cancer and liver cancer. Due to the unavoidable movements of organs such as breathing and blood flow, it is hampered by the need to protect otherwise healthy areas. Phantoms are of great importance in this field as simulations can be used to determine the maximum safe dose. Radiotherapy are usually guided by magnetic resonance image (MRI). There are developed phantoms made from gels or solutions that exhibit specific contrast in MRI, because of mechanical limitations these are only installed in cylindrical or spherical containers and not be able to simulate the geometry of real human organs. This project will aim to manufacture single material then multimaterial phantoms using direct ink writing based on silicone and its composite to extend to complex geometries as real human tissues especially brain and show appropriate grey-white contrast when characterised by MR to mimic tissue regions. The second target is to optimize silicone composite to extend to a more accessible region of T_1 - T_2 relaxation time and meanwhile adjust its rheology properties to meet the basic requirements of 3D printing.

Investigating the Bioactivity, Degradation Mechanisms, and Structural Properties of Innovamatrix for Chronic Wound Healing

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Research Theme: Biomaterials

Year of study: Year 2

Abstract:

Burn wounds, particularly those that fail to heal in a timely and orderly manner, represent a form of chronic wound with complex pathological features and significant clinical challenges. This research investigates Innovamatrix, a decellularised porcine placental extracellular matrix, as an advanced biological dressing with the potential to enhance wound healing. The study aims to understand how Innovamatrix supports key regenerative processes, including cell viability, proliferation, migration, angiogenesis, and extracellular matrix remodelling. To achieve this, a multi-faceted methodology has been employed, combining in vitro assays (LIVE/DEAD, AlamarBlue, PicoGreen) with structural and compositional analyses to evaluate bioactivity and material integrity. Future work will focus on uncovering the underlying molecular mechanisms by which Innovamatrix modulates immune responses and promotes tissue regeneration. This will include assessing macrophage polarisation, cytokine expression profiles, and angiogenic potential through gene and protein-level analysis. Additionally, degradation studies and in vivo wound models will be implemented to evaluate long-term performance and biocompatibility. Together, these efforts aim to establish a mechanistic understanding of Innovamatrix's therapeutic effects and support its translation into clinical applications for chronic wound management.

Peptide hydrogels for 3D models of liver regeneration

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Research Theme: Select one of the following and delete the rest:

Biomaterials;

Year of Study (Presentation Type): Select one of the following and delete the rest: [Year 2 \(Talk\)](#)

End-stage liver disease is becoming a huge medical burden for society. However, the current gold standard, Liver transplantation, has obvious limitations such as the lack of donors and the high cost of therapy. This project aims to use Self-Assembly Peptide Hydrogel (SAPH) as a platform of a in vitro long-term liver model.

HepG2 cells were seeded into PeptiGel® Alpha 8™. The viability, liver-specific markers and overall stability of the system were examined using various techniques to evaluate the suitability of PeptiGel® Alpha 8™ as a long-term liver model platform. The results are also compared with various SAPHs tested in past studies to elucidate the most suitable SAPH for this application.

In addition, an attempt to use the animal-free product was made by substituting part of the culture medium with human serum or synthetic serum. Experiments on adapting cells to animal-free serum were done to determine a suitable candidate for substituting FBS in the culture medium used.

A new technique aimed at disassembling gels utilising dissolution was also developed. This technique allows the extraction of spheroids formed in the gel for further analysis.

Melt electrowriting of poly-(3-hydroxyalkanoate) scaffolds for rotator cuff repair

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Research Theme: [Biomaterials](#)

Year of Study (Presentation Type): [Year 2 \(Presentation\)](#)

Rotator cuff tears are a leading cause of chronic musculoskeletal pain, with graft-based surgical repairs frequently resulting in incomplete healing.

This study investigates the processing of a medium-chain-length poly-(3-hydroxyalkanoate) (mcl-PHA), a biodegradable bacterial polyester, via melt electrowriting (MEW) to fabricate scaffolds for tendon-to-bone regeneration. mcl-PHA was synthesized through microbial fermentation and characterized using thermogravimetric analysis, differential scanning calorimetry, and oscillatory rheology to define a viable MEW process window.

Compared to gold standard polycaprolactone (PCL), mcl-PHA allowed printing at reduced temperatures (40–50 °C) and pressures (0.1–0.3 MPa) due to its lower crystallinity, a glass transition temperature of ~ -40 °C, and low melt viscosities (350–550 Pa·s). Initial fibres were coarse (80–220 μm) and merged. However, fibre fidelity improved significantly at 100 °C, with diameters approaching 5 μm . Grids with 500 μm spacing were reliably printed, with indications of finer resolution possible. A design of experiments approach is currently being used to systematically optimize processing parameters.

These findings highlight mcl-PHA's potential for precise, reproducible MEW scaffold fabrication, making it a promising material in complex tissue engineering applications such as for the rotator cuff tendon-to-bone interface.

Developing a 3D printed skin model to analyse the cellular and epigenetic effects of interleukin-17 inhibitors in psoriasis

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Research Theme: [Biomaterials](#)

Year of Study (Presentation Type): [Year 2 \(Presentation\)](#)

Psoriasis is a chronic non-contagious autoimmune skin disease usually resulting in inflamed red and white scaly patches of skin. Psoriasis has no known cure, but symptoms can be controlled by treatments such as steroid creams and UV light. Psoriasis affects 2-3% of the population and 125million people worldwide. Although biological therapeutics have revolutionised the treatment of disease, there is still a significant proportion of patients that fail to respond, patients that relapse and long term, drug free remission is not readily achievable.

There is evidence how skin from psoriasis patients is differentially methylated compared to that of healthy skin, with the implication that this methylation may maintain keratinocytes in a hyper-inflammatory state. Long term treatment response may therefore be dependent on the control of this methylation state.

This project will utilise an optimised 3D printed skin model to investigate how interleukin-17 inhibitors, a successful therapeutic in the treatment of psoriasis, can alter the epigenetic profile of keratinocytes, and how this then could maintain these cells in a less inflammatory state. A healthy and a disease 3D skin model, including skin and immune cells, will be developed to investigate how IL17 treatment affects methylation, and the consequences of this on parameters such as inflammation, immune cell infiltration and skin cell phenotype.

Development of advanced bone biomaterials using cell-derived extracellular matrix and bioactive glasses

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Research Theme: Biomaterials

Year of Study (Presentation Type): 2nd year

Mesenchymal stem cells (MSCs) migrate to the site of injury in response to biochemical signals, orchestrating tissue regeneration. Their functional behaviour is strongly influenced by the surrounding niche, which provides a dynamic combination of biochemical and physical cues. Decellularised extracellular matrices (ECMs) provide biomimetic microenvironment to support MSC adhesion and differentiation; however, xenogeneic ECMs can be immunogenic, and recombinant systems often lack the functional complexity of native matrices. Human bone marrow MSC-derived ECMs (C-ECMs) can provide specific signals and cues required for osteogenic differentiation in 2D, offering better control and simplicity. To further harness these advantages, it is essential to unravel MSCs responses to C-ECM components in a 3D environment. As a first step, we evaluated the dose-dependent modulation and spatial homogeneity of MSC behavior using 2D models of C-ECM, aiming to translate these findings into oxidized alginate-based hybrid bioinks that could potentially recapitulate the cues that would induce osteogenic differentiation.

Municipal Wastewater as a Resource for Next-Generation Biomaterials: A Circular Bio-Economy

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Research Theme: Select one of the following and delete the rest:
[Biomaterials](#).

Year of Study (Presentation Type): Select one of the following and delete the rest: [Year 2 \(Talk\)](#)

Abstract

According to a United Nations (UN) report on waste quality and wastewater, globally, 80% of wastewater is discharged into ecosystems without treatment. This contributes significantly to global water scarcity, which could be intensifying water pollution by threefold by 2050. Globally, 380 billion m³ (380 trillion liters) of municipal wastewater is generated annually. A promising approach to address these challenges involves the bioremediation of Municipal Wastewater coupled with the cultivation of two different microalgal species to produce biofertilizers, thereby supporting the water-food-agriculture nexus. Municipal wastewater offers a cheap source of nitrogen, phosphorous and trace elements, which can significantly accumulate into biomass. In this study, three microalgae strains were cultivated in synthetic municipal wastewater and BBM as a control. Herein, comparative phytoremediation of the three microalgae species was employed in synthetic municipal wastewater and results were evaluated for 30 days at batch scale. In addition to, tracking the variation in optical density, specific growth rate, total chlorophyll and biomass at laboratory scale. Along with this pollutant removal was also checked through ICPMS and TOC analyzer. Conclusively, wastewater medium has the potential for cultivation of microalgae as compared to control. Utilizing microalgae

in municipal wastewater treatment is seen as a sustainable approach towards the green circular economy

KEYWORDS

Biomass, BBM, *Chlorella Sorokiniana*, *Micractinium conductrix*, *Chlorella vulgaris*

Graphene based end-effector sensors for teleoperated robotics in extreme environments

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Research Theme: [Nano and Functional Materials](#)

Year of Study (Presentation Type): [Year 2 \(Talk\)](#)

Nuclear reactors are required to be shut down and maintained frequently during their lifetime. Maintenance carried out includes pipes being inspected, re-welded and re-joined. As well as the inspection and replacement of other components such as Tungsten wall tiles. This must be completed remotely due to space constraints and to avoid jeopardizing the safety of humans. To this end the current focus is to develop remote tools that can function in an extreme nuclear environment (i.e. radiation-hard robotics).

This project will work closely with UKAEA (UK Atomic Energy Authority) and RACE (Remote Applications in Challenging Environments) to design, test and install a new end effector sensor based on graphene MEMS (Micro Electromechanical System) for a nuclear rated bilateral telerobotic system. The new MEMS device will be a capacitive ultrasonic transducer designed to collect information from the gripper of the telerobotic system. The new information will be collected via ultrasonic non-destructive testing which tests the integrity of the material or component by passing high frequency sound waves through it and detecting wave distortions. With the help of graphene's excellent electrical and mechanical capabilities this sensor should achieve previously unseen pressure and sensitivity ranges. This is based upon the past research within the nano-functional materials group.

Nanobody-conjugated graphene based electromechanical biosensors

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Research Theme: Nano and Functional Materials

Year of Study (Presentation Type): Year 2 (Talk)

The aim of my PhD project, basically, is to develop a graphene-QCM biosensor with protein nanobody probes to detect analyte for mass screening of diseases. We are planning to build the biosensing platform using reduced graphene oxide (rGO), nanobody, and QCM. QCM (quartz crystal microbalance) is an acoustic device utilising the piezoelectric effect of a quartz crystal, the resonant frequency of the device would shift when mass is added. The change in mass could then be calculated from the shift in frequency through an equation called the Sauerbrey equation. QCM offers real-time and label-free detection. It provides a direct, quantitative result relating to mass changes, with detection limit in the range of nanograms per millilitre. The spin coating of graphene oxide and thermal reduction to form rGO is an easy and cost-effective process that could be used to provide a platform for the binding and functionalisation of the nanobody to the QCM chip. The nanobody is a fragment of a camelid antibody, while maintaining the functionality of antibody, it is much smaller. The goal is to develop a rapid, sensitive and selective biosensing system that works in both buffer and serum solutions.

In situ TEM for understanding of the electrochemical performance of iridium based OER catalysts

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Research Theme: Nano and Functional Materials

Year of Study (Presentation Type): Year 2 (Talk)

Proton exchange membrane water electrolysis (PEMWE) is one of the most promising processes for the production of green hydrogen. However, the acidic electrolyte and highly oxidising potential restricts anode materials for the oxygen evolution reaction (OER) to scarce and expensive iridium oxides, which still fall below the appropriate activity and stability to facilitate PEMWE at a commercial scale.[1] Furthering understanding of structure-property relationships under these corrosive electrolysis conditions could inform and accelerate the development of more active, stable and lower cost anode materials. In recent years, transmission electron microscopy (TEM) has advanced to the point where the study of liquid phase systems is possible at the atomic scale through encapsulation between two ultra-thin graphene membranes.[2] This collaborative project between Johnson Matthey and The University of Manchester aims to develop the state-of-the-art graphene-based liquid cell platform to enable the structural characterisation of iridium oxide electrode materials in realistic electrolyte conditions using high resolution TEM.

References:

[1] M. Clapp, C. M. Zalitis and M. Ryan, *Catal. Today*, 2023, **420**, 114140.

[2] N. Clark, D. J. Kelly, M. Zhou, Y.-C. Zou, C. W. Myung, D. G. Hopkinson, C. Schran, A. Michaelides, R. Gorbachev and S. J. Haigh, *Nature*, 2022, **609**, 942-947.

Synthesis of Photoluminescent 3 and 4-Metal Sulfide Nanoparticles towards Development of High Entropy Quantum Dots

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Research Theme: Select one of the following and delete the rest:

Nano and Functional Materials;

Year of Study (Presentation Type): Select one of the following and delete the rest: Year 2 (Talk)

High Entropy materials are gaining traction in materials science for their stabilisation of the crystal structure, which opens a large region of unique chemical compositions that remain unexplored. The properties afforded by high entropy materials point to significant advantages in areas such as catalysis and potential optoelectronic applications - further driving interest towards direct fine-tuning of the bandgap and surface morphology.

Various relatively low-temperature bottom-up synthesis methods of photoluminescent 3 and 4-metal sulfide colloidal nanoparticles in oleylamine have been explored, establishing a broader picture of the factors impacting elemental distribution during synthesis. Shown by data collected from powerful characterisation techniques such as x-ray diffraction and STEM-EDX, promise has been demonstrated towards achieving a 5 or more metal combination in future work.

Photoluminescence spectroscopy and UV-Vis absorption spectroscopy have been subsequently used to investigate the optoelectronic properties of the nanoparticles and allow for general tuning of material composition for a desired band gap.

Abstract Template:

Enhancing Electrode Stability via Dual Cation Pre-Intercalation in Vanadium Oxide for Calcium-Ion Battery

Name: Zibo Zhou

Email: Times New Roman, Size 12

Research Theme:

Nano and Functional Materials;

Year of Study (Presentation Type): Year 2 (Talk)

Recent advancements in rechargeable battery technology are shifting focus from traditional lithium-ion (Li-ion) batteries to multivalent ion batteries for higher energy density in electric vehicles and portable applications. Calcium-ion Batteries (CIB) are particularly promising due to their abundance and the high theoretical electrochemical performance of the Ca metal anode.

The choice of cathode material is critical for battery performance. Vanadium oxides, with their layered structures and variable oxidation states, facilitate electron transfers in redox reactions, making them potential high-capacity cathode materials. However, they suffer from poor cycling performance due to crystal structure instability during ion transport.

The ion pre-intercalation method has been shown to stabilise the crystal structure of V_2O_5 during redox reactions in Li^+ and Zn^{2+} ion batteries. This study examines $KCaVO$, a pre-intercalated vanadium oxide, using SEM, EDX, and XRD, along with electrochemical tests such as CV and GCD in Ca electrolytes, to evaluate its performance.

High Selectivity 2D-Layered Double Hydroxide Hybrid Membranes for Redox Flow Batteries Application

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Research Theme: Nano and Functional Materials

Year of Study (Presentation Type): Year 2 (Talk)

The Redox Flow Battery (RFB) has emerged as a highly suitable technology for large-scale stationary energy storage in the current era. Its significance is rooted in its essential contribution to speeding up the global deployment of renewable energy. Nevertheless, the frequently employed perfluorinated sulfonated ion exchange membranes in commercial applications encounter issues of low selectivity. The incorporation of an inorganic filler, such as layered double hydroxide, into the membrane enhanced selectivity when compared to the pure nafion. Layered double hydroxide (LDH), known for its distinctive layered structure and customizable transition metal compositions within the layers, along with balancing anions in the interlayer spacing, has sparked significant research interest in various fields, particularly in energy storage.

In this study, MgAl-OH LDH was successfully synthesized with an Mg to Al ratio of 2:1 using co-precipitation method followed by hydrothermal treatment. The XRD pattern of the synthesized LDH exhibited the typical characteristics of hydrotalcite-like structures which has the R-3m space group and a interlamellar spacing of 0.759 nm. The surface morphology of the synthesized LDH showed a nanoplate-like structure with a nearly hexagonal shape and an average particle size of approximately 90 nm.

In addition, this research will incorporate LDH as a filler within a nafion matrix for use in redox flow batteries. The membrane will undergo characterization using several techniques, including ionic conductivity, permeability, ion exchange capacity, water uptake, and SEM. Furthermore, the electrochemical performance in the redox flow battery will be investigated to determine the effectiveness of incorporating LDH into the membrane for redox flow battery applications.

Self-assembly of cellulose nanocrystals in geometrical confinement

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Research Theme: [Nano and Functional Materials](#);

Year of Study (Presentation Type): [Year 2 \(Talk\)](#)

Extracted from plant-based resources, cellulose nanocrystals (CNCs) are sustainable colloidal matter that can spontaneously self-assemble into cholesteric mesophases upon evaporation. The resulting films exhibit iridescent structural colouration. In most cases, the self-assembly process follows sessile droplet drying, which is led by the flow dynamics within the droplets, causing the formation of optical artefacts. One of the most prominent artefacts is the formation of the ring-shaped deposition patterns similar to the coffee-ring effect (CRE). In this work we aim to control this phenomenon during droplet drying by introducing boundary constraints on substrates by modulating the balance between capillary and Marangoni flows involved in CRE. By changing the geometric parameters of the template, such as the size and the shape, we discovered that it is possible to manipulate the fluid dynamics within the geometric confinement, which in turn alters the spatial distribution of CNC concentration in the suspension droplet. Using our systemic studies, it is possible to fabricate iridescent CNC thin films with predictable thickness distribution without further additives or treatment. Furthermore, we demonstrated the evaporation dynamics of the CNC suspensions on various stages of CRE formation and inferred a reliable strategy to modify the surface morphology of CNC photonic films.

Developing atomic-structural descriptors of the performance of IrO_x electrocatalysts

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Research Theme: Imaging and Characterisation

Year of Study (Presentation Type): Year 2 (Talk)

Abstract:

The development of proton exchange membrane (PEM) water electrolyzers has provided a platform for transforming renewable energy into the chemical energy of hydrogen, a storable and, therefore, more reliable fuel supply. However, the wide-scale realisation of PEM electrolyzers is hindered by their high capital cost, owing to the dependence on the oxides of the precious iridium (Ir) metal as the anodic electrocatalyst. Utilising the Ir electrocatalyst loading more effectively is necessary to realise the wide-scale application of PEM electrolysis. However, an incomplete understanding of the relationship between the catalyst's atomic structure and electrochemical performance remains a bottleneck for supporting an optimised catalyst synthesis pathway. This study endeavours to probe key structural fingerprints of Ir oxide-based catalysts using advanced transmission electron microscopy and diffraction techniques to outline the activity-structure relationships at play.

Optimisation of Lead-Free Sodium Bismuth Titanate Ferroelectric Ceramics for Enhanced Energy Discharge Performance and Stability

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Research Theme: Coating and Ceramics

Year of Study (Presentation Type): Year 2 (Talk)

Abstract

Lead-free ceramics have emerged as a sustainable alternative for high-energy storage applications in electric vehicles, mobile devices, and pulsed power technologies. Among these, $0.94\text{Na}_{0.5}\text{Bi}_{0.5}\text{TiO}_3-0.06\text{BaTiO}_3$ (NBT-6BT) ceramics have garnered significant interest due to their high polarisation and robust ferroelectric properties combined with moderate relaxor behaviour. However, their direct application in energy storage is limited by their large electric field (E) and polarisation (P), which hinder optimal energy storage performance. This research addresses these challenges by incorporating $0.85\text{NaNbO}_3-0.15\text{CaTiO}_3$ (NN-CT_{15%}), an optimised system with exceptional dielectric properties, into the $(1-x)$ (NBT-6BT) – x (NN-CT_{15%}) ceramics, where $x = 0.00-0.30$. This strategic integration disrupts the long-range ordered ferroelectric domains of NBT-6BT, transforming macrodomains into nanodomains ($x \geq 0.10$) and enhancing relaxor characteristics under high electric fields. The resulting system with disrupted long-range order results in remarkable properties, including high electrical permittivity (>1000) at room temperature and a recoverable energy density (W_{rec}) of $\sim 4.8 \text{ J}\cdot\text{cm}^{-3}$ with efficiency (η) of $\sim 79\%$, an exceptional value for lead-free ceramics. Therefore, the study highlights the synergistic effects of NN-CT on NBT-6BT, demonstrating its potential as a next-generation material for eco-friendly and high-performance energy storage devices.

Processing of SiC Ceramic Matrix Composites

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Research Theme: Coating and Ceramics

Year of Study (Presentation Type): Year 2 (Talk)

Ceramic silicon carbide (SiC) has excellent capabilities to withstand high temperatures but it is very brittle. Material strength can be improved by reinforcing the SiC ceramic matrix with ceramic fibres to create a SiC ceramic matrix composite (CMC). The high temperature resistance and strength of SiC CMCs make it a suitable candidate as a structural material for extreme service conditions. However, the fabrication of SiC CMCs is complicated which hinders its widespread use in industry. Polymer Infiltration and Pyrolysis (PIP) has promise as a relatively simple process option but needs improvement to be able to consistently produce quality SiC CMCs. Previous work on PIP made great strides at improving the SiC matrix purity but has had negative effects on its mechanical properties. The current work is attempting to mitigate the negative effects of the updated PIP process while maintaining the newly acquired high matrix purity as much as possible. This is being done by thoroughly investigating the effects of each processing parameter to then optimize the process to fabricate a quality SiC CMC suitable for industrial use.

MXene based functionalisation of ceramic coatings produced by plasma electrolytic oxidation of light alloys

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Research Theme: Coating and Ceramics

Year of Study (Presentation Type): Year 2 (talk)

Plasma electrolytic oxidation (PEO) is an advanced surface treatment method used to produce stable barrier oxide coatings on light alloys.

These coatings show promise across many sectors but faces limitations as they can only do so much as a passive protective layer, making further engineering very important for performance enhancement.

In sliding contact environments these coatings must be adapted for changing conditions. To account for this, adaptive lubricants are often utilised.

Common examples of these include graphite or molybdenum disulphide-based solid lubricants, but they have limited long-term capabilities. We are investigating if MXenes, a class of 2D materials, can perform better where the current examples are limited due to the comparative increased bonding strength between layers of transition metal compounds within their structure, providing more resistance to delamination under repeated sliding contact.

To improve and assess the performance we are optimising the PEO surface characteristics and the method of incorporating the lubricant to enhance compatibility with MXene additions, followed by performing reciprocating sliding wear tests under altering conditions.

We anticipate that incorporating MXenes into PEO coating systems could provide more consistent wear resistance enhancement over time and additionally withstand increased loading compared to the current common solid lubricants.

Degradation mechanism of ytterbium based EBCs by CMAS and steam

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Research Theme: Coating and Ceramics

Year of Study (Presentation Type): Year 2 (Talk)

Ytterbium disilicate (YbDS) is a promising material to be used in environmental barrier coatings (EBCs) to protect Si-based ceramic matrix composites (CMCs) from oxidation and corrosion in gas turbine engines. One notable drawback of YbDS is its susceptibility to degradation caused by steam and calcium-magnesium-aluminum-silicate (CMAS). Although the degradation of YbDS caused by these two factors have been investigated separately, the synergistic effect of these two elements on YbDS is largely unknown. In this study, a series of experiments was conducted to examine the differences between the degradation of YbDS when exposed to CMAS in air and in steam. The results show that regardless of exposure duration and temperature, steam appears to increase the melting point of CMAS and hinders its infiltration into YbDS. Furthermore, CMAS and Yb form a reaction layer in steam that is not present in air. These results imply that steam affects the chemical reactions and infiltration kinetics during CMAS degradation of YbDS. To summarize, this work demonstrates that CMAS degradation of YbDS occurs differently in air compared to that in steam, and a systematic comparative study is required to understand how steam alters the mechanism behind CMAS attack in YbDS.

Fibrous Silica Sealing Post-treatments for Corrosion Protection of Anodised A1050

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Research Theme: [Coating and Ceramics](#)

Year of Study (Presentation Type): [Year 2](#)

Surface treatments are widely used on lightweight metals and alloys in the transport industry to enhance corrosion and wear resistance, ultimately extending the lifespan of components. Anodising is a common electrochemical coating process for modifying the surface of aluminum to improve its corrosion resistance. However, anodised aluminum has a porous surface, which limits its effectiveness in providing large-scale corrosion protection. To further enhance corrosion resistance, sealing post-treatments are required to seal the pores and improve the protective properties of the coating.

This study aims to develop an environmentally friendly coating technology for the corrosion protection of aluminum. The coatings were produced through anodising in phosphoric acid at four different voltages (ranging from 30 to 45 V), followed by a sealing post-treatment with fibrous silica. This work demonstrates that increasing the voltage leads to larger pore sizes and greater coating thickness. Aluminum anodised at 45 V exhibits a surface with large pores, with an average pore diameter of 89 nm. The presence of larger pores allows for better incorporation of fibrous silica, resulting in a denser surface and improved corrosion protection. The developed coating system is thoroughly characterised in terms of its composition and morphology.

Development of ceramic coatings on AZ31 magnesium alloy by the Aerosol Deposition (AD) method

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Research Theme: Coating and Ceramics.

Year of Study (Presentation Type): Year 2 (Talk).

The Aerosol Deposition (AD) method has been identified as a coating technology with the potential to enhance the surface finish and corrosion performance of Mg alloys. The AD method is a room-temperature spraying technique based on shock-loading solidification as a result of the collision between ultrafine ceramic particles and a substrate. The high-velocity collision is driven by the pressure difference, which transports the aerosolized particles from the aerosol chamber through a nozzle to the evacuated deposition chamber.

The objective of the present study is to develop a ceramic coating with enhanced corrosion resistance, with a view to extending the service life of magnesium-based components. The preliminary research is centred on the evaluation of the influence of the particle powder precursor on the coating deposition process. In this study, a range of powder pre-treatment processes is evaluated, including high-energy ball milling and spray drying. The influence of the powder composition is also evaluated with the powders that contain 100 wt. % Al_2O_3 , 90/10 wt. % $\text{Al}_2\text{O}_3/\text{CeO}_2$ and 70/30 wt. % $\text{Al}_2\text{O}_3/\text{CeO}_2$. The deposition parameters are then optimised in terms of working distance, flow rate, and scan rate. The developed coatings are characterised in terms of microstructure and composition by Scanning Electron Microscopy/Energy-dispersive X-ray Spectroscopy (SEM/EDS), X-ray Diffraction (XRD) and laser scanning confocal microscopy. The corrosion resistance of the coating is then subject to evaluation by electrochemical methods, including open circuit potential (OCP), potentiodynamic polarisation (PDP), and electrochemical impedance spectroscopy (EIS).

A Cheap, Simple and Scalable Technique for the Production of Ceramic Coatings

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Research Theme: Coating and Ceramics

Year of Study (Presentation Type): Year 2 (Talk)

Electrophoretic deposition (EPD) can produce dense, homogenous, and smooth coatings on highly complex surfaces within minutes under ambient pressures and temperatures. EPD is viable for a broad range of materials as it simply relies on dispersing particles, imparting charge onto them and then directing them to an electrode/substrate to be deposited. One of the most promising yet minimally explored use cases for EPD is in ceramic coatings, particularly in the aviation sector. Environmental barrier coatings (EBCs) in conjunction with ceramic matrix composites (CMCs) have the potential to enable a new generation of high-performance gas turbines but the current widely used techniques (e.g. APS) are unlikely to produce EBCs to industry standards on a large scale. Research now aims to show that EPD is not just simple, cheaper and more scalable than current EBC production techniques but is also able to produce higher quality longer lasting coatings.

The Effect of Tungsten-Precursor Addition on the Thermoelectric Properties of Nb-doped SrTiO₃ Ceramics

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Research Theme: Coating and Ceramics;

Year of Study (Presentation Type): Year 2 (talk)

Thermoelectric (TE) materials are alternative renewable energy sources, that can convert waste heat into electricity. Perovskite oxides are very attractive TE materials, because they have superior thermal and chemical stability, but traditionally have had low thermoelectric zT and only operate efficiently at high temperatures which limits their deployment capability. A case in question is n-type SrTiO₃ (STO), which possesses a large Seebeck coefficient and a good power factor (σS^2), which is comparable to that of commercial Bi₂Te₃. However, the extremely low electrical conductivity and high thermal conductivity of STO limits TE performance. In this work, we present a new route to processing niobium-doped STO ceramics, whilst simultaneously using ammonium tetrathiotungstate [(NH₄)₂WS₄] to introduce phonon scatterers at grain boundaries. Samples with highest tungsten content [$x = 2$ wt%] showed the best thermoelectric performance, with a maximum power factor of $\sim 1.41 \times 10^{-3} \text{ Wm}^{-1}\text{K}^{-2}$ at 323 K. Sintering in reducing atmosphere increased the formation of oxygen vacancies, and hence increased the carrier concentrations, reaching $\sim 4.70 - 4.93 \times 10^{21} \text{ cm}^{-3}$, which results a great enhancement on electrical conductivity. However, the Seebeck coefficient was slightly impacted due to the small variation of carrier concentrations. Total thermal conductivity showed similar trends, with κ decreasing as temperature increases. This work provides a feasible way to improve the thermoelectric properties of strontium titanate ceramics.

HELLO TOMORROW

Faculty of Science and Engineering

POSTGRADUATE RESEARCH

Day 1 - Wednesday, 14th May

Year 1 Poster Session

Forename	Surname	Theme	Poster Number
Supanut	Kitphaitun	1. Biomaterials	1
Balint	Macsuga	1. Biomaterials	2
Alexandra-Medea	Nagy	1. Biomaterials	3
Vasiliki	Nikolaou	1. Biomaterials	4
Chenliang	Song	1. Biomaterials	5
Jiaho	Xu	1. Biomaterials	6
Farouq	Alatassi	2. Coatings and Ceramics	7
Charles	Edwards	2. Coatings and Ceramics	8
Zongkai	Feng	2. Coatings and Ceramics	9
Jiangnan	Hu	2. Coatings and Ceramics	10
Ke	Hu	2. Coatings and Ceramics	11
Zhuyao	Li	2. Coatings and Ceramics	12
Erol Cem	Özgör	2. Coatings and Ceramics	13
Xiaomu	Sui	2. Coatings and Ceramics	14
Jingwei	Wei	2. Coatings and Ceramics	15
Chenxi	Zhang	2. Coatings and Ceramics	16
Alhanouf	Alrwais	3. Imaging and Characterisation	17
Aidan	Neil	3. Imaging and Characterisation	18
Yanxuan	Wang	3. Imaging and Characterisation	19
Yunlong	Xu	3. Imaging and Characterisation	20
Dalal	Ali	4. Metallurgy and Corrosion	21
Kun	Bai	4. Metallurgy and Corrosion	22
Matthew	Brayne	4. Metallurgy and Corrosion	23
Olivia	Broadbent-Clark	4. Metallurgy and Corrosion	24
Emma	Buckworth	4. Metallurgy and Corrosion	25
James	Butler	4. Metallurgy and Corrosion	26
Grace	Fidler	4. Metallurgy and Corrosion	27
William	Foster	4. Metallurgy and Corrosion	28
Hemanth Abhinav	Gunthamalla	4. Metallurgy and Corrosion	29
Bardia	Hashemi Yazdi	4. Metallurgy and Corrosion	30
Adrian	Huggon	4. Metallurgy and Corrosion	31
Lingfei	Kong	4. Metallurgy and Corrosion	32
Adrian	Leung	4. Metallurgy and Corrosion	33
Michael	McGlynn	4. Metallurgy and Corrosion	34
Xavier	Ojeda	4. Metallurgy and Corrosion	35
Shen	Tian	4. Metallurgy and Corrosion	36
Elsa	Verheul	4. Metallurgy and Corrosion	37

Department of Materials Conference
Y1 Poster Session, *Nancy Rothwell Event Space*
Wednesday 14th May 12:30-2:15pm

Qianglong	Wang	4. Metallurgy and Corrosion	38
Matthew	Warner	4. Metallurgy and Corrosion	39
Chuyuan	Xu	4. Metallurgy and Corrosion	40
Ge	Zhang	4. Metallurgy and Corrosion	41
Seham	Alamri	5. Nano and Functional Materials.	42
Michael	Hutton	5. Nano and Functional Materials.	43
Sruthi	Sreeraj	5. Nano and Functional Materials.	44
Merve Seyma	Surel	5. Nano and Functional Materials.	45
Jacob	Young	5. Nano and Functional Materials.	46
Sumudu	Adikaram	6. Polymers and Composites	47
Dhruve	Aidasani	6. Polymers and Composites	48
Othman	Alyahya	6. Polymers and Composites	49
Arvin Jia Qing	Chen	6. Polymers and Composites	50
Jian	Li	6. Polymers and Composites	51
Haoze	Li	6. Polymers and Composites	52
Yuhao	Liang	6. Polymers and Composites	53
Akshay	Mahale	6. Polymers and Composites	54
Mary	Pool	6. Polymers and Composites	55
Nasser	Rehman	6. Polymers and Composites	56
Edward	Savage	6. Polymers and Composites	57
Chloe	Smith	6. Polymers and Composites	58
Toby	Squire	6. Polymers and Composites	59
Wenbo	Wu	6. Polymers and Composites	60
Haoran	Zhang	6. Polymers and Composites	61
Yichi	Zhang	6. Polymers and Composites	62
Lena	Bartoszewicz	7. Textiles and Apparel	63
Tanvir Mahady	Dip	7. Textiles and Apparel	64
Mariam	Hassan	7. Textiles and Apparel	65
Emran	Hossain	7. Textiles and Apparel	66
Md Faisal	Mahmud	7. Textiles and Apparel	67
Priyadarshini	Venkatasalam	7. Textiles and Apparel	68
Ziqi	He	8. Fashion Management and Marketing	69
Yaxin	Lyu	8. Fashion Management and Marketing	70

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Title: Novel 3D cellulose nanocomposite Scaffold for repairing Skeletal Muscle

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Research Theme: Biomaterials and Tissue Engineering

Year of Study (Presentation Type): Year 1 (Poster)

Abstract

In this research, 3D nano-biocomposite scaffolds for aligning and repairing skeletal muscle will be fabricated by ice - template cryogenation which can create unidirectional-structured scaffold. Furthermore, these scaffolds were composed of three main components which are cellulose-nanowhiskers (CNWS), Gelatin (Gel) and Chitosan (Chit). The addition of core-shell nanoparticle (Gel/Chit/Gel) into these scaffolds with surface modification can improve cell adhesion, proliferation and differentiation, also enhance the compatibility among different components, and prevent agglomeration leading to poor mechanical properties in nanocomposite system. These scaffolds are being developed for eliminating the limitation of 2D spin-coated multilayer scaffold in the previous work in terms of physical and nanomechanical properties, efficiency for aligning skeletal muscle and mimicking as 3D native extracellular matrix (ECM). The effect of types of cellulose (tunicates cellulose and bacteria nanocellulose), composition concentration in core-shell structure, parameters in surface modification and fabrication time/temperature in those techniques will be investigated by various characterization methods including Material testing, Cell-material Interaction Testing and Application Testing. These 3D scaffolds should have excellent porosity and wettability, mechanical properties supporting for skeletal muscle growth by alignment in specific direction which can fulfil to improve further as 4D or injectable scaffold for implanting into human body in the future.

Evaluation of Electrostimulation-Mediated Bone Healing with 3D Models

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Research Theme: Biomaterials

Year of Study (Presentation Type): Year 1 (Poster)

Abstract

Dental implants have a failure rate of 5-10%. However, lifestyle (smoking), health conditions (diabetes mellitus, cancer), and peri-implant diseases significantly increase the risk of failure. Due to varying health conditions, there is no overall gold standard for ensuring osseointegration and restoring alveolar bone tissue [1]. Electrical stimulation (ES) has been shown to induce stem cell proliferation and osteogenic differentiation; therefore it is a promising therapeutic tool for promoting bone healing at the site of the implant [2]. This project aims to develop a high throughput bioreactor, to investigate the effect of capacitively coupled (CC) ES on the osteogenic potential of human mesenchymal stem cells (hMSCs) for the enhancement of dental implants. Thereby, enabling the rapid testing of CC ES regimes and their effect on osteogenesis, proliferation, alignment and migration of hMSCs. Through finite element analysis the generated electric field (EF) is modelled and predicted inside the bioreactor. The migration of hMSCs under CC ES is assessed in addition to their alignment in a wound model fabricated from fibrin hydrogel. Finally, 3D scaffolds: fibrin, polycaprolactone (PCL)/ β -tricalcium phosphate (β -TCP) and fibrin/PCL/ β -TCP will be created and complemented with a titanium implant mimic for the *in vitro* study of osseointegration under CC ES.

References

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- [2] Khaw, Juan Shong et al. "Electrical stimulation of titanium to promote stem cell orientation, elongation and osteogenesis." *Acta biomaterialia* vol. 139 (2022): 204-217. doi:10.1016/j.actbio.2021.08.010

Elucidating the effects of electrostimulation in oral cavity cell populations

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Research Theme: [Biomaterials](#)

Year of Study (Presentation Type): [Year 1 \(Poster\)](#)

Abstract body text; Times New Roman, Size 12; Left Justified; Max. 200 words; No figures or tables to be included.

Abstract:

Introduction

Periodontitis is a prevalent inflammatory oral disease that leads to tooth and alveolar bone loss. Periodontal ligament stem cells (PDLSCs) are similar to mesenchymal stem cells (MSCs), and can undergo osteogenesis, offering regenerative potential for the alveolar bone. Electrostimulation enhances osteogenesis in multiple cell types including MSCs. This study evaluates the potential of capacitive electrostimulation (CES) to enhance PDLSC osteogenesis.

Methods

PDLSCs were cultured for 14 and 21 days in a custom CES bioreactor, for choosing the voltage parameters and evaluating the osteogenic effects of CES. An optimal CES regime (50 or 70 mV/mm, 6 h/day) was determined based on metabolic activity and differentiation, over 14 days using resazurin staining, DNA quantification and ALP activity.

Results

At 14 days, 50 mV/mm reduced PDLSC's metabolic activity on day 7 ($p=0.0006$), while 70 mV/mm had no effect ($p>0.05$). Both test groups showed decreased ALP activity ($p=0.0006$ for 50 mV/mm, $p=0.0021$ for 70 mV/mm).

Conclusion

The preliminary results indicate that the CES regimes used reduce ALP activity, metabolic activity and proliferation. These are preliminary studies and need repeating to ensure result reliability. Further optimization of cell seeding density and regimes will also be explored

Smart Hydrogels for Light-Guided Cartilage Repair

Abstract Template:

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Research Theme: Select one of the following and delete the rest:

[Biomaterials;](#)

Year of Study (Presentation Type): Select one of the following and delete the rest: [Year 1 \(Poster\)](#)

Abstract body text; Times New Roman, Size 12; Left Justified; Max. 200 words; No figures or tables to be included.

Cartilage tissue possesses limited capacity for self-repair, and existing treatments often fail to fully restore its native structure and function. This project aims to engineer 3D-bioprintable, light-responsive hydrogels utilising the spontaneous and fast gelation of click chemistry, between tetrazine and norbornene groups. These hydrogels are designed to replicate the extracellular matrix and enable precise control over cartilage formation by incorporating human embryonic stem cells that respond to light through the OptoBMP system. Initial hydrogel formulations have been developed using gelatin-tetrazine and gelatin-norbornene, with early work focusing on teleostean (fish-derived) gelatin and current efforts directed toward bovine gelatin for comparative evaluation. Future development will involve the integration of hyaluronan-norbornene to create hybrid materials with enhanced biological functionality. To optimize gel performance, rheological analysis will be employed to design stiffness gradients that align mechanical properties with cellular responses.

Tough and stiff injectable gels from inter-linked microgels

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Research Theme:

Biomaterials

Year of Study (Presentation Type): Year 1 (Poster)

In order to realise the great promise of injectable gels for rapid, surgery-free tissue repair, there is an urgent need for new systems with high-performance mechanical properties. Because of their excellent compressibility properties, previously developed injectable double crosslinked microgel (DXMG) gels have been used to repair damaged intervertebral discs. However, there has never been a double cross-linked microgel with stretchable properties. In this project, we aim to create new DXMGs with stretchable properties that meet or exceed the mechanical properties of the (non-injectable) dual network gels and maintain the same or better compressive properties than the previous injectable dual cross-linked microgels. The new direction proposed in this paper aims to create DXMGs with mechanical properties not presently available in injectable gels, thus creating a new platform for injectable DXMGs with new physical properties.

Phototherapy based microneedle system for diabetic wounds healing

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Research Theme: Biomaterials

Year of Study (Presentation Type): Year 1 (Poster)

Diabetic wounds (DWs) are a common complication of diabetes, but they can bring painful, amputation and even death to patients. The complex microenvironment makes it hard to treat and become chronic wounds. Traditional treatments require specialized equipment and medical personnel, resulting in a significant economic burden on patients and their families. Wound healing dressings due to their affordability and portability, have garnered increasing attention. Among them, microneedle wound dressing systems are particularly suited for diabetic wounds healing, thanks to their high customizability and subcutaneous delivery capability. Recently, more and more researchers focus on this area. Phototherapies including photothermal, photodynamic, photosynthesis and so on have been applied in diabetic wounds healing for a while. This technology has advantages such as being environmentally friendly, low-energy consuming, and non-invasive, making it still shown promise in diabetic wounds healing. Therefore, we want to combine these two technologies together in diabetic wounds healing to develop novel phototherapy-based microneedle wound healing systems.

Characterisation and Development of CVD Diamond-to-Metal Bonds for Microwave Components in Nuclear Fusion Systems

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Research Theme: Coating and Ceramics.

Year of Study (Presentation Type): Year 1 (Poster).

Advancements in nuclear fusion technology demand materials that can endure the extreme conditions present in high-power microwave components, particularly concerning the substantial power losses within waveguides, windows and cavities [1]. These losses generate heat, leading to elevated temperatures and thermal gradients across materials. Chemical Vapour Deposition (CVD) diamond has emerged as a promising candidate for critical fusion reactor components due to its exceptional thermal conductivity and mechanical properties [2]. This study focuses on developing and characterising CVD diamond-to-metal bonds for microwave components serving as vacuum barriers in fusion systems. The research explores bonding CVD diamond to metals such as stainless steel (SS 316LN), copper (OFHC or CuCrZr alloys), and aluminium (6062).

Key analyses include pre- and post-cyclic fatigue testing to assess bond integrity in terms of vacuum sealing and thermal conductivity. Scanning and Transmission electron microscopy [3] and X-ray diffraction are employed to observe and characterise the behaviour of bonds under operational stresses. Preliminary findings aim to inform the development of reliable, high-performance components, advancing the integration of CVD diamond into nuclear fusion technologies. This work contributes to enhancing the durability and efficiency of systems operating under extreme conditions, supporting the progression of nuclear fusion as a sustainable energy solution.

[1] Kudryavtsev, I.V., Minakov, A.V. & Mityaev, A.E. (2019). The Influence of High-Power Microwave Signal Transmission on the Thermoelastic Condition of a Waveguide. *J. Mach. Manuf. Reliab.* 48, 306–313. <https://doi.org/10.3103/S1052618819040101>

[2] Scherer, T. & Strauss, Dona & Meier, Andreas & Mathis, Yves-Laurent & Judin, Vitali & Mueller-Sebert, Wolfgang & Smirnov, W. & Nebel, Christoph. (2011). Investigations of microwave and THz radiation losses in CVD diamond and chemically modified diamond. *MRS Proceedings.* 1282. 10.1557/opl.2011.452.

[3] Kaboli, Shirin & Burnley, Pamela C.. (2018). Strain Analysis in Polycrystalline Diamond under Extreme Conditions. *Microscopy and Microanalysis.* 24. 980-981. 10.1017/S1431927618005391.

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Abstract Template:

Hydrogen trapping and permeation in metallic and ceramic coatings for fusion powerplant applications

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Research Theme: Coating and Ceramics

Year of Study (Presentation Type): Year 1 (Poster)

Nuclear fusion has the potential to be the solution to the world's ever-growing energy needs. The two main fuels that nuclear fusion uses to produce energy are two isotopes of hydrogen: deuterium and tritium. Tritium is highly radioactive, so effectively maintaining tritium inventory will be key to the safe operation of any future fusion power plant. Hydrogen and its isotopes readily diffuse through many structural materials such as steel, so barrier coatings are required to inhibit this. However, little is currently known about the behaviour of tritium in the barrier coatings themselves and in larger coating systems. Therefore, my project seeks to investigate these behaviours and determine the optimum hydrogen barriers for fusion powerplant applications.

Various candidate materials will be exposed to deuterium, followed by an extensive characterisation process to determine the hydrogen trapping and permeation behaviours associated with each material. This characterisation will involve the use of thermal desorption spectroscopy (TDS) and Rutherford Back-Scattering Spectroscopy (RBS), as well as additional microstructure characterisation techniques. The collected experimental data will inform and validate hydrogen isotope trapping and permeation modelling, enabling the prediction of tritium inventory over time.

Durable Engineering Coatings by Aerosol Deposition

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Research Theme: Coating and Ceramics.

Year of Study (Presentation Type): Year 1 (Poster)

Tungsten has been recognized as a potential first wall material due to its high melting point, excellent resistance to neutron radiation. However, its high melting temperature also makes tungsten difficult to process and the recently used thermal spraying technology produces coatings with high porosity and is prone to problems related to thermal mismatch with the cladding. Therefore, developing a method to produce tungsten coatings at room temperature could be highly beneficial.

In this work, Aerosol Deposition (AD) is employed to deposit high-density, high-adhesion tungsten coatings on Silicon Carbide (SiC) substrates at room temperature. The microstructure and mechanical properties of the coatings will be characterized across multiple length scales using X-ray diffraction (XRD), scanning electron microscopy (SEM), transmission electron microscopy (TEM), and micro-mechanical testing.

Compositional design of protective refractory coatings for strong environmental resistance by high entropy engineering

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Research Theme: Coating and Ceramics

Year of Study (Presentation Type): Year 1 (Poster)

Abstract: Refractory metal alloys (e.g., W, Mo, Nb, Ta) are widely used as high-temperature structural materials due to their exceptional melting points, mechanical strength, and creep resistance. However, their poor oxidation resistance leads to rapid degradation in extreme environments, necessitating the development of protective coatings with superior oxidation resistance and durability.

This study employs high-entropy engineering to design and optimize oxidation-resistant refractory coatings. High-entropy refractory alloys are synthesized via arc melting using Nb, Mo, Ta, W, V, Cr and Y with Al/Si. Their phase composition and microstructure are characterized using scanning electron microscopy (SEM) and electron probe microanalysis (EPMA). Site-specific short-term oxidation behaviour is investigated using focused ion beam (FIB) and SEM to identify phases capable of forming continuous protective alumina/silica scales. Bulk alloys are then fabricated based on these compositions to evaluate their oxidation resistance and fracture toughness. Finally, the optimal composition is applied as a coating on refractory alloys, and its oxidation behaviour is assessed in high-temperature environments. This study aims to provide a novel materials design strategy for enhancing the oxidation resistance of refractory alloys in extreme conditions.

Development of Epoxy/Vitrimers Nanocomposites Coatings for Corrosion Protection of Magnesium

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Theme: Coating and Ceramics

Year of Study (Presentation Type): Year 1 (Poster)

Among the metal structural materials used in engineering, magnesium (Mg) alloys are the lightest. They are characterized by low density, outstanding electromagnetic shielding performance, and superior vibration-damping properties. Such advantages have enabled the wide application of Mg alloys in the automotive manufacturing, aerospace engineering and the marine industry. Nevertheless, their limited corrosion resistance significantly restricts their widespread use. To overcome this problem, this project aims to develop a high-performance smart coating that combines vitrimers and epoxy nanocomposites. The excellent corrosion resistance of this coating is attributed to the function of epoxy resin and nanofillers, and the self-healing ability is endowed by the reversible dynamic bonds (S-S) from vitrimers. When the coating suffers damage, the reversible dynamic covalent bonds in vitrimers react to external stimuli and trigger the self-healing mechanism. During this process, the broken molecular chains reconnect and restructure, efficiently sealing the cracks and flaws on the coating surface, barring the entry of corrosive substances.

The prepared coatings will be thoroughly studied using diverse microscopic and spectroscopic techniques to characterize their structure and composition. Furthermore, the corrosion resistance and self-healing efficiency are evaluated by Electrochemical Impedance Spectroscopy (EIS) and scratch tests. This systematic approach ensures that the developed smart coatings can satisfy the long-term protection needs of Mg alloys.

Microstructural Region Identification in Thermal Barrier Coatings via Nanoindentation Loading Response Analysis

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Theme: Coating and Ceramics

Year of Study (Presentation Type): Year 1 (Poster)

TBCs are essential for protecting high-temperature components in gas turbines by reducing thermal loads, improving efficiency, and extending service life. Among various techniques, EB-PVD forms coatings with vertically oriented columnar structures that grow directly from the substrate surface, providing excellent resistance to thermal cycling and thermal shock. However, the microstructural heterogeneity, particularly between intra-column and inter-column regions, introduces significant challenges in evaluating local mechanical behavior and predicting failure mechanisms.

This study proposes a nanoindentation-based method for the identification of microstructural regions within the top layer of TBCs. By focusing on the loading section of the indentation curve, mechanical response features are extracted, such as pop-in behavior, and parameters from power-law fitting ($P = K \cdot h^n$), capturing the potential differences in deformation behaviours, associated with local structural variations. These features, reflecting parameters such as stiffness response, discontinuities, and overall relationship between load and displacement, are utilized in combination with unsupervised clustering to investigate the correlation between indentation signatures and specific microstructural zones.

The current results demonstrate that microstructural differences within the columnar structure can be identified based on mechanical response, without relying on high-resolution imaging (SEM). With continued development, the method may also be extended to other coating systems and graded materials.

Enhancing the Structural Integrity and Density of SiC_f/SiC Ceramic Matrix Composites with the Addition of Si Particles

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Research Theme: Coatings and Ceramics

Year of Study (Presentation Type): Year 1 (Poster)

Abstract body text;

SiC_f/SiC ceramic matrix composites (CMCs) have attracted attention for their better thermal and mechanical performances in aerospace and nuclear applications when compared to their metal alloy counterparts. They could be processed via Polymer Impregnation & Pyrolysis (PIP), Chemical Vapor Infiltration (CVI), Melt Infiltration (MI) etc. techniques. However, PIP yields relatively lower dense and highly porous CMCs with excess carbon content resulting from the inefficient ceramization of the precursors when compared to CVI and MI. In order to overcome this problem, Si particle addition will be made into the SiC matrix in certain proportions, different diameters and different morphologies. Si particles are expected to increase the density of the overall CMC and enhance the structural integrity of SiC matrix by incorporating itself to the SiC matrix network and also react with residual carbon, which has poor mechanical performance, at high temperatures (≥ 1400 °C) to yield SiC.

Influence of Steam on the CMAS Resistance Mechanism of $Gd_2Zr_2O_7$ -Based Thermal Barrier Coatings

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Research Theme: Coating and Ceramics

Year of Study (Presentation Type): Year 1 (Poster)

Thermal barrier coatings (TBCs) are widely used in gas turbines to protect underlying components from high-temperature gases. One of the main degradation mechanisms of TBCs is the CMAS ($CaO-MgO-Al_2O_3-SiO_2$) attack from volcanic ash, which can react with the coating and damage its structure. Gadolinium zirconate (GZO), as a novel TBC material, has been shown to resist CMAS attack by rapidly forming a stable apatite phase. The apatite serves as a dense protective layer, effectively blocking further CMAS penetration. However, with the growing interest in hydrogen as a cleaner fuel, the combustion environment will contain more steam, which may alter the reaction process between CMAS and TBC materials. In this study, comparative experiments were designed to investigate CMAS degradation in air and steam environments at 1300 °C, and the Gd/Zr compositional percentage of GZO material was considered. To characterise the reaction layers, XRD, SEM, EDS, Raman and TEM were employed to study the thermodynamics and kinetics of CMAS degradation. The results indicate that high Gd content provides stronger resistance to CMAS, while in low-Gd regions, steam suppresses apatite formation. These findings demonstrate that steam can significantly alter CMAS degradation, affecting the protective role of GZO.

Effects of A-site doping in BiFeO₃-BaTiO₃ piezoelectric ceramics

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Research Theme: Coating and Ceramics;

Year of Study (Presentation Type): Year 1 (Poster)

Abstract: Lead-free ferroelectric ceramics based on bismuth ferrite-barium titanate (BiFeO₃-BaTiO₃, BF-BT) solid solutions have shown great promise for applications in high-temperature piezoelectric transducers. Such devices are becoming increasingly important for structural condition monitoring at temperatures up to 600 °C. It has been recently demonstrated that dopant elements such as Mn²⁺ and La³⁺ can be effectively employed to suppress Bi vaporisation and oxygen vacancy formation, therefore improving the dielectric, ferroelectric and piezoelectric properties of BF-BT ceramics. In this work, we focus on the A-site doping, especially donor elements within the ABO₃ perovskite structures, and their effects in functional properties and the associated high-temperature behaviours will be investigated. The main aim of the project is to develop understanding the mechanisms of A-site doping on BF-BT piezoelectrics. Factors affecting the ferroelectric domain wall mobility will be evaluated through experimental investigations on the effects of chemical composition and subsequent heat treatment parameters such as annealing and quenching on the structure, microstructure and functional properties.

Environmental degradation of additively manufactured Ni-based superalloys

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Research Theme: Coating and Ceramics

Year of Study (Presentation Type): Year 1 (Poster)

Nickel-based superalloys provide high strength, toughness, and excellent resistance to oxidation and corrosion at elevated temperatures in power-generation turbine applications. Additive manufacturing (*AM*) is a potential candidate to represent conventional casting and forging for fabricating high-performance Ni-based superalloy components since it realizes a high level of geometry design freedom, shorter processing time, and lower costs. However, the *AM*-induced microstructure anisotropy will significantly affect the oxidation behaviours of nickel components along different planes, leading to detrimental effects in industry. This study introduces a novel *ABD-900 AM* nickel-based superalloy by selective laser melting (*SLM*) for anisotropy characterisation and isothermal oxidation tests in dry laboratory air. Early-stage oxidation (2 hours) and prolonged exposure (100 hours) at 1000 °C allow insights into the oxidation behaviour of novel *ABD-900 AM*. Thermodynamic analyses and kinetic calculations are combined to discuss the anisotropic oxidation performance parallel (*XZ*) and perpendicular (*XY*) to the build direction (*z*). The influence of post heat treatment on microstructure evolution of the as-printed *ABD-900 AM* is preliminarily elucidated.

Abstract Template:

The Development of Colour X-ray Imaging Using Hyperspectral Detectors)

Name: Alhanouf Alrwais

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Research Theme: [Imaging and Characterisation](#).

Year of Study (Presentation Type): Select one of the following and delete the rest: [Year 1 \(Poster\)](#).

Recent advancements in colour X-ray imaging, particularly through the use of hyperspectral detectors, represent a significant evolution in non-destructive analytical techniques. This poster presents a comprehensive overview of the development and application of hyperspectral X-ray imaging systems, emphasizing their ability to provide detailed spatial and spectral information for elemental analysis. By employing hyperspectral detectors such as the HEXITEC detector, which offers high energy resolution and enables the simultaneous measurement of elemental compositions, it is possible to capture a wide range of elemental distributions within a single imaging session.

The integration of hyperspectral detectors enhances the ability to resolve overlapping spectral features, thereby enabling precise chemical identification and mapping within complex matrices. This advancement is critical in fields ranging from materials science to medical diagnostics, where accurate chemical composition analysis is essential. The poster illustrates various case studies in which hyperspectral imaging has been successfully applied, demonstrating its potential to revolutionize traditional imaging modalities by delivering richer, more informative images without causing damage to the samples.

Through this exploration, the transformative impact of hyperspectral detectors in colour X-ray imaging is underscored, highlighting their role in advancing research and applications that require precise elemental analysis.

Fuel Retention and Release Mechanisms in Breeder Blanket Materials for Nuclear Fusion Devices

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Research Theme: Imaging and Characterisation

Year of Study (Presentation Type): Year 1 (Poster)

As global energy demands continue to rise and concerns over climate change intensify, developing a clean and sustainable primary energy source has become increasingly critical. By emulating the fusion processes that sustain the sun, nuclear fusion promises a virtually limitless and sustainable energy solution. Current fusion reactor designs rely on breeder blanket and fuel cycle (BBFC) technologies to generate, store, and supply tritium, a hydrogen isotope used in the fusion process. However, tritium can diffuse into surrounding structural materials within BBFC systems, potentially becoming trapped, weakening mechanical properties through hydrogen embrittlement, and reducing fuel cycle efficiency.

This research investigates the release and retention behaviour of tritium in candidate breeder blanket structural materials, and how extreme reactor conditions—such as neutron irradiation, high temperatures, and breeder material corrosion—influence these mechanisms. Gr.91 creep-resistant steel and reduced activation ferritic-martensitic (RAFM) steels, such as Eurofer 97, were exposed to deuterium—a tritium proxy—via electrochemical charging and will be compared to future exposures using gas loading via a gas-driven permeation system (GDPS) and plasma ion exposure charging using DELPHI-II. The trapping behaviour of deuterium will be analysed using thermogravimetric analysis (TGA), NanoSIMS, and electron microscopy. NanoSIMS, a high-resolution imaging technique, enables nanometre-scale surface mapping of light elements and reveals how deuterium distribution correlates with microstructural features before and after in-operando exposures.

Atomic-Scale Investigation of Structural Disorder in Cycled NMC-811 Cathode via

3D Δ -PDF Analysis

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Research Theme: Imaging and Characterisation

Year of Study (Presentation Type): Year 1 (Poster)

$\text{LiNi}_{0.8}\text{Mn}_{0.1}\text{Co}_{0.1}\text{O}_2$ (NMC-811) is a high-nickel content layered cathode material that aims to reduce the dependency on cobalt (as used in conventional LiCoO_3 cathodes), given the socio-economic issues associated with cobalt production¹.

This study will employ 3D-electron diffraction experiments along with 3D- Δ -pair distribution function (Δ -PDF) analysis to explore the fundamental causes of capacity fade due to structural degradation during cycling, including cation mixing (Ni/Li anti-site defects) and phase transitions to disordered spinel/rock-salt phases² to address the critical need for mechanistic insights into performance degradation.

Through tomographic imaging and 3D structural modelling, the experimental results reveal that after cyclic treatment some diffraction peaks exhibit significant delocalisation along the crystallographic c-axis, indicating a breakdown in the interlayer correlations while still maintaining the general hexagonal structure within each layer. The nature of the disordering in these layers is unclear but may be due to transition metal substitution onto lithium layers, explaining the possible reduced capacity. Furthermore, a secondary phase with a rock salt-like structure gradually forms in the surrounding regions while part of the intact crystal core remains. This has been shown based on the whole picture of diffraction patterns from 500 cycled NMC-811 material.

Reference

- (1) Savina, A. A.; Abakumov, A. M. Benchmarking the Electrochemical Parameters of the $\text{LiNi}_{0.8}\text{Mn}_{0.1}\text{Co}_{0.1}\text{O}_2$ Positive Electrode Material for Li-Ion Batteries. *Heliyon* **2023**, *9* (12), e21881. <https://doi.org/10.1016/j.heliyon.2023.e21881>.
- (2) Qian, G.; Wang, J.; Li, H.; Ma, Z.-F.; Pianetta, P.; Li, L.; Yu, X.; Liu, Y. Structural and Chemical Evolution in Layered Oxide Cathodes of Lithium-Ion Batteries Revealed by Synchrotron Techniques. *National Science Review* **2022**, *9* (2), nwab146. <https://doi.org/10.1093/nsr/nwab146>.

Visualization of interface evolution in solid-state batteries based on electron microscope

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Research Theme: Imaging and Characterisation

Year of Study (Presentation Type): Year 1 (Poster)

Abstract:

Lithium-ion batteries (LIBs) as the core component of various energy storage devices have seen unprecedented development in recent years. Solid-state batteries (SSBs) have potential for future batteries compared with liquid-based batteries due to their higher energy density and improved safety. However, interfacial instability and unfavorable contact of multiple interfaces inside batteries will markedly restrict further application of SSBs. As a powerful characterization tool, electron microscope (EM) makes it possible to visualize the evolution of interfaces in SSBs during electrochemical cycling. Its superior resolution allows direct imaging of the solid-solid interfaces and track pathways of ionic diffusion and degradation at the atomic level. Furthermore, suitable in-situ EM techniques could be employed to image these progresses dynamically, which could also possibly provide significant insights that will be applied to enhance the battery performance and lifetimes. Therefore, this project will utilize advanced scanning electron microscope and transmission electron microscope to focus on the connection between structural evolution and electrochemical properties of SSBs systems. The microscopic visualization are expected to complement other macroscopic characterization to more accurately elucidate the evolution mechanisms.

Linking Corrosion Reactions, Hydrogen Embrittlement, and Adsorption to Surface Passive Film Properties.

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Metallurgy and Corrosion

Abstract

Hydrogen embrittlement is a critical failure mechanism that could minimise the ductility and strength of metals causing a random and unexpected material failure. It is essential to understand this characteristic to ensure the safety and reliability of components used in the corrosive and hydrogen-rich environments. Therefore, this project investigates the link between corrosion reactions, hydrogen embrittlement, and the absorption to surface passive film properties of type 316L stainless steel. The study aims to identify the local sites where hydrogen gas evolves by using in-situ optical observation of cathodically polarized 316L stainless steel in AGAR gel. The AGAR gel was used to slow down the reaction, allowing for clearer visualization and observing the changes of hydrogen formation in the real-time. Cathodic polarisation of 316L stainless steel showed the local sites where hydrogen gas was formed in the AGAR gel. As a result, the localized hydrogen gas formation indicated active reaction sites, and it shows that passive film on 316L stainless steel may have inhomogeneous properties affecting hydrogen absorption and evolution.

These reactive sites will be further investigated for their surface chemistry, topography, and electrochemical behaviour using advanced characterization techniques using Atomic Force Microscopy (AFM), Scanning Kelvin probe Microscopy (SKPFM), X-ray Photoelectron Spectroscopy (XPS), Laser-Induced Breakdown Spectroscopy (LIBS), and Scanning Electron Microscopy (SEM) with Energy Dispersive X-ray analysis (EDX). Understanding how hydrogen interacts with passive films is significant in preventing hydrogen embrittlement and enhancing the reliability of sustainable structural materials in hydrogen-based conditions.

Hydrogen Retention in Metals under Cryogenic Exposure

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Research Theme: Metallurgy and Corrosion

Year of Study (Presentation Type): 1st Year Poster

Abstract

Hydrogen is recognized as a potential clean energy carrier, critical to the global shift towards sustainable energy systems. This research addresses the critical issue of hydrogen ingress into structural materials—focusing on stainless steel and aluminium alloys—under low-temperature environments characteristic of cryogenic storage systems.

In this work, several experimental methodologies are applied: (1) Hydrogen concentration assessments using LECO combustion analysis and Laser-Induced Breakdown Spectroscopy (LIBS), enabling quantitative evaluation of hydrogen uptake. (2) Mechanical property analysis under cryogenic conditions using the Deben Tensile Stage, providing relationships into hydrogen-related embrittlement and strength. (3) Hardness measurements, using the correlation between hydrogen-induced lattice distortions and material hardness, to assess hydrogen effects on microstructure.

High Temperature Performance of Alloy 800H in an Impure Helium Environment

Matthew Brayne

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Metallurgy and Corrosion

Year 1 poster

High-temperature gas-cooled reactors (HTGRs) are evolutionary designs derived from advanced gas-cooled reactors (AGR), but they utilize helium instead of carbon dioxide. This research evaluates candidate structural materials for HTGR applications by systematically examining their resistance to oxidation, carburisation, decarburisation, and creep under simulated reactor conditions. Corrosion in HTGRs is primarily driven by impurities in the helium coolant, possibly including CO, CO₂, O₂, CH₄, H₂O, and H₂. Initial oxidation studies conducted in a mild vacuum evaluated the effect of low oxygen on the oxidation behaviour of Alloy 800H and stainless steel 316H. Results revealed a strong dependence on surface preparation, where ground surfaces facilitated the formation of a thin, protective chromia layer, while OPS-polished surfaces promoted a non-protective duplex oxide consisting of magnetite and chromia. Interestingly, Alloy 800H also exhibited preferential oxidation of aluminium along grain boundaries, the implication of which on creep performance will be evaluated in future work. Future work will focus on advanced materials characterization of the tested samples using electron microscopy as well as investigating material performance (including creep) under impure helium environments with controlled impurity levels to better replicate HTGR operational conditions.

Improving the tolerance of aluminium alloys to impurity elements

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Research Theme: Metallurgy and Corrosion;

Year of Study (Presentation Type): Year 1 (Poster),

The properties of aluminium alloys are greatly influenced by their composition but can be further altered through homogenisation heat treatments. In this study the phases present during solidification and changes that occur during homogenisation are investigated in three different aluminium alloys with varying amounts of magnesium and manganese. Characterization of the microstructure is performed using optical and scanning electron microscopy along with differential scanning calorimetry. The results are compared with JMatPro calculations. The as-cast microstructure was determined to have $Al_6(Mn,Fe)$, $\alpha-Al(Mn,Fe)Si$, and Mg_2Si phases with additions of T-AlCuMg in the alloy with increased Mg. During homogenisation the Mg_2Si phase underwent dissolution and the $Al_6(Mn,Fe)$ phase transformed into the $\alpha-Al(Mn,Fe)Si$ phase. As Mg content increased in the alloys, the rate of Mg_2Si dissolution decreased along with the rate of the $Al_6(Mn,Fe)$ to $\alpha-Al(Mn,Fe)Si$ transformation.

Microstructure crack growth relationships in Ti64

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Research Theme: Metallurgy and Corrosion;

Year of Study (Presentation Type): Year 1 (Poster)

The growth of cracks in Ti64 is of great importance to the safety of components within the aerospace industry, like fan blades, failures of these parts damage confidence in the industry [1]. Therefore, the goal of the project is to determine; how does the microstructure and microtexture of Ti64 effect the crack growth rate in loading regimes with and without dwell. To achieve this the project has been split into four work packages; microstructure and texture characterisation, crack path experiments, crystal plasticity modelling and 3D microstructure characterisation.

In my first year of study, I have begun to characterise the microstructure and microtexture of Ti64 through, optical microscopy, BSE imaging and EBSD mapping, the results of which are presented in this poster. Further study will include crack micro-plasticity experiments through fatigue tests probing specific microtextures, as determined from the microtexture characterisation, and HRDIC analysis. As well as crack tip plasticity modelling using existing crystal plasticity models and the experimental results of the fatigue tests. Finally, using synchrotron x-ray diffraction the 3D microtexture of the sample will be measured before in-situ fatigue experiments which will cause crack growth so that the microtextures influence on crack growth can be determined.

[1] BEA. (2019). TECHNICAL REPORT - Accident to the Airbus A380 registered F-HPJE and operated by Air France on 30/09/2017 en route over Greenland - October 2017 - June 2018 - Searches Phase I & II.

Abstract Template:

Measurement and Simulation of Laser-Metal Interactions

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Research Theme: Select one of the following and delete the rest:

[Metallurgy and Corrosion;](#)

Year of Study (Presentation Type): Select one of the following and delete the rest: [Year 1 \(Poster\)](#)

Investigating how metallic structures respond to energy imparted by high-power lasers is of growing importance across a range of scientific and engineering fields. Allied to this understanding is the need to develop predictive tools to accurately model these interactions. One of the main challenges in modelling this interaction is the design of experimental setups capable of capturing the complex processes that occur as metal melts and evaporates under rapid transient heating. This is further complicated by the influence of surface conditions and coatings, both of which are critical in practical applications. This project aims to further the understanding of laser-material interactions involving a variety of technologically relevant materials, including steels, aluminium alloys, and a range of surface finishes and coatings. Using novel instrumentation, key thermo-physical properties will be measured during trials at the high-power laser facilities in Manchester. Coupon testing and the use of various apparatus, such as an oscillating vessel viscometer and a differential scanning calorimeter, will be necessary to determine the temperature dependence of fundamental thermo-physical properties at NPL, and to investigate the sensitivity of, and uncertainty in, the data with respect to surface finishes. The results of these measurements will be used to inform and refine models under development at Manchester, enabling more reliable predictions of the effects of laser-based energy on metallic structures.

Retained austenite decomposition in low alloy steels

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Research Theme: Select one of the following and delete the rest:

Metallurgy and Corrosion;

Year of Study (Presentation Type): Select one of the following and delete the rest: Year 1 (Poster)

Low alloy steels are used in a variety of engineering applications as structural materials. They are often heat treated to form microstructures comprising hard microconstituents such as bainite and martensite. Typical heat treatment usually comprise austenitisation, quenching and tempering steps. Following quenching, it is often found that small amounts of austenite remain untransformed at room temperature, called retained austenite. This retained austenite can be found as carbon-enriched austenite blocks, or films which are stabilised between martensite laths. While the amount of this is small, it may influence the final microstructure and properties of the final component after tempering. The presented work uses X-Ray diffraction (XRD) with Rietveld refinement and electron backscatter diffraction (EBSD) to measure the amount of retained austenite in the samples prior to and post tempering. Additionally, quench dilatometry is used observe austenite decomposition in situ.

Understanding the influence of the composition and microstructure of PVD coatings on the performance of coated claddings.

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Research Theme: Metallurgy and Corrosion

Year of Study (Presentation Type): Year 1 (Poster)

Ensuring the safety of nuclear power reactors has been at the forefront of their development, deployment and operation whereby improvements in both materials and fuels technology remains central to the success of the sector. The main aim of accident tolerant fuel (ATF) development is to identify and evaluate alternative fuel system technologies that can further enhance the safety of light water reactor (LWR) systems. Enhanced ATFs can tolerate a severe accident in the reactor core for a considerably longer time than the current $\text{UO}_2\text{-Zr}$ -alloy fuel system, while improving the fuel performance during normal operations and operational transients. Presently, the addition of a chromium-based coating to Zr through magnetron sputtered physical vapour deposition (MS-PVD) has been shown to be a promising ATF contender. However, significant variations in the coating's performance occurs as the deposition parameters and coating design are altered. Further investigation of the influence of these parameters on the microstructure, mechanical properties and irradiation performance of chromium-based coated claddings is needed if they are to be accepted as a feasible ATF alternative that can act as a "drop-in" replacement for current and future PWR reactor designs.

Micro-Mechanical Testing of Fusion Steel: The Effect of Temperature and Strain Rate

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Research Theme: Metallurgy and Corrosion

Year of Study (Presentation Type): Year 1 (Poster)

Nuclear fusion has the potential to offer sustainable and reliable electricity. However, it is currently impossible to physically expose candidate materials for in-vessel components to a tokamak operating condition (high heat and neutron fluxes) until the first reactor becomes operational. Hence, the ability to understand the effect of this environment experimentally is limited to surrogate techniques with low certainty. In the absence of a comprehensive database of materials properties, predictive models and advance simulation techniques will be required.

UKAEA is developing predictive models that are based on a mechanistic understanding of microstructure-mediated deformation and failure. Robust data of properties - slip, hardening laws, deformation mechanisms and microstructural parameters - under fusion-relevant conditions are required to validate and parametrize the models. Information regarding plasticity is crucial at the nano-scale, and must be probed in thin irradiated layers. Hence, nanoindentation will be used for the measurement of highly-spatially resolved mechanical response. Advanced characterization techniques like SE/BSE imaging, EBSD, confocal microscopy coupled with FIB milling will be used for correlation with the mechanical testing. The project will contribute essential understanding and measurement of plasticity of iron-based fusion alloys, including temperature, strain rate and irradiation effects to qualify the crystal plasticity model performance.

Abstract — Materials Release Rate Under Fusion Environments

Fusion energy promises clean, limitless power, but building reactors that can survive its extreme conditions remains a major challenge. In particular, material used in the cooling systems in European projects such as ITER and DEMO are exposed to high temperatures, high pressures, and extreme radiation. These conditions can lead to the gradual corrosion and release of metal ions into the water, which can also be activated due to the neutron radiation. This can cause a great deal of difficulties in terms of maintenance and disablement.

This project focuses on how these corrosion products are formed and how their activation can affect the water chemistry. A custom-built experimental setup will be used to expose some candid materials such as CuCrZr, Eurofer-97 and 316-L to fusion-like water conditions and temperature to track the rate of materials release over the lifetime of the reactor. Advanced tools such as ICP-MS will be used to measure the material dissolution, and imaging techniques to examine any changes to the material surface.

By combining the experimental results with current mathematical models, metal release rate can be predicted and used in future designs and safety codes used for fusion reactors. The findings support global efforts, including the EURO fusion program, to build better materials for the next generation of fusion reactors.

Mathematical Modelling of High Energy Density Laser-Substrate Interactions

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Research Theme: Metallurgy and Corrosion

Year of Study (Presentation Type): Year 1 (Poster)

Mathematical modelling of laser-substrate interactions permits the exploration of scenarios with physical change that occurs too rapidly to be measured easily.

Here the open-source thermal-fluid-dynamics toolbox 'laserbeamFoam' is used to simulate high energy density laser-substrate interactions. By utilising a finite-volume discretisation scheme to solve the governing equations - namely the conservation of mass, momentum and energy; these non-linear equations are iterated to convergence to provide insight over timescales of seconds, with simulation run-times of days.

The laser beam is discretised into rays that are tracked through a domain. When a ray encounters an interface some energy is reflected and some is absorbed, depending on the angle of incidence and material properties.

The absorbed energy melts and vaporises the material giving a molten recess with a liquid to gas boundary. Forces work to deform the liquid and confine subsequent incident rays. A capillary or 'keyhole' develops and rays are reflected down deep into the keyhole.

laserbeamFoam allows the user to manipulate a beam, or an array of beams, incident on single or multi-component substrates, and adjust laser and material properties. This gives a broad field of view to research, progress and validate our understanding of laser-substrate interactions at a fundamental level.

Title: Adjust welding parameters in Additive Manufacturing to control the microstructure

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Research Theme: [Metallurgy and Corrosion](#);

Year of Study (Presentation Type): [Year 1 \(Poster\)](#)

In additive manufacturing, components fabricated through layer-by-layer deposition undergo complex thermal histories, leading to microstructural characteristics distinct from those of conventionally manufactured parts. Notably, phenomena such as CET (Columnar-to-Equiaxed Transition) can emerge in additively manufactured components. Compared to casting, additive manufacturing offers greater flexibility in adjusting process parameters (e.g., heat input, scan speed, cooling strategies) to control temperature gradients and solidification rates, thereby tailoring the microstructure. This control may involve optimizing one or multiple parameters. This poster aims to elucidate how these parameters govern microstructural evolution, particularly in manipulating CET behavior, to achieve enhanced mechanical properties and uniformity in additively manufactured alloys.

Surface Modification of tungsten alloys to reduce hydrogen permeation

Name: Adrian Leung, Maulik K Patel (Secondary Supervisor, University of Liverpool), Christian Nygaard, Teuntje Tijssen (Industrial Supervisors, United Kingdom Atomic Energy Authority) and Philip D Edmondson (Primary Supervisor, University of Manchester)

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Research Theme: Select one of the following and delete the rest:

[Metallurgy and Corrosion;](#)

Year of Study (Presentation Type): [Year 1 \(Poster\)](#)

It is imperative to maximise the available tritium inventory for sustainable fusion energy by reducing permeation and trapping in materials. Thus, the transport of hydrogen isotopes through the reactor needs to be understood. The purpose of this project is to understand the influence of microstructural features on the effect of hydrogen isotope permeation. It is well known that permeability varies between different materials, which in the fusion environment means they must also withstand radiation damage at high temperatures. The project plans to perform surface modification of tungsten in the near surface (10-30 microns) to investigate the effect of defects microstructures on permeation, including the use of ion irradiation as a proxy for radiation damage. Subsequently, the permeation and retention of hydrogen isotopes in tungsten will be studied using the Gas Driven Permeation System (GDPS) at the University of Manchester. Tungsten coupons were cut using Electrical Discharge Machining (EDM) into 10 x 10 x 3mm square coupons and analysed with Scanning Electron Microscopy (SEM) & X-ray Diffraction (XRD). A proposal was accepted by the Dalton Cumbria Facility's Spring ion irradiation campaign. Ongoing progress is to further prepare and characterise samples while also preparing to irradiate samples for testing in the GDPS.

Understanding in-reactor formed oxides on zirconium cladding

Name: Michael McGlynn

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Research Theme: Metallurgy and Corrosion

Year of Study (Presentation Type): Year 1 (Poster)

Zirconium (Zr) is a commonly used cladding for fuel rods in pressurised water reactors because of its corrosion resistance and low neutron absorption. Due to the corrosive environment within reactors the oxidation of Zr is a limiting factor in the cladding's lifetime. While it has been studied rigorously in out-reactor tests, work on in-reactor corrosion is scarce because of difficulties obtaining samples. This project has been given access to samples corroded in the Vogtle reactor by our sponsors at Westinghouse. The sample alloys are ZIRLO[®] and Optimized ZIRLO[™] which, having lower tin content, has shown improved corrosion resistance in autoclave tests. We will analyse how the composition of these samples relates to their corrosion rates in a reactor environment. We also aim to compare the corrosion of these in-reactor samples to data we will gather from out-reactor corrosion testing. X-ray diffraction will be the main analytic technique used on the Zr samples. This is a non-destructive method capable of analysing stresses, texture, and phase fraction in a large sample volume. It can also examine the substrate to make connections between it and the oxide behaviour. This will complement electron microscopy work done by collaborators at Oxford University.

Strain rate and temperature effects in slip activity in Titanium IMI834

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Research Theme: Metallurgy and Corrosion

Year of Study: Year 1 (Poster)

Cold dwell is a time-dependent degradation process that can lead to the reduction of fatigue life of aero-engines. Cold dwell fatigue occurs in titanium alloys under cyclic loadings with dwell periods at peak stress below the yield strength. These dwell periods are associated with critical operational phases of flights, such as take-off. There are no measurements at the microscale that can demonstrate how this mechanism operates in an actual microstructure. Here digital image correlation was used to investigate the material response to loading cycles at the micro- scale. Representative samples extracted from an actual forging were loaded to 80% and 90% of its yield strength, followed by a dwell period to induce creep at room temperature. In the high-resolution digital image correlation experiments images were captured to allow the measurement of local strain development after loading at each stress level. Slip activity was analyzed using the in-house built Python library, DefDap [3] to identify active slip systems. The slip activity and strain distribution in the primary and secondary alpha were also determined at all stages. These unique measurements help to elucidate the mechanisms behind the dwell debit in Titanium IMI834.

References:

- [1] M. Bache, International Journal of Fatigue IV 25.9 (2003), pp. 1079–1087.
- [2] Y. Xu et al., International Journal of Plasticity 134 (2020) 102753.
- [3] M.D. Atkinson et al., Zenodo (2020).

Numerical Modelling of Multi-Component Liquid Metal Systems during State Transitions

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Research Theme: Metallurgy and Corrosion

Year of Study (Presentation Type): Year 1

Developing mathematical and numerical methods to accurately describe heterogeneous systems with large property gradients is essential for advancing our understanding of complex, multiphase systems. In such systems, properties like electrical conductivity and magnetic permeability can vary several orders of magnitude between metallic, structural, and gaseous phases. Therefore, an accurate prediction of the magneto-thermo-hydrodynamics in these cases requires a framework that accounts for multiple phases with large property contrasts, descriptions of turbulence development in the fluid region, and solidification. Current approaches, however, are typically limited to single-phase systems with weak electromagnetic contrasts, and therefore this new framework would provide unprecedented fidelity and have widespread industrial impact; from safety-critical processes such as high-integrity component manufacturing, including welding and additive manufacturing, to energy systems like nuclear fusion and fission power plants. One critical application within nuclear fusion is the study of liquid metal breeder blankets, which are responsible for both heat extraction and tritium breeding – the safe and efficient operation of these components requires accurate predictions of the magneto-thermo-hydrodynamics in such systems.

Development of a New Approach to Prevent Hydrogen Embrittlement (HE) in Aluminum Alloys

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Research Theme:

Metallurgy and Corrosion;

Year of Study (Presentation Type):

Year 1 (Poster)

7xxx series Al alloys are widely utilized in automotive frames and aerospace applications, owing to their excellent tensile strength and fatigue resistance. However, hydrogen atoms can enter the microstructure during hydrogen gas exposure, atmospheric corrosion, or electrochemical charging. The presence of hydrogen could lead to hydrogen embrittlement (HE) of that alloy. More research is needed to better understand the effect of corrosion and hydrogen on crack nucleation. In this project, electrochemical charging in NaCl has been used to expose 99.5% pure Aluminium and Al7075-T6 to hydrogen. A black film forms on the surface of Al7075-T6 during hydrogen charging, due to the corrosion reaction and deposition of a smut layer. The hydrogen charged microstructures were then assessed using an in-situ imaging platform during exposure to water and oil, to observe hydrogen effusion. Video recording and differential pressure analysis was carried out, showing that the hydrogen gas outgassing rate increased with charging time. The effect of desmutting and anodic oxidation was assessed, indicating to be key factors determining the outgassing rate. The overarching goal of this project is to apply surface engineering to generate a HE resistant near surface layer for preventing the hydrogen embrittlement.

Uncertainty Quantification Methods for Crystal Plasticity Modelling of Fusion Materials

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Research Theme: Metallurgy and Corrosion

Year of Study (Presentation Type): Year 1 (Poster)

Materials used for plasma-facing components in a fusion reactor will suffer a unique combination of damages from thermal, electromagnetic, and neutron irradiation effects. To ensure chosen materials can maintain structural integrity for at least five years, the probability that components will fail under fusion relevant conditions must be accurately determined. Crystal plasticity models simulate the evolution of material microstructures under applied loads and provide information on where plastic deformation has occurred, which is an indicator of material failure. Focusing on CuCrZr alloys, two types of crystal plasticity model, phenomenological and dislocation density based, will be implemented and the quantitative differences between simulation outputs will be examined. To determine probabilities of failure from crystal plasticity modelling, statistically equivalent simulated microstructures will then be used to provide initial uncertainty bounds on material parameters, before a Markov chain Monte Carlo algorithm constructs a distribution for each material parameter after deformation. Statistical analysis of these results will then determine material failure risk probabilities. Future work will involve developing an integrated risk assessment, using experimental data and simulations to accelerate the qualification of fusion components. Alternative uncertainty quantification methods will also be tested to produce failure risk estimates with reduced computation time.

Thermal Condition-Driven Microstructure Control in Metal Additive Manufacturing

Name: Chuyuan Xu

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Research Theme: Metallurgy and Corrosion;

Year of study: Metal Additive Manufacturing (MAM) is an advanced technique for fabricating complex components through localized melting and solidification of metal powders. For metallic alloys, rapid and spatially varying thermal cycles during processing govern microstructural evolution and defect formation, ultimately influencing the mechanical performance of the fabricated parts. In this study, a heat conduction-based simulation model was developed in ABAQUS to analyse the relationship between local thermal evolution and key microstructural characteristics, including grain morphology, crystallographic orientation, and phase distribution. The experimental analysis will be carried out using electron backscatter diffraction (EBSD) and in situ X-ray characterisation. The results of this study offer theoretical guidance for the controlled design of microstructures in complex components and establish a foundation for process optimization and performance enhancement.

Abstract

Bipolar Electrochemistry for Probing the Effect of Hydrogen Embrittlement on SCC of Stainless Steel

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Research Theme: Metallurgy and Corrosion

Year of Study (Presentation Type): Year 1 (Poster)

Bipolar electrochemistry has been explored to assess the corrosion behaviour of type 316L and type 420 stainless steel. The goal is to use this technique for studying the corrosion behaviour of stainless steels, and to better understand the initiation of stress corrosion cracking (anodic) and hydrogen embrittlement (cathodic) using a novel bipolar electrochemistry set-up.

The first year was mainly concerned with better controlling the bipolar electrochemistry set-up and being able to quantify and measure the acting electrical field on the sample surface. This was done by exploring a novel bipolar design simulating local polarisation and decoupled redox conditions. This was also carried in a customised design of an electrolyser electrochemical cell.

Several bipolar tests with type 420 stainless steel and type 316L were conducted, and the first results showed that

1. the first bipolar corrosion tests on type 420 & 316L stainless steel, which give nice data by changing feeder electrodes.
2. Designed a new method/cell to measure and control our bipolar response by varying current and voltage.
3. Measured and quantified local responses in our new bipolar device.
4. Explored applications of closed bipolar devices (for Devanathan cell devices).

(Next-Generation Lead-Free Dielectric Ceramics for High-Performance Capacitors)

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Research Theme: Nano and Functional Materials.

Year of Study: Year 1 (Poster)

High-temperature and high voltage lead-free dielectric ceramics are crucial for advanced power electronics used in electrical vehicles. However, present ceramic capacitors, predominantly based on BaTiO₃, face significant challenge when operating at high temperature and high voltage environment.

While relaxor ferroelectrics with different compositions have demonstrated promise for high temperature uses, most current materials, such as BaTiO₃, BiFeO₃ and Na_{0.5}Bi_{0.5}TiO₃ are difficult to operate in such an environment. Common failure mechanisms include electric field induced phase transformation, high dielectric loss and low permittivity.

This project aims to address these limitations by creating a complex solid solution based on lead-free BiFeO₃-SrTiO₃ (BF-ST) to generate a relaxor dielectrics with high permittivity ~1000 and low $\tan\delta < 0.02$ with thermal stability during a wide range of temperature from up to 200 °C. The lead-free ceramic's compositions will be fabricated by solid-state reaction method. The project will primarily investigate the structure-property relationships and the impacts of various doping strategies to enhance the stability of dielectric performance in these materials over a broad range of temperatures.

High entropy organic semiconductors for new optoelectronic and phonically active materials

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Research Theme: Nano and Functional Materials

Year of Study (Presentation Type): Year 1 (Poster)

To limit the effects of global warming, the development of new green materials for use in electronic devices is increasingly important. Organic semiconductors (OSCs) are solution processable, allowing device manufacturing at a lower energy cost than traditional inorganic semiconductors. Band structure engineering in semiconductors allows for precise control over the electronic properties of the material. However, for OSCs, limitations exist in the degree of band structure engineering that can be achieved via molecular design or blending similar materials. Developing new approaches has the potential to allow OSCs to be used in new low-energy embedded electronics. In this work, blends of diphenylhexatriene (DPH) derivatives were explored to establish if a complex mixture of five DPH derivatives could be used to form a new highly ordered crystalline structure. GIWAXS was employed to investigate the crystallisation of the individual components as well as complex mixtures to compare them. Results indicate that DPH derivatives possessing long alkyl chain functional groups formed lamellae-type structures which likely dominated the crystallisation process and prevented the formation of hybrid crystal structures. Further work will be done to explore combinations of DPHs possessing different functional groups and explore their propensity to form new hybrid crystal structures from complex mixtures.

Colloidal Quantum Dots Doped by Single Rare Earth Ions for Quantum Memories and Repeaters

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Research Theme: Nano and Functional Materials.

Year of Study (Presentation Type): Year 1 (Poster)

Singly doped colloidal quantum dots (CQDs) are promising spin-photon interfaces for quantum repeaters and memories for several reasons: the dopant spin couples with an exciton in the CQD via an exchange interaction, resulting in a significantly larger optical cross-section than isolated ions; established CQD synthesis techniques can create a low-spin environment that enhances the dopant spin lifetime; and CQDs' substrate-free nature allows easier integration into photonic structures such as nano-antenna and micro-cavities.

A significant challenge has been the stochastic nature of the doping processes that makes it difficult to achieve reliable single doping and to position the single dopant centrally in the CQD. A recent project demonstrated that CQD growth from a singly doped molecular cluster could solve these problems for doping with Mn^{2+} ions. However, the milli-second spin lifetimes needed for long-range quantum repeaters require rare earth dopants like Gd^{3+} or Er^{3+} .

This project focuses on fabricating yttrium oxide (Y_2O_3) and yttrium clusters (penta, octa, and nonanuclear), known for their stability and optical properties. These materials will be doped with rare earth ions to achieve photoluminescence (PL) in the 1.5-1.6 μm range, suitable for quantum communication applications, with characterization to include TEM, SEM, XRD, and fluorescence spectroscopy.

High Entropy 2D Materials for Efficient Water Splitting

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Research Theme: Nano and Functional Materials

Year of Study (Presentation Type): Year 1 (Poster)

Green hydrogen production via water splitting is a promising method for achieving sustainable energy solutions. High-entropy materials (HEMs) have recently emerged as promising electrocatalysts due to their tunable compositions, structural stability, and defect-rich nature. Two-dimensional (2D) materials offering large surface area, high density of active sites, unique electronic properties, and efficient charge transport are particularly suited for enhanced electrocatalytic applications. Furthermore, elemental doping is an efficient strategy to tailor electronic structure and surface chemistry, leading to enhanced catalytic activity, selectivity, and long-term stability. This study focuses on the development of doped 2D HEMs as high performing catalysts for overall water splitting, targeting both hydrogen evolution reaction (HER) and oxygen evolution reaction (OER). This study aims to optimise the composition and structure of HEMs to achieve superior catalytic activity. The properties of the synthesised materials will be evaluated using comprehensive characterization techniques followed by electrochemical testing to elucidate their catalytic efficiency and durability with aiming to achieve next-generation materials for clean-energy applications.

Direct Writing of Lanthanide Chalcogenides

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Research Theme: Nano and Functional Materials

Year of Study (Presentation Type): Year 1 (Poster)

Focused Electron Beam Induced Deposition (FEBID) is a technique used in the direct writing of nanostructures- primarily semiconducting materials. This novel method of creating nanostructures represents a more cost-effective method when compared to Extreme Ultraviolet lithography. As a prerequisite to this work, there needs to be a strong foundation of understanding the material being 'written'.

The interest in oxysulfide (M_2OS_2 [where M=Metal]) research has grown since the early 2000s.¹ Lanthanide-based oxysulfides (Ln_2OS_2) possess unique features originating from the nature of lanthanide metals. Their applications range from oxygen storage to semiconductors.² The development of high entropy (HE) oxysulfides was published in 2021 in the work of Ward O'Brien *et al.*³

The possibility of using these HE Ln_2OS_2 compounds and developing them within the FEBID work is new, novel and interesting. Further, there exists an opportunity to develop HE Lanthanide Oxyselenides- an exclusive material that at the time of writing, represents an underdeveloped area of materials science.

The synthesis of Ln_2OS_2 thin films is of current interest, and subsequently the synthesis of Lanthanide-Selenide precursors and investigating the thermal decomposition to Oxyselenides are the focus of the first year of this PhD.

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Abstract Template:

Development of Theoretical and Numerical Models to Expound the Thermal Behaviour of Nanocomposite Phase Change Materials

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Research Theme:

[Polymers and Composites.](#)

Year of Study (Presentation Type): Year 1 (Poster)

Phase Change Materials (PCMs) can go through a phase transition and store/release heat energy as latent heat. They are ideal for Thermal Energy Storage (TES) and thermal regulation devices due to their high heat storage densities and the ability to store/release heat at a constant temperature. Hence, they can be effectively utilised in a variety of applications such as building energy management, solar units, electronic cooling units and battery thermal management, where PCMs might be an ideal solution as it is a passive cooling method that does not consume energy, unlike complicated, conventional active cooling methods. However, the lower thermal conductivities of PCMs affect the heat absorption rates. This can be improved by adding nanoparticles, but this causes the viscosity of the composite PCM to rise, minimising the convection rates. Hence, the type and the volume of nanoparticles added should be carefully determined. Metallic fins can also be used to create heat transfer pathways within PCMs. The shape and position of the fins can also be optimised, considering the performance of the whole PCM unit. Initially, this project aims to experimentally study the thermal performance of multiple composite PCMs. Then, suitable models will be developed to explain/model their behaviour. Eventually, some potential applications (such as EV batteries) will be considered to design and optimise thermal performance using Computational Fluid Dynamics (CFD) modelling, which will then be validated using experimental results using optimised composite PCMs.

Keywords: [Phase Change Materials](#), [Battery Cooling](#), [Computational Fluid Dynamics](#), [Cooling Unit Optimisation](#)

Quantifying & Qualifying Polymer Recyclate

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Research Theme: Polymers and Composites

Year of Study (Presentation Type): Year 1 (Poster)

With the devastating effects of anthropogenic climate change and pollution becoming ever more evident, research focused on driving down global consumption of fossil-fuels to produce polymers is crucial. Mechanical recycling is the primary apparatus to economically and ecologically reprocess polymers into new products and curb utilisation of virgin feedstock. This research looks at degradation of poly(ethylene terephthalate) (PET) over multiple extrusion cycles, emulating closed-loop recycling systems for bottles. Correlations were formed between fundamental changes in molecular structure (results showed a 15% decrease in molecular weight over 5 extrusion cycles) to melt, rheological, and mechanical properties. This study also aims to address gaps in literature pertaining to how additives used to counteract the degradation inherent in PET mechanical recycling, such as Joncryl (epoxide styrene-acrylic chain extender), change and build up over multiple cycles in closed-loop systems. Future research goals include defining means of identifying when PET may no longer be suitable to sustain a closed-loop system. Additionally, enhancement of lower-grade PET waste (such as pots, tubs, and trays) will be examined for recycling into fibres (sector with largest demand for recycled PET (rPET)), to address diminishing supply of rPET for the industry as progress is made in circularisation of higher-grade PET.

Abstract Template:

Shifting to Non-metallic Materials in Hydrocarbon Pipeline Applications

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Research Theme:

Polymers and Composites.

Year of Study (Presentation Type): Select one of the following and delete the rest: Year 1 (Poster), Year 2 (Talk), Year 3 (Poster)

Abstract

Globally, the transportation of hydrocarbon products relies heavily on metallic pipelines due to their efficiency, and cost-effectiveness. However, metallic pipelines are subjected to significant challenges arising from corrosion, which may lead to substantial leakage, and, ultimately, severe catastrophic events. Unlike metallic pipelines, non-metallic pipelines are a promising alternative for the transportation of hydrocarbon pipelines worldwide. Non-metallic pipelines exhibit remarkable attributes, such as excellent corrosion resistance and superior mechanical properties. However, non-metallic pipelines are still subjected to challenges that can reduce their lifecycle. Luckily, most of these challenges have been thoroughly addressed in various areas; however, studies inadequately cover the required inspection programs, maintenance procedures, and optimum manufacturing processes. Therefore, this study aims to expand the understanding of composite hydrocarbon pipelines' properties and performance reflecting the site's actual conditions. This was achieved by manufacturing a number of carbon fibre-reinforced polymer composite pipes with an epoxy matrix using braiding techniques. Additionally, these pipes were subjected to several tests, and their results showed outstanding enhancements, including a 17% increase in Maximum Allowable Operating Pressure compared to the existing non-metallic pipelines. Also, this project introduced an innovative approach for monitoring and emphasizing the necessary inspection and maintenance programs for the entire network of non-metallic pipelines.

Development of Nanocomposite Coatings for Aluminium Alloy Based Hydrogen Storage Tanks

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Research Theme: Polymers and Composites

Year of Study (Presentation Type): Year 1 (Poster)

Storage tanks are typically used to carry and transport hydrogen safely between locations for energy production. However, these tanks risk being impacted by hydrogen embrittlement, a phenomenon where metal ductility and strength decrease due to hydrogen absorption and diffusion, leading to fracturing and leakage. To minimise this, polymer coatings are a potential solution, effective in reducing the amount of hydrogen that can interact with the metallic surfaces. My research project focuses on the development and application of nanocomposite coatings on aluminium alloy 6061-T6 substrates, a standard liner material within type 3 hydrogen tanks. The formulations I am investigating for the coatings are GNPs/epoxy thermoset and GNPs/epoxy vitrimer nanocomposites. GNPs (graphene nanoplatelets) are added as filler in these nanocomposite coatings to improve the mechanical strength and gas barrier properties of the polymers whilst also promoting the self-healing ability through higher thermal conductivity in the epoxy vitrimers relative to the epoxy thermosets. Other factors such as the hydrogen permeation, electrical conductivity, adhesivity, and recyclability along with topographical and morphological characterisations are also variables to be measured and assessed to determine the functionality of these materials as coatings.

Abstract Template:

Graphene nanoplatelets composite

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Research Theme: Polymers and Composites

Year of Study (Presentation Type): Select one of the following and delete the rest: [Year 1 \(Poster\)](#),

Abstract body text; Times New Roman, Size 12; Left Justified; Max. 200 words; No figures or tables to be included.

Nowadays, nanoscale composites based on graphene and flexible polymer matrices offer a promising approach for the development of multifunctional composites with excellent mechanical, electrical and thermal properties. In this study, high-purity and large-surface area graphene nanoplatelets (GNPs) and graphene are added to the soft silicon elastomer Ecoflex to fabricate a new type of composite. Composites with different graphene loadings are prepared, and characterization techniques such as TGA, FTIR, SEM and Raman spectroscopy are carried out to study their structures, thermal properties and mechanical properties. Special attention should be paid to optimizing the dispersion and functionalization of graphene to enhance the interface compatibility with the Ecoflex matrix. The expected composites should exhibit significant improvements in thermal conductivity, mechanical strength and electrical responsiveness, demonstrating their application potential in flexible sensors, thermal management systems and wearable electronic devices. This study provides new insights into the design of lightweight, high-performance, and flexible graphene-based composites for next-generation multifunctional technologies.

Hierarchical Vitrimer Composites

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Research Theme: Polymers and Composites.

Year of Study (Presentation Type): Year 1 (Poster)

Epoxy resins and their (nano)composites are widely used in the industry because of the resin's high mechanical properties. However, the covalent cross-linking which gives epoxies their high performance also makes them challenging to reprocess or recycle. Thus, there is an urgent need to replace them with a polymer system that can be reprocessed or recycled without compromising the properties of the materials. Currently two possible routes are considered; reversibly cross-linked thermosets and highly processable thermoplastics. Epoxy vitrimers are considered a potential route for the former, because of their dynamic covalent bonding system (DCBS). This DCBS enables epoxy vitrimers to be reshaped, repaired, reprocessed and recycled. In terms of processable thermoplastic, Elium[®] has recently been released by Akrema Global. Recent researches show that the mechanical properties and thermodynamic properties of the Elium[®] are similar to epoxy resins in its processing are reported by industry. This project aims to investigate the potential of vitrimers and Elium[®] to replace currently used epoxy resins for the development of recyclable high-performance (nano)composites. In particular, this project will study the effect of hierarchical structures for the composite and investigate the potential applications of the composite in the automotive and wind turbine industry.

1 **Title: Investigating the environmental fate and biological impacts of labelled**
2 **nanoplastics**

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5 **Theme:** Polymers and Composites

6 **Year of Study (Presentation Type):** Year 1 (Poster)

7 **Abstract**

8 There are escalating concerns surrounding plastic pollution, particularly the
9 infiltration of nanoplastics into ecosystems and potentially into the human body. Most
10 existing studies employed polystyrene (PS) plastics as their model particles, which is
11 easier to produce in laboratory, however, this approach lacks environmental
12 representative as PS nanoplastics does not adequately represent the diversity of plastic
13 type, size distribution, surface properties, and consequently, the behaviour and
14 interactions with contaminants and organisms. This project aims to develop a
15 production method for environmentally realistic polyethylene terephthalate (PET)
16 nanoplastics by combining mechanical fragmentation, photo-oxidation, and biological
17 degradation. Comprehensive characterisation of the resulting nanoplastics including
18 shape, surface morphology, specific surface area, size distribution, degradation degree
19 and crystallinity will be conducted using Scanning Electron Microscope, Asymmetrical
20 Flow Field-Flow Fractionation, etc., which will elucidate how various degradation
21 pathway and their combinations influence the properties of nanoplastics and their
22 interaction with pollutants. Furthermore, the labelled realistic PET nanoplastics will be
23 employed in toxicological studies to investigate their effect on cells and aquatic

24 organisms. By comparing the effect of realistic nanoplastics with sphere PS particles,
25 this project will contribute a more accurate understanding on the environmental fate
26 and biological impacts of nanoplastics.

Valorisation of Thermoset Resin Degradation Products Through Pressurized Steam-Based Recycling.

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Polymers and Composites.

Year 1 (Poster)

Recycling composites is crucial for achieving environmental sustainability. Although these materials are highly durable, their recycling remains challenging and contributes to increased landfill waste. Repurposing composites can mitigate the environmental impact of these materials, conserve valuable resources, and foster a circular economy by reusing them in manufacturing processes [1].

Various recycling strategies mechanical, thermal, and chemical are currently employed, owing to their scalability and cost-effectiveness [2]. However, these methods face limitations, including high energy consumption, reduced fibre quality, and altered fibre morphology [2][3]. In particular, the deposition of charcoal on fibre during pyrolysis negatively affects the mechanical performance of reclaimed carbon fibre.

To address these challenges, researchers are developing novel approaches for recycling thermoset epoxy resins and composites, with a focus on recovering high-value fibres and resin degradation products for reuse [4]. This work examines the potential of a pressurized steam-based recycling process to valorize thermoset resins used in composite manufacturing [2]. By investigating this innovative approach, we aim to establish a more sustainable and efficient manufacturing paradigm that minimizes waste and environmental impact.

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Chemical Recycling of Automotive PC/ABS

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Research Theme: Polymers and Composites

Year of Study (Presentation Type): Year 1 (Poster)

Polycarbonate acrylonitrile butadiene styrene (PC/ABS) is one of the most widely used plastic blends, commonly found in automotive and electronic applications. However, its heterogeneous nature poses significant challenges to recycling, leading to its frequent disposal via landfilling or incineration¹. In collaboration with Polestar, a sustainability minded electric car company, this work proposes a way to recycle this material via chemical recycling. The PC is depolymerised by heating with acetic acid and a basic organocatalyst in a process known as acetolysis. The ABS is not affected by this process so can be removed and recycled. A catalyst screening carried out on PC pellets revealed that more basic, nucleophilic catalysts performed best, whereas non-nucleophilic bases were ineffective regardless of their basicity. The acetolysis method was transferred to PC/ABS pellets and complete depolymerisation of the PC was measured after 2 hours and water addition enabled the agglomeration and removal of the ABS. Future work on this project will involve recycling automotive parts made of PC/ABS allowing the effects of colourants and additives on the recycling process to be studied. This chemical recycling approach offers a promising route toward reducing the environmental impact of PC/ABS by enabling its recovery and reuse.

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Changing the Linear Model: A Path to Circular Lab Plastics

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Materials science: polymers

Year 1: poster

Plastics are indispensable in scientific research, providing sterile, durable, and versatile solutions for various applications. However, the widespread use of single-use lab plastics within a linear economic model has resulted in substantial environmental and economic concerns. Research institutions worldwide generate an estimated 5.5 million tonnes of plastic waste annually, contributing significantly to global plastic pollution [1,2]. Despite this, lab plastic waste remains largely uncharacterised, with limited data on its composition and potential for circular reuse. Current disposal methods, including autoclaving and incineration, contribute approximately 550 kg CO₂ per tonne of waste, exacerbating environmental impact [3]. Moreover, the classification of lab plastics as hazardous waste due to potential chemical or biological contamination presents a major barrier to mechanical recycling, even for widely recycled polymers such as polyethylene (PE), polypropylene (PP), and polyethylene terephthalate (PET) [4]. Mechanical recycling has the potential to reduce emissions by up to 3.0 tonnes of CO₂ per tonne of plastic compared to virgin plastic production [5]. This study aims to address critical knowledge gaps in lab plastic waste properties and decontamination methods, facilitating their integration into existing recycling infrastructure.

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Increasing Sustainability & Retaining Value in Mechanically Recycled Automotive Polymers

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Research Theme:

Polymers and Composites.

Year of Study (Presentation Type): Year 1 (Poster)

Efforts to combat global warming necessitate the shift from a linear to circular economy, aiming to reduce emissions, resource extraction, and pollution. As the automotive sector moves towards this goal, considerations for more sustainable material choices become increasingly necessary. The European Union mandates that by 2030, new vehicles must contain 30% recycled plastics, with 25% sourced from the automotive sector. Currently, only 19% of automotive plastics are recycled into low-value applications, while the rest ends up in landfills or incineration facilities.

This study explores enhancing mechanically recycled polymers for high-value applications by analysing their performance, processing methods, and structure. Mechanical recycling processes such as sorting, compounding, and moulding were examined for their effect on properties like impact strength and melt flow viscosity. Findings reveal higher extrusion temperatures significantly degrade impact strength of high-performance polymers like automotive polypropylene (PP) by up to 48%. Scanning electron microscopy (SEM) images shows correlations between plastic morphology and impact properties.

Future research will focus on blending post-consumer recycled materials with pristine automotive-grade polymers at varying percentages (20–40 wt%) to study property retention. This work supports the automotive sector's transition to sustainability by optimizing mechanical recycling processes for improved material performance and reduced environmental impact.

Understanding Microplastic Release from Protective Paint

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Research Theme: Polymers and Composites.

Year of Study (Presentation Type): Year 1 (Poster)

Epoxy networks are commonly used as the matrix for industrial protective coatings. For structures such as bridges and boats, the crosslinked structure bestows strength and durability, which are key properties for the successful prevention of asset corrosion. However, upon breakdown – through mechanical damage or weathering – released microplastics are likely to exhibit this same durability in the environment.

Microplastic pollution is a growing concern, since these particles remain in the environment, infiltrating ecosystems and food chains, and have recently been discovered in human placenta samples¹. Unfortunately, paint derived microplastics have seldom been studied, having only recently been identified as a major source. To enable preventative measures, this project will focus on understanding the thermal, mechanical and photo-oxidative breakdown of industrially prepared protective coatings, and its relation to microplastic release. This will be performed using a series of gravimetric, thermal, and spectroscopic techniques, in both bulk and at the nanoscale. The local initiation of fracturing will be identified to indicate the main factor involved in total paint failure. From the experiments conducted thus far, the main initiator appears to be mechanical damage, which then accelerates natural weathering phenomena. These mechanisms synergise to escalate catastrophic breakdown, from a hairline crack, to irreparable delamination.

References:

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Electrically conductive adhesives based on nanomaterials for effective and sustainable Joule CFRPs bonding and selective debonding.

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Research Theme: Polymers and Composites.

Year of Study (Presentation Type): Year 1 (Poster)

CO₂ emission targets and light-weight structure requirements are driving the aerospace industry towards high strength, type II structural epoxy adhesives over traditional, heavier alternatives.

High levels of crosslinking lead to impressive strength-to-weight ratios but high curing temperatures, typically at ~120 °C, traditionally requiring autoclaves. However, alternative methods aim to reduce energy usage. Current out of autoclave (OoA) methods use other external heat sources (blankets, lamps, etc.), where heat transfers through the component to the bond line, causing poor localised heating and significant heat loss.

Previous Joule heating work has shown that dispersing conductive nanomaterials throughout epoxies creates a conductive network. Passing a current through generates thermal energy (byproduct of electrical resistance) to cure the epoxy internally bonding two adherends together. Similarly, Joule heating cured epoxy adhesives above their glass transition temperature (T_g) allows for sustainable debonding and recovery of the adherends for reuse.

The main aim of the project is to expand the fundamental understanding of Joule bonding within epoxy adhesives as an OoA alternative and potential for selective debonding. Observing how changing the adhesive formulation (i.e. conductive filler loading, toughening agents) affects mechanical and functional properties. While also investigating the impact of key parameters in the joule heating set-up.

Using polymer nanoparticles to increase the toughness and stability of Perovskite solar cells

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Research Theme: Select one of the following and delete the rest:

Polymers and Composites.

Year of Study (Presentation Type): Select one of the following and delete the rest: Year 1 (Poster)

Abstract : In the experiments, I use a variety of polymers and the block polymer as additives to preparation of perovskite films ($\text{Cs}_{0.1}\text{FA}_{0.9}\text{PbI}_3$). The grain sizes and UV images of different films were tested under four different concentrations [0% (control), 0.3%, 0.5%, 1%] of polymers and block polymers. The results show that the polymer and block polymer can increase the grain size of the perovskite film, and make the grain boundary of the film clearer and the surface smoother, and thus improve the quality of the film. In addition, according to UV-VIS spectral data, these additives all improve the light absorption of perovskite films. It was found that the humidity stability of perovskite films was more stable after adding additives.

From material constraints to intelligent systems: current obstacles and forward-looking strategies in the development of flexible sensors

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Research Theme: Polymers and Composites.

Year of Study (Presentation Type): Year 1 (Poster)

Abstract:

Flexible sensors have attracted much attention due to their potential in wearable electronics, biomedical monitoring, soft robotics, and environmental sensing. However, their widespread application faces many persistent challenges. A series of material issues such as mechanical durability, biocompatibility, and long-term stability, as well as signal output and processing, integration with flexible substrates, and scalable manufacturing remain key obstacles to achieving consistent performance. This poster discusses the current development limitations of flexible sensors, the many problems they face, and how to improve the performance of flexible sensors in the future. It will also discuss how to make flexible sensors more intelligent with the addition of AI.

Multi-Functional Hybrid Epoxy Nanocomposites Filled with Exfoliated Kaolinite & MWCNT

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Research Theme: Polymers and Composites

Year of Study (Presentation Type): Year 1 (Poster)

Abstract:

After their discovery, carbon nanomaterials such as carbon nanotubes and graphene have been widely used as nanofillers incorporated into matrices of a different nature with the objective of improving the polymer's properties and develop multifunctional polymer nanocomposites. In recent decades, use of nanoclay as filler materials were also becoming more important, where kaolinite and MMT are promising candidates for enhancing various properties of composites. However, there were still lack of findings in hybridized filler systems.

This PhD project focuses on developing multifunctional hybrid epoxy nanocomposites by combining two different nanofillers, MWCNTs and exfoliated kaolinite, in an epoxy matrix. Kaolinite structure is stacked 2D sheets composed of 1:1 silica (SiO_2) and alumina (Al_2O_3), bonded by hydroxyl groups (OH), which hinders gas or heat diffusion due to the tortuous path it creates that can slow down the diffusion rate. Thus, properties that will be targeted herein are gas barrier properties, flame retardancy, as well as synergistic effects on tensile and electrical properties. To quantify these properties, techniques such as SEM, AFM, Raman and FT-IR will be employed. With the existence of MWCNT, the resistive heating properties of the composite will also be investigated for its potential de-icing or Joule heating curing applications.

‘Unite to Revive’: Can EPR-Driven Collaboration Between Brands and Charity Shops Advance Circular Practices?

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Research Theme: Textiles and Apparel

Year of Study (Presentation Type): Year 1 (Poster)

Charity shops in the UK have historically contributed to environmental and social welfare by diverting textiles from waste, providing affordable clothing, training volunteers, and supporting various causes. However, the fashion industry's overconsumption issue, driven by low-quality, trend-focused clothing, has turned charity shops into dumping grounds for excess stock. This influx of poor donations has led to declining sales, reduced funding, and increased shipments of unsold items to the Global South, pushing charities into financial distress and raising prices for customers. Given the 2030 climate targets such as limiting global warming to 1.5°C under the Paris Agreement and promoting responsible consumption and production as outlined in the UN Sustainable Development Goals, there is growing drive behind legislative measures like Extended Producer Responsibility (EPR), which hold producers accountable for the full lifecycle of their products. This research explores how EPR principles can be applied to partnerships between charity shops and brands to enhance operations, restore positive impact, and prepare brands for future EPR policies, potentially offering a competitive edge. Drawing on post-growth economy theory and critical engaged research, this qualitative study will use a case study involving a charity and its brand partner to integrate theory with practice and assess local impact.

Design and Development of Novel Bioactive Dressing for Controlled Drug Delivery in Advanced Multifunctional Wound Care

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Research Theme: Textiles and Apparel

Year of Study (Presentation Type): Year 1 (Poster)

Abstract

Effective wound care continues to pose critical challenge in the healthcare sector. Despite significant strides, scope for improvement remains to address simultaneous infection control, exudate management, mechanical attributes and sustained drug-delivery for prolonging healing environment. To advance bio-nano fusion-driven wound care solutions, this study proposes to design and develop a multi-layered nanofibrous wound dressing composed of biopolymers and therapeutic bioactive components. Nanofiber formation by electrospinning will facilitate exceptional control over fibre structure, ensuring sufficient porosity for adequate breathability, fluid absorption and cell growth. The outer layer will protect the inner layer's sensitive biocomponents and drugs, ensuring appropriate integrity to withstand mechanical stress. Bacterial Cellulose (BC) is selected as the base biopolymer to exploit its biocompatibility, high porosity, great water absorption and holding capacity. BC's inherent limitations, like lack of antimicrobial and healing-prompting properties, will be addressed by integrating biocomponents or drugs. The developed scaffold will undergo in-depth physical, chemical, mechanical and thermal evaluations along with in vitro biological assessments, including antimicrobial resistance and drug delivery performance. Overall, this research aims to establish the feasibility and multifunctional performance of a nanofiber-based wound dressing that supports long-term healing and infection control.

Abstract Template:

Textile-based Energy Storage (Times New Roman Bold, Size 12)

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Research Theme: Textiles and Apparel;

Year of Study (Presentation Type): Year 1 (Poster)

Abstract body text; Times New Roman, Size 12; Left Justified; Max. 200 words; No figures or tables to be included.

Electronic textiles (e-textiles) have significant interest in the research community as lightweight, flexible devices with broad applications ranging from wearable sensing of key physiological parameters to LED displays. To truly become wearable, they require an integrated energy source, avoiding the use of bulky battery packs. Supercapacitors are an attractive energy source due to their rapid discharge rates, and long lifetimes. However, a major challenge for their commercialisation is the large voltage drops they experience over small lengths, and lack of scalable, sustainable production method without compromising the mechanical, wearable and electrochemical properties. This project seeks to find a viable solution to address these problems.

Title: Engineering of textile based compression systems for sports and medical applications using Computer Aided Design and 3D printing

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Research Theme: Textiles and Apparel

Year of Study (Presentation Type): Year 1 (Poster)

Abstract body text

Compression garments (CGs) are specialised elastic clothing engineered to apply controlled mechanical pressure on various body areas, promoting venous return and supporting underlying tissues. Widely adopted in both medical and sports contexts, CGs serve critical roles in improving blood circulation, supporting muscles, and enhancing overall body shape. In the medical domain, graduated compression garments are essential in managing chronic venous insufficiency and reducing venous hypertension, with strong clinical evidence supporting their efficacy, particularly in treating leg ulcers. In sports, athletes utilise lower extremity CGs to boost performance through blood circulation, accelerate post-exercise recovery, and prevent secondary injuries. Initially produced through cut-and-sew methods using elasticated knitted fabrics, the development of CGs has advanced significantly with the introduction of CAD-controlled electronic flatbed and circular knitting technologies. These modern techniques allow precise manipulation of fabric tension to create garments with graduated compression profiles along the limb, enhancing physiological benefits and wearability. To achieve both the comfort properties and the necessary compression characteristics the selection of the appropriate fibre types and fabric construction plays a key role. The evolution of CG technology along with the utilisation of advanced knitting methods and advanced materials aid in delivering effective, body-responsive compression solutions.

Graphene Functionalisation for Enhanced Dispersion and Multifunctionality in Epoxy Resin Composites

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Year of Study (Presentation Type): Year 1 (Poster)

Abstract:

Graphene-based epoxy composites have attracted significant research interest due to their superior mechanical, electrical, and thermal properties. Uniform dispersion of GNPs is critical for optimising load transfer and achieving improved mechanical, thermal, and electrical properties. However, challenges such as restacking, agglomeration, and poor interfacial bonding often limit the performance of composites in the application end. To address this, both covalent and non-covalent functionalisation techniques could achieve maximum filler loading efficiency, leading to overall property enhancement. The research identifies key factors influencing composite properties, such as GNP purity, thickness, orientation, concentration, and curing conditions. Various processing techniques like ultrasonication, ball milling, and high shear mixing, etc., are the common practices for integrating functionalised GNPs into the epoxy resin. The existing literature highlighted that homogenous dispersion and strong matrix-filler interactions are essential for realising the full potential of graphene-based composites. This study will optimise functionalisation methods and scalable processing techniques to convert these lab-scale improvements into industrial applications across automotive, aerospace, biomedical, and other high-performance sectors.

Abstract

Title: The development of Next-Gen Textile Materials for Fashion

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Textiles and Apparel – Year 1 (Poster)

From lab to loom: Harnessing Bacteria for the Textiles of Tomorrow

Motivation: Global fibre production hit 124 million tonnes in 2023, with only <1% recycled from post-consumer textiles. Moreover, polyester – dominating at 57% and largely fossil-based, drives the sector's environmental impact.

Background: While cotton and MMCFs are often viewed as the viable alternatives to synthetics, their extraction and processing involve significant energy consumption and the use of harsh chemicals. Alternatively, bacterial cellulose (BC), produced by *A. xylinus* (a cellulose-producing bacterium), is a renewable biopolymer. Its highly pure, crystalline nanofibrillar structure offers superior mechanical strength and high-performance potential.

Problem statement: Despite its potential, BC remains underused in textiles. This is due to poor solubility and weak fibre-forming ability caused by strong hydrogen bonding and high degree of polymerisation. While companies like Nanollose use viscose and lyocell methods, reliance on petroleum-based solvents limits true environmental sustainability.

Method: This research aims to develop a systematic method to dissolve BC and spin it into fibres while retaining its structural integrity. We begin with NMMO as a reference solvent to establish a performance baseline, then explore greener solvents like DES for sustainable fibre production.

Conclusion: The developed dope and fibres will undergo SEM, FTIR, XRD, GPC, rheology, and tensile testing for comprehensive characterization and performance evaluation.

Keywords: Bacterial cellulose, man-made cellulosic fibres (MMCFs), N-Methylmorpholine N-oxide (NMMO), biopolymers, green solvent, sustainable textiles.

Reconceptualizing Brand Gender: A Sociological and CCT Perspective on Dynamic Brand Gender Construction in the Chinese Context

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Research Theme: Fashion Management and Marketing

Year of Study (Presentation Type): Year 1 Poster

This study aims to reconstruct brand gender theory through the lens of Consumer Culture Theory (CCT), challenging the traditional psychological and static paradigms that have dominated previous research. By adopting a sociocultural perspective, this research emphasizes the critical role of multi-actor interactions—particularly between brand managers and consumers—in the creation, negotiation, and ongoing reconstruction of brand gender. It positions brand gender as a dynamic, socially constructed phenomenon rather than a static brand attribute.

Focusing specifically on the Chinese market, the study examines how sociocultural factors shape the expression of brand gender among domestic fashion brands. Additionally, it explores the discrepancies and potential conflicts arising between consumer perceptions of brand gender and the brand's own expressions, investigating how such tensions influence brand positioning and equity.

To address these theoretical and practical challenges, this research proposes a conceptual model for brand gender construction informed by CCT. Furthermore, it develops a brand-consumer co-creation model to illustrate the mechanisms through which brands and consumers collaboratively shape brand gender. This approach provides both theoretical advancements and practical guidance for brands to effectively manage dynamic brand gender perceptions, thereby maintaining brand clarity and competitiveness within an increasingly fluid and culturally diverse marketplace.

Investigating the impact of virtual AI vs. Human live streamers on consumers' attention and purchase intention under the moderating effect of the need to belong when shopping on live streaming e-commerce platforms in China

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Research Theme: Fashion Management and Marketing

Year of Study (Presentation Type): Year 1 (Poster)

Fashion online retailers have increasingly adopted virtual AI streamers in live-streaming e-commerce. Silicon Intelligence, the leading AI-generated avatar creator in China, plans to create 100 million by 2025. Virtual AI streamers is becoming an alternative of human streamers. Previous studies have identified how virtual influencers' characteristics can affect consumers' reactions in social media context. However, little is known about how consumers' behavioural responses and psychological needs vary when facing human and virtual streamers. Drawing on the Elaboration Likelihood Model (ELM), this study will examine how characteristics of human vs. virtual streamers affect consumer purchase intention. Two studies will be designed corresponding to Chinese consumers on Taobao.com. Study 1 (N=15) will use an eye-tracking experiment to examine the impact of the involvement level on consumers' attention. Study 2 (N=400) will collect data via an online survey to test the effects of different live-streamer types on consumers' purchase intention under the moderating effect of the need to belong. The findings will contribute to understanding the interpersonal relationship between live streamers and Gen Z and millennials in the fashion live-streaming e-commerce context. This study will extend the ELM framework and contribute to human-AI interaction, live-streaming e-commerce marketing and consumers' online psychological needs.

HELLO TOMORROW

Faculty of Science and Engineering

POSTGRADUATE RESEARCH

Day 2 - Wednesday, 15th May

Y3 Poster Session

Department of Materials Conference
Y3 Poster Session, *Nancy Rothwell Event Space*
Thursday 15th May, 13:00 – 14:45

Forename	Surname	Year Group	Theme	Poster Number
Ioana	Albu	3	1. Biomaterials	1
Andrew	Blake	3	1. Biomaterials	2
Qixun	Chu	3	1. Biomaterials	3
Fatih	Eroglu	3	1. Biomaterials	4
Megan	Green	3	1. Biomaterials	5
Samantha	Heslop	3	1. Biomaterials	6
Keir	Nathan	3	1. Biomaterials	7
Eve	Tipple	3	1. Biomaterials	8
Junzheng	Wen	3	1. Biomaterials	9
Chao-Yu	Yang	3	1. Biomaterials	10
Jannatul Robaiat	Mou	3	2. Coating and Ceramics	11
Yunye	Gao	3	2. Coatings and Ceramics	12
Yuchen	Lu	3	2. Coatings and Ceramics	13
Jiajun	Shi	3	2. Coatings and Ceramics	14
Shaokai	Tang	3	2. Coatings and Ceramics	15
Adam	Barker	3	3. Imaging and Characterisation	16
Emily	Barot	3	3. Imaging and Characterisation	17
Jacopo	Del Gaudio	3	3. Imaging and Characterisation	18
Dongze	He	3	3. Imaging and Characterisation	19
Macaulay	Turner	3	3. Imaging and Characterisation	20
Zelong	Wang	3	3. Imaging and Characterisation	21
Muhammad Junaid	Anjum	3	4. Metallurgy and Corrosion	22
Jinghui	Chen	3	4. Metallurgy and Corrosion	23
Yangchao	Deng	3	4. Metallurgy and Corrosion	24
Samuel	Eka	3	4. Metallurgy and Corrosion	25
Samuel	Engel	3	4. Metallurgy and Corrosion	26
Thomas	Hillman	3	4. Metallurgy and Corrosion	27
James	Osborn	3	4. Metallurgy and Corrosion	28
Chunyang	Wen	3	4. Metallurgy and Corrosion	29
Emre	Aydemir	3	5. Nano and Functional Materials	30
Eleanor	Jones	3	5. Nano and Functional Materials	31
Gabriele	Kalantaite	3	5. Nano and Functional Materials	32
Marc	Owen	3	5. Nano and Functional Materials	33
Pai	Peng	3	5. Nano and Functional Materials	34
Hiru	Senehedheera	3	5. Nano and Functional Materials	35
Shenzhi	Shen	3	5. Nano and Functional Materials	36
Jingyi	Wang	3	5. Nano and Functional Materials	37
Laila	Al Saihati	3	6. Polymers and Composites.	38
Sarab	Alantali	3	6. Polymers and Composites.	39
Amani	Alotaibi	3	6. Polymers and Composites.	40

Department of Materials Conference
Y3 Poster Session, *Nancy Rothwell Event Space*
Thursday 15th May, 13:00 – 14:45

Fatmah	Alsalam	3	6. Polymers and Composites.	41
Eloise	Billington	3	6. Polymers and Composites.	42
Maria Andrea	Castillo Bohorquez	3	6. Polymers and Composites.	43
Akash	Ghosh	3	6. Polymers and Composites.	44
Yeshas	Kuntamalla	3	6. Polymers and Composites.	45
Yufeng	Liang	3	6. Polymers and Composites.	46
Shanthar	Rajinth	3	6. Polymers and Composites.	47
Yuyao	Wang	3	6. Polymers and Composites.	48
Yiwen	Zhang	3	6. Polymers and Composites.	49
Guanyu	Zou	3	6. Polymers and Composites.	50
Md Abdullah	Al Mamun	3	7. Textiles and Apparel	51
Zeeshan	Azam	4	7. Textiles and Apparel	52
Qiantong	Chen	3	7. Textiles and Apparel	53
Lina	Jfairi	3	7. Textiles and Apparel	54
Ifeoluwa Omolola (Lola)	Sodipo	3	7. Textiles and Apparel	55
Yunhao	Wu	3	7. Textiles and Apparel	56
Xiaonan	Xu	3	7. Textiles and Apparel	57
Hazel	Chan	3	8. Fashion Management and Marketing	58
Lucy	Charlish	3	8. Fashion Management and Marketing	59
Megan	Eames	3	8. Fashion Management and Marketing	60
Lujain Nabeel a	Hassoubah	3	8. Fashion Management and Marketing	61
Salima	Shimo	3	8. Fashion Management and Marketing	62
Xiaoxue	Wang	3	8. Fashion Management and Marketing	63
Sumayah	Wazir	3	8. Fashion Management and Marketing	64
Xiaoqing	Zhang	3	8. Fashion Management and Marketing	65

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Biofabrication of a vascularized 3D bone tissue

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Research Theme: Biomaterials

Year of Study (Presentation Type): Year 3 (Poster)

Abstract body text:

Bone defects lead to millions of orthopaedic interventions each year. Autologous grafts, while considered a gold-standard treatment approach, face challenges like donor site morbidity, infection risks, and limited availability. Vascularization remains critical for 3D-engineered bones to prevent necrosis. This project aims to develop a 3D vascularized bone tissue construct using the methodology of freeform reversible embedding of suspended hydrogels (FRESH) bioprinting. A collagen hydrogel containing a co-culture of HUVECs and hMSCs will be bioprinted inside a bone-like developed construct to form microvascular structures. The bone tissue construct will be developed in vitro by encapsulating hMSC-derived spheroids within a nanofibrillar cellulose (NFC) hydrogel matrix.

hMSC spheroids, formed via agarose molds, underwent 7-day osteogenic pre-stimulation before NFC encapsulation and 21-day culture with osteogenic supplements. Non-embedded spheroids were also studied under different osteogenic differentiation conditions (7-day only, 14-day only, and 21-day stimulation). Viability, metabolic activity, dsDNA concentrations, and osteogenic differentiation markers (calcium, alkaline phosphatase, collagen I/III) were assessed. Rheological properties of both hydrogels were also studied to estimate initial printing parameters. Results confirmed viable spheroids with osteogenic traits, while rheological tests highlighted the NFC's shear-thinning behavior, ideal for bioprinting. A 7-day osteogenic stimulus proved sufficient for differentiation, with NFC stability at higher concentrations (0.5%) enhancing bioprinting precision.

Development of a multi-culture platform for immune biomarker discovery in early lung cancer

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Research Theme: Biomaterials.

Year of Study (Presentation Type): Year 3 (Poster).

Objectives:

As a result of inadequate early detection, lung cancer is the largest cause of cancer-related death worldwide. We have developed a multi-culture platform (MCP) which is more versatile and physiologically relevant than co-culture systems and *in vivo* cancer models, for immune biomarker discovery in early lung cancer.

Methods:

MCPs were designed using SolidWorks® and manufactured from liquid photopolymer resins by stereolithography. To validate immune crosstalk and test biocompatibility, Jurkat T cells were stimulated by phorbol 12-myristate 13-acetate (PMA), and co-cultured for 48h with THP-1 monocytes, before measuring phenotype changes by mass cytometry (CyTOF), and metabolic viability by AlamarBlue assay compared to gold-standard Transwell® plates.

Results:

Stimulated Jurkat T cells induced the differentiation of THP-1 monocytes into macrophage phenotype in the MCP, which was confirmed by changes in morphology and extracellular marker expression. Compared to gold-standard transwell plates, there was no loss in metabolic activity and viability of A549 and 16hbe cells in the MCP.

Conclusions:

We have developed and validated the MCP, a reusable *in vitro* platform which enables multi-directional immune crosstalk in a 24-compartment customisable design. The MCP is compatible with imaging and agitation instruments for dynamic co-culture experiments using for immune biomarker discovery in lung cancer.

Designing the self-assembling peptide - gelatin methacrylate composite bioinks for 3D cell bioprinting

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Research Theme: Biomaterials

Year of Study (Presentation Type): Year 3 (Poster)

GelMa, a soft hydrogel bioink, has emerged as one of the most commonly used materials for 3D bioprinting and cell encapsulation. Nevertheless, GelMa is a liquid material that requires crosslinking during the printing process, making it difficult to maintain high shape fidelity. This project first demonstrates the printability of self-assembling peptide hydrogels (SAPHs), which exhibit spontaneous self-assembly behavior. It then explores the design and application of a SAPH–GelMa composite bioink, aiming to use it as a novel biomaterial for cell encapsulation in 3D bioprinting, with post-printing UV curing.

Results: In this study, the properties of SAPH and GelMa were characterized, confirming the shear-thinning behavior of SAPH and its printability as a 3D printing ink. Next, we investigated the minimum concentration of GelMa required in the composite hydrogel to allow mechanical handling after crosslinking. The results showed that adding 20 mg/mL of GelMa is sufficient to develop a crosslinkable SAPH/GelMa composite bioink that can be mechanically manipulated. Through various characterizations, we further studied how the addition of GelMa affects the mechanical and printability properties of the composite hydrogel. Finally, we aim to use fibroblasts to verify that the novel composite bioink can be applied in 3D bioprinting for cell encapsulation.

Physiologically relevant in vitro bone model using 3D printed porous PLGA and HA-PLGA scaffolds to study breast cancer metastasis to bone

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Research Theme: Biomaterials

Year of Study (Presentation Type): 3 (Poster)

Bone is a primary site for breast cancer metastasis, highlighting the need for advanced in vitro bone models that better replicate the native bone microenvironment. Traditional 2D cultures lack the complexity of cell-cell and cell-matrix interactions found in bone tissue. In this study, we engineered a physiologically relevant 3D in vitro bone model using 3D-printed porous scaffolds composed of PLGA and hydroxyapatite-loaded PLGA (HA-PLGA), seeded with bone marrow mesenchymal stem cells (BM-MSCs). Scaffolds were fabricated using fused deposition modelling and characterised for porosity, hydroxyapatite distribution, mechanical strength, degradation, and surface wettability. Both scaffold types exhibited uniform pore structures, moderate hydrophilicity, and comparable compressive strength, providing a suitable environment for cell attachment and proliferation. BM-MSCs demonstrated high viability, robust proliferation, and successful osteogenic differentiation on both scaffold types, with HA incorporation further enhancing cell adhesion and bone-like tissue formation. To more closely mimic physiological conditions, the engineered bone model will be integrated into a Quasi-Vivo microfluidic system, with separate chambers for the bone and breast cancer models. This dynamic co-culture platform will enable investigation of the interactions between metastatic breast cancer cells and the engineered bone microenvironment, providing valuable insights into the mechanisms of bone metastasis and supporting the development of targeted therapies.

Developing new 3D-hydrogel models of the mammary gland to investigate breast cancer initiation

This research aims to develop a synthetic *in vitro* model of the functional unit of the mammary gland to investigate the initiation of breast cancer. The current gold standard for *in vitro* modelling of the mammary gland utilises Matrigel™, a naturally derived extracellular matrix derived from Engelbreth-Holm-Swarm mouse sarcoma. However, this is limited by batch-to-batch variability and poor chemical definition. Therefore, to overcome these disadvantages, this research utilises self-assembling peptide hydrogels, PeptiGels™ developed by Saiani and colleagues, which are chemically well-defined, biocompatible and tuneable in their properties.

Two Peptigels, Alpha8 and Alpha7, were characterised in their stiffness and biocompatibility. Both hydrogels supported the formation of spheroids from EPH4, mouse epithelial cells, however, Alpha8 is more stable over a 21 day culture period and could be tuned in its stiffness through dilution with PBS to stimulate different microenvironments. Alpha8 however, was unable to support the formation of polarised acini after a 21-day culture period. Therefore, Alpha8 was successfully functionalised with Matrigel, Laminin 1 and Laminin derived peptide sequences. In all conditions, EPH4 cells formed spheroids from single cells. Furthermore, functionalisation with Matrigel promoted the formation of a heterogeneous population of spheroids with hollow lumens mimicking mature acini.

Development of a Functionalised Tendon Repair Augmentation Device Using Electrospun Polycaprolactone

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Research Theme: [Biomaterials](#)

Year of Study (Presentation Type): [Year 3 \(Poster\)](#)

Tendons are one of the key connective tissues within the human body and are responsible for transferring the forces exerted by muscles to bones to facilitate movement. Their functionality controlling high mechanical loads predisposes tendons as a key site of injury, with common tendinopathies including tendonitis, tendinosis, tears, and complete tendon rupture.

Current therapeutic approaches include surgical intervention via tendon retrieval and reapproximation, with varying degrees of success dependent upon the complexity of the anatomical region. Limitations to the surgical practices include adhesion formation and insufficient mechanical capability restoration, increasing the risk of re-rupture following surgery. Research efforts aim to mitigate the risk of re-rupture by developing biocompatible, functionalised materials to support tissue regeneration and provide mechanical support to the injury site.

This research aims to functionalise the established Tendon Repair Augmentation Device, a polymer-based, knitted scaffold that provides a biological niche to encourage cell in-growth. Functionalisation using bioactive molecules aims to encourage further cell migration and subsequent extracellular matrix deposition at the injury site to promote tissue regeneration. Material manufacture using electrospinning provides promise in material development that mimics native tissue architecture, whilst being able to incorporate bioactive molecules within the material for sustained release post-injury.

Abstract Template:

Crystalline Beta Phase as a Function of Temperature in Electrospun and Melt Extruded PVDF

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Research Theme:

Biomaterials;

Year of Study (Presentation Type): Year 3 (Poster)

Polyvinylidene fluoride (PVDF) an electroactive beta phase. As a flexible polymer with high piezoelectric output when there is a large crystalline beta phase fraction (F_{CB}), it is an attractive option for physiological and structural health monitoring. Traditionally piezoelectric PVDF is produced through melt extrusion followed by a poling step to increase the F_{CB} . Electrospinning is an alternative production technique in which PVDF in solution is extruded through a needle under high voltage, producing a mat of nanofibers with high F_{CB} in situ.

However, the F_{CB} decreases when exposed to high temperatures, causing hesitancy towards using piezoelectric PVDF in electronics where high temperature processing steps are required. However, literature conflicts on the degree of degradation and the temperature at which this occurs. Current academic literature has focused on the commercial melt extruded/poled PVDF.

The study utilises a range of temperature exposures from ambient to 200°C over a range of times; 1 minute, 1 hour, and 24 hours. Both electrospun and commercial PVDF are exposed to these temperatures and FTIR is performed to obtain the beta phase content, DSC is performed to obtain the crystallinity, and the product of the two represents the crystalline beta phase.

The results show markedly different temperature responses between electrospun and melt extruded PVDF. Both the crystallinity and overall beta phase content as a function of temperature varied between the two forms of PVDF with the electrospun form showing a higher F_{CB} .

In conclusion, electrospun PVDF can be produced with a higher F_{CB} than commercially obtained melt extruded PVDF. Further, electrospun PVDF shows less crystalline beta phase degradation when exposed to high temperatures for both short and extended periods of time.

Abstract Template:

Development of *in vitro* bladder cancer models to investigate the effects of hypoxia on the tumour microenvironment

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Research Theme: Select one of the following and delete the rest:

Biomaterials

Year of Study (Presentation Type): Select one of the following and delete the rest: Year 3 (Poster)

Abstract body text;

Bladder cancer is the 2nd most common urological malignancy worldwide. Whilst non-muscle invasive bladder cancer (NMIBC) has a good prognosis with 5-year survival rates of over 90%, once bladder cancer becomes muscle invasive (MIBC), the 5-year survival rate drops to >40%.¹ Key treatments for MIBC include chemotherapy, immunotherapy, and radiotherapy. The nature of the tumour microenvironment is critical for predicting treatment response, as exhibited behaviours such as hypoxia are associated with a metastatic phenotype and reduce the effectiveness of radiotherapy on MIBC tumours.² However, current 2D cell culture methods that are used to investigate the radio-resistance of MIBC do not accurately represent the dynamic tumour microenvironment. 3D *in vitro* models provide a solution to investigate the cellular behaviour in a tuneable system that can recapitulate the *in vivo* environment.³ This project aims to fabricate a 3D, self-assembling peptide hydrogel (SAPH) based, *in vitro*, model of the bladder cancer tumour microenvironment by developing a co-culture of bladder cancer cell lines and human immune cells.

References: [1] National Cancer Institute, 2023, *Bladder Cancer Prognosis and Survival Rates*, date accessed 07/03/25, available at <https://www.cancer.gov/types/bladder/survival>.

[2] Bodgi. L. et al., Assessing Radiosensitivity of Bladder Cancer *in vitro*: A 2D vs. 3D Approach. *Front. Oncol.* **9**, 153, 2019.

[3] Mu. P. et al., Newly Developed 3D *in vitro* Models to Study Tumour-Immune Interaction. *J. Exp. Clin. Cancer Res.* **42**, 2023.

In Vitro Cardiac Model Using Self-Assembly Peptide Hydrogel for Studying Congenital Heart Diseases

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Research Theme: Biomaterials;

Year of Study (Presentation Type): Year 3 (Poster)

Congenital heart diseases (CHDs) are among the most prevalent congenital anomalies, necessitating advanced models to understand their complex mechanisms. This study evaluates the use of self-assembly peptide hydrogels (SAPHs) as scaffolds for cultivating cardiac organoids to model early heart development and CHD pathology in vitro. Initially, the cardiomyoblast cell line H9C2 was used to optimize encapsulation conditions and study cell-hydrogel interactions. Subsequently, chambered cardiac organoids were encapsulated in SAPHs for 21 days, followed by assessments using optical mapping, immunofluorescence, and light sheet microscopy. To model CHD, organoids were genetically modified via knockout of STX18-AS1, a long non-coding RNA implicated in atrial septal defects. The SAPHs supported high cell viability and prolonged contractile activity. Light sheet microscopy revealed significant structural abnormalities in knockout organoids compared to controls, including enlarged cavities and altered morphology. Immunofluorescence indicated cardiomyocyte accumulation at the hydrogel interface. These findings demonstrate that SAPHs are effective scaffolds for cardiac organoid culture and present a promising platform for studying CHD pathogenesis. Future work aims to enhance organoid complexity to better recapitulate human cardiac physiology.

In silico cross- β fibrils design

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Research Theme: Biomaterials;

Year of Study (Presentation Type): Year 3 (Poster)

Abstract (max. 200 words):

Cross- β nanofibrils morphologies and physicochemical properties have been engineered for biomedical applications such as cell culture and controlled drug release. However, with limited high-resolution data from cryogenic electron microscopy (cryo-EM) and nuclear magnetic resonance, designing suitable non-covalent interactions for cross- β assembly can be challenging. To improve screening and optimization for cross- β nanofibrils engineering, we propose a computational workflow enabling systematic exploration of peptide assembly at the atomic level. First of all, we sample over peptide backbone conformation and peptide assembly to select the fibril assembly unit. Then, we apply a package we have developed to build hypothetical cross- β nanofibrils. Finally, we apply a metadynamics protocol to refine the helicity of the cross- β nanostructures. In this work, peptides of 8 to 10 amino acids of Phe, Lys, and Glu residues are selected, and several peptide-assembled structures are modeled to compare with twisted nanofibrils observed from cryo-EM and transmission electron microscopy (TEM) data. We observe that stable fibril structures can be sensitive to subtle changes in inter-peptide and intra-peptide interactions, provided by the atomic details of packed Phe residues and hydrogen bonds with Lys and Glu residues.

Mitigating Cracking in Aerosol Deposition Coatings through Glass Addition during Heat Treatment

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Research Theme: Coating and Ceramics

Year of Study (Presentation Type): Year 3 (Poster)

Coatings fabricated by the aerosol deposition (AD) method inevitably develop cracks after annealing due to the release of internal residual stress. However, AD coatings are often employed in environments involving elevated temperatures, making the retention of a stable and intact microstructure during or after annealing critically important. In this study, glass powder was incorporated into Al_2O_3 -YSZ composite coatings to investigate its effect on mitigating crack formation post-annealing. The microstructural evolution and mechanical properties of the composite coatings were systematically evaluated before and after annealing. Furthermore, the underlying mechanism responsible for crack mitigation was discussed in detail. This work offers a promising strategy to enhance thermal stability and crack resistance of annealed AD coatings.

Effect of pulse bipolar polarisation frequency and current ratio in PEO process on energy consumption and coating characteristics on 1050 Al alloy

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Year of Study (Presentation Type): Year 3 (Poster)

Being an electrochemical surface modification technique, plasma electrolytic oxidation (PEO) can produce coatings that are compact, crystalline and well adhered to the metal substrates, improving their wear and corrosion resistance. It is known that high-quality coatings require application of certain electrical polarisation that causes transition of arcing PEO process to soft sparking or even post sparking anodising, where initial micro-discharges are extinguished. Usually, such softening phenomena are achieved by setting up specific current ratio between negative and positive pulses ($J_{\text{neg}}/J_{\text{pos}} > 1$ for aluminium), which leads to a sudden drop in the anodic voltage and a change of micro-discharges into white sparks. The goal is to understand how controlling current pulse parameters can facilitate achieving discharge softening and how the established soft sparking regime can affect the formation of PEO coatings. This work investigated cooperative effects of the current ratio and pulse frequency on transition to soft sparking, energy consumption and coating characteristics (e.g. phase composition and microstructure). The results indicate that increase in current ratio promotes softening phenomena for all frequencies; increase in frequency (only up to 1000Hz) facilitates soft sparking transition. At 5000 Hz, no $\alpha\text{-Al}_2\text{O}_3$ was formed in PEO coatings with predominance of $\gamma\text{-Al}_2\text{O}_3$; the coating morphology was significantly changes to mixed type without layers. In addition, the Si element was uniformly distributed throughout the entire coating in this case but was preferably enriched at the electrolyte-coating interface when coatings were produced under other operating conditions.

Lead-free BiFeO₃-BaTiO₃ ferroelectric ceramics for high temperature applications

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Theme: Coating and Ceramics

Year of study: Year 3 (Poster)

Abstract

Environment-friendly lead-free Bismuth ferrite-barium titanate (BF-BT) in the form of thin films or nano powders and/or ceramics have become a research hotspot due to their high Curie temperature, excellent electro strain property, high dielectric constant, relatively low dielectric loss, large electromechanical coupling coefficient and piezoelectric constant. BiFeO₃ is a promising candidate for high temperature applications due to its high Curie temperature of approximately 825°C; on the other hand, the high coercive field and high leakage current due to the presence of coexisting Fe²⁺ and Fe³⁺ ions have limited its development. On the other hand, Barium Titanate has very good piezoelectric properties, but its curie temperature is very low. In the present work, we focus on integrating BiFeO₃-BaTiO₃ (BF-BT) solid solutions, with particular attention to the improvement in ferroelectric behaviour and curie point relative to that of conventional lead-based materials. Conventional solid-state reaction methods have been used to prepare the samples. For structural characterization and microstructure samples are scanned by X-ray diffraction and scanning electron microscope. Functional Properties will also be shown in the results. It will provide a comprehensive picture of how the addition of dopants alters the structural and functional attributes of BF-BT ceramics, contributing to understanding its potential benefits or drawbacks. The possibility of integrating these materials into high-temperature ultrasonic transducers/sensors is also assessed.

Tungsten-Diamond Composite For Plasma-Facing Materials

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Research Theme: Coating and Ceramics

Year of Study (Presentation Type): Year 3 (Poster)

Conventionally, tungsten has been identified as the best plasma-facing material (PFM) candidate for nuclear fusion applications. However, a recent study has ranked Diamond (1st) and Tungsten (3rd) as top candidates for PFMs following screening using comparisons of thermal properties, sputtering, and hydrogen isotope inventory [1]. Existing studies on tungsten have identified problems with oxidation, recrystallisation, embrittlement, and radiation-induced degradation. Tungsten cannot resolve fusion material challenges alone. There is a need to fill the research gaps in other promising PFMs, especially diamond materials.

This work studies the plasma-material interaction (PMI) of deuterium plasma with CVD diamond and tungsten-coated CVD diamond, aiming to combine the best properties of the two materials, sputtering resistance from tungsten and excellent thermal and mechanical properties from diamond. Experiments in the Magnum-PSI linear plasma device exposed both materials to low-energy (35 eV), high-flux ($>1.4 \times 10^{23} \text{ m}^{-2}\text{s}^{-1}$) deuterium plasma with fluences from 3.6×10^{24} to $1 \times 10^{26} \text{ m}^{-2}$. The material properties and irradiation damages are characterised, including sub-micron crystallites of tungsten coating, bonding, residual stress, telephone cord buckling, and deuterium erosion and retention.

[1] A. Fedrigucci, et al., PRX Energy, 3(4), 043002 (2024)

[2] D.J. Cherniak, et al., Geochim. Cosmochim. Acta, 232, 206–224 (2018)

[3] T. Tanabe, Phys. Scr., T159, 014044 (2014)

A Machine Learning approach to Breeder Blanket optimisation for Fusion Tokamaks

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Research Theme: Imaging and Characterisation

Year of Study (Presentation Type): Year 3 (Poster)

Neutronics is essential for the design, operation, and decommissioning of future fusion devices, involving neutron energy distributions, activation, and gamma decay assessments. While Monte Carlo simulations offer high-fidelity neutronics analyses, they are computationally intensive.

This work explores the use of machine learning (ML), specifically Monte Carlo-informed random forest models, to accelerate neutronics calculations for tritium production in Tokamak breeder blankets—a key challenge due to tritium scarcity. The model predicts neutron energy spectra within the blanket, which is segmented into layers containing breeder, multiplier, coolant, and structural materials. Each layer is sequentially modelled, accounting for neutron moderation, multiplication, and reflection.

Using the predicted spectra and cross-sectional data, the model estimates reaction rates such as the tritium breeding ratio. This enables rapid design iteration while maintaining accuracy, with results validated by conventional Monte Carlo simulations (e.g., OpenMC). The ML framework also supports downstream activation and shutdown dose rate assessments.

An example application to an EU-DEMO blanket design will be presented, demonstrating the model's flexibility and potential to streamline breeder blanket development.

Graphene-Assisted Transmission Electron Microscopy of Ribosomes

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Research Theme: Biomaterials

Year of Study: 3

We introduce liquid-phase transmission electron microscopy (LP-TEM) as a powerful and emerging tool in structural biology, offering the ability to image biomolecular complexes in their native, hydrated state at room temperature. This approach represents a significant advancement by extending the capabilities of single particle analysis (SPA), which traditionally relies on cryogenic methods, into a room-temperature liquid environment. Our work focuses on the integration of graphene supports and the development of innovative encapsulation strategies to stabilize samples during imaging. Specifically, we design and fabricate graphene liquid cells (GLCs), which provide a thin, robust, and electron-transparent environment for high-resolution imaging in liquid. These GLCs minimize beam-induced motion and reduce radiation damage, enabling the visualization of delicate biological structures with minimal artifacts. Utilizing this technology, we successfully demonstrate the first structural determination of a ribosome in a liquid environment at room temperature. This breakthrough opens new avenues for studying dynamic biological processes and conformational states that may be inaccessible using conventional cryo-electron microscopy. Overall, our findings highlight the transformative potential of LP-TEM in structural biology, offering a novel and complementary approach for high-resolution imaging of macromolecular complexes under near-native conditions.

Jacopo del Gaudio (School of Materials)

3D to 2D: The stereological challenge of 2D analysis for grain size measurement of additively manufactured alloys

Poster submission

3D to 2D: The stereological challenge of 2D analysis for grain size measurement of additively Additive manufacturing technologies consist of different manufacturing approaches that build up the digitally designed part layer by layer, enabling the production of complex geometries with minimal material waste compared to conventional manufacturing approaches. The resulting microstructure is characterised by a preferred texture in the build direction of the part, with elongated grains.

The 2D microstructure is conveniently imaged by electron backscatter diffraction (EBSD). This study deals with the subsequent step of inferring the 3D microstructure from a series of statistically significant 2D images. The operation of inferring the 3D metrics from the 2D images is called stereology. The aim of this work is to understand if and when the stereological approach fails to infer the 3D microstructure metrics or not. The 3D microstructure of two nickel superalloy samples, the first conventionally manufactured and the second additively manufactured using the “femto-second laser serial sectioning technique” (fs-laser SST), and the 2D and 1D microstructure metrics, in particular the grain area and the maximum Feret diameter, have been extracted. These metrics were compared with 2 simplified stereological models, the equivalent fit ellipsoid and the equivalent fit spheroid.

Damage evolution in multilayer braided composite tubes under torsion studied by in-situ X-ray computed tomography

Name: Dongze He

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Theme: [Imaging and Characterisation; Polymers and Composites;](#)

Year of Study (Presentation Type): [Year 3 \(Poster\)](#)

In this study, the comprehensive failure mechanism of tubular braided carbon fibre reinforced polymer (CFRP) composites under torsion is investigated by time-lapse synchrotron X-ray CT imaging combined with an in situ tension/compression/torsion rig. Fibre tracing is used to identify and distinguish the fibre tows in different orientations. To our knowledge, this is the first time the sequence of damage has been tracked in 3D for torsional failure of multilayer braided CFRP tubes. Visible damage is first observed at 1% shear strain. After this torsional strain (a) damage initiated as radial intra-tow cracking (major part) and inter-tow debonding (minor part), then (b) propagated by inter-tow debonding and peripheral intra-tow cracking, (c) the kinking bands are formed due to the space provided by the developing inter-tow debonding and increasing torsion load at 1.5% shear strain and the mechanical performance starts degradation and (d) the macroscale structural stiffness decreased with the progressive accumulation of the gap of inter-tow debonding causing kinking bands when the stress reached the peak value. In further work these 3D images will be used to set up image based finite element models of the damage sequence and other braid architectures will be studied.

Mass spectacular parasites: Applications of Secondary Ion Mass Spectrometry and Imaging Mass Spectrometry in Parasitology

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Research Theme: Select one of the following and delete the rest:

Imaging and Characterisation;

Year of Study (Presentation Type): Select one of the following and delete the rest: Year 3 (Poster)

Mass spectrometry imaging is a quickly developing field that can map the spatial chemical and molecular composition of biological sample. It allows users to localise compounds of interest 'label free' ensuring no change in molecular kinetics through the introduction of a tag and removing the need for antibody development. This poster will outline 2 mass spectrometry imaging techniques and include a case study of how we are using them to study whipworm.

The Cameca **NanoSIMS 50L** is a high lateral resolution secondary ion mass spectrometry microprobe (beam size can be focused to 50 nm) that can be used to image and measure elemental and isotopic distributions in samples at subcellular scale. A primary ion beam impacts a sample surface which produces atomic and small ionic species which are then detected in a mass spectrometer. We have used the NanoSIMS to identify the feeding mechanism of *Trichuris muris* through the introduction of isotopically labelled nutrients. NanoSIMS can then be used to localise the nutrients at a subcellular scale via measuring enrichment of the stable isotope above the natural abundance.

Time of Flight SIMS (**ToF SIMS**) is a technique similar to NanoSIMS however it has a *gentler* primary ion beam which allows extraction of molecular ions and molecular fragments, these are detected via a Time-of-Flight detector. This has a lower lateral resolution (typically around 1 μm) but gives more molecular information. We have used ToF SIMS to localise lipids within *Trichuris spp.*

Both of these techniques have different advantages and drawbacks, however, are applicable to many different contexts in parasitic research. Using these case studies, we have shown the power of each of the techniques and demonstrated their applications across parasitology.

Abstract body text; Times New Roman, Size 12; Left Justified; Max. 200 words; No figures or tables to be included.

Name: Zelong Wang

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Theme: Imaging and Characterisation

Year of Study (Presentation Type): Year 3 (Poster)

High Resolution 2D and 3D EBSD Analysis of Alloy Composition Effects on Microstructure and Grain Boundaries in (Ag,Cu)(In,Ga)Se₂ Thin Films

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Perovskite-type (Ag,Cu)(In,Ga)Se₂ (ACIGS) thin-film absorbers deliver excellent optoelectronic performance, yet the relationship between alloy chemistry, microstructure and device behaviour is still unclear. High-resolution electron backscatter diffraction (EBSD) in two and three dimensions have been applied to five ACIGS layers with different [Ag]/([Ag]+[Cu]) (AAC = 0 - 0.07) and [Ga]/([In]+[Ga]) (GGI = 0.3 - 0.83). Three-dimensional datasets were generated by serial Xenon-plasma focused-ion-beam sectioning with EBSD mapping of each newly exposed surface, enabling full reconstruction of grain morphologies and boundary types. Raising AAC markedly enlarged grains and increased the $\Sigma 3$ twin-boundary density, whereas increasing GGI suppressed grain growth and produced a finer, boundary-rich network. The latter trend results from the higher formation energy of CuGaSe₂ relative to CuInSe₂ and the microstrain introduced as the c/a ratio diverges from the pseudocubic point (GGI \approx 0.23), both of which favour strain relaxation via boundary formation. This 3D visualisation provides a realistic basis for optoelectronic modelling and shows how Ag and Ga alloying tunes grain structure. Our results clarify microstructural consequences of compositional engineering and guide the optimisation of next-generation ACIGS solar cells.

Next generation Li-ion Pouch Cells: Sustainable Solutions for Corrosion Resistant Cell Tabs

Muhammad Junaid Anjum¹, Robert Lindsay¹, Kieren Hall², Martyn Brown²

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2) Avocet Battery Materials, Crewe/UK

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Research Theme: (Metallurgy and Corrosion) Corrosion performance of Li-ion battery tabs in fluorides and chlorides containing solutions

Year of Study (Presentation Type): 3rd Year

Lithium-ion pouch cells are a primary power source for electric vehicles. To ensure their longevity, attention must be given to the corrosion resistance of various components, including the tabs that connect these cells to the external world. Currently, the industry relies on chromate-coated tabs composed of either aluminium or nickel-coated copper, which are known to perform well. However, a more environmentally friendly alternative surface treatment is urgently needed. This project addresses this challenge by exploring the corrosion of tab materials in pertinent environments to identify key performance indicators to facilitate the development of more benign surface treatments that are both technically feasible and commercially scalable.

As part of this project, a study has been undertaken to evaluate the impact of chloride and fluoride ions (fluoride ions are present in a pouch cell electrolyte) on nickel in aqueous solution. Immersion in either chloride or fluoride-containing solution resulted in improved corrosion resistance over time. Surface analysis indicates that this performance can be attributed to the formation of a layer of nickel oxide/hydroxide that acts as a protective barrier. Assuming transferability to the commercial cell electrolyte, which will be tested as a next step, these data suggest that the Ni-based coating alone is sufficient to provide the required corrosion resistance, and chromate treatment is not essential. If validated, this finding could provide a simple route to more environmentally friendly tab production.

The role of Fe-rich intermetallic on strain localization and local damage mechanism in recycled aluminium alloy

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Research Theme: Metallurgy and Corrosion

Year of Study (Presentation Type): Year 3 (Poster)

Abstract:

Impurity elements, especially iron (Fe), inevitably form Fe-rich intermetallic compounds (IMCs) in recycled aluminium alloys, some of which can detrimentally impact alloy performance. This study investigates the correlation between particle-induced strain localization and local damage formation, aiming to elucidate the influence of increasing Fe content in recycled 6xxx series (Al-Mg-Si) alloys. Three-dimensional (3D) in-situ SR- μ CT combined with analytical in-situ HRDIC and EBSD was employed to identify and track the evolution of particle-related damages. The results reveal that local damage predominantly originates from particle-cracking voids (PCVs). Void identification and tracking indicate continuous PCV nucleation accompanied by individual void growth and coalescence throughout deformation. A bimodal strain distribution is observed within the recycled alloy, comprising non-deforming particle regions and localized high-strain zones surrounding the particles. Correlative results analysis suggests that variations in IMC particle size, morphology, and spatial distribution significantly influence strain localization and grain rotation local behaviours, thereby governing the particle-cracking mechanisms. These findings provide new insights into the development of impurity-tolerant recycled aluminium alloys with an optimized balance between strength and ductility.

Data Modelling of Through-Life Nuclear Dissimilar Metal Welds for Structural Integrity Assessment

Name: Samuel Eka

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Research Theme: Metallurgy and Corrosion;

Year of Study (Presentation Type): Year 3 (Poster)

Structural failures on nuclear dissimilar metal weld (DMW) pipe joints have major impact on plant operations, triggering emergency shutdowns and unplanned remedial works. This is largely attributed to residual stresses locked in during manufacture and further exacerbated by in-service loading conditions. Traditional scientific methods such as experimental and computational analysis are generally used for design and structural integrity assessments of nuclear DMWs. Data-driven solutions have emerged as an area of research interest to compliment these traditional methods given their potential to provide more insight into structural integrity drivers.

This work presents a methodology for developing efficient data models which capture the necessary data on structural integrity and life-cycle management of critical assets such as nuclear DMW welds. Data models are designed for selected processes (called protocols) using Unified Modelling Language (UML). Class diagrams are developed to show data classes, attributes and relationships between data entities. Object diagrams are used to validate the class diagrams. This work supports the subsequent phases of research consisting of database design for systematic data storage, extraction, analysis and machine learning model development for predictive assessments.

Understanding the Effects of Subsurface Microstructure on Surface Microplasticity

Name: Samuel Engel

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Research Theme: [Metallurgy and Corrosion](#)

Year of Study (Presentation Type): [Year 3 \(Poster\)](#)

In this work, we demonstrate how the subsurface grain morphology in a crystalline metallic material can affect the microplasticity on the free surface under uniaxial tensile deformation. This method utilises a stochastic Monte Carlo Markov Chain (MCMC) process to vary the subsurface microstructure of a volume element (VE) used for crystal plasticity (CP) simulations. This is accomplished by allowing the seeds of a Voronoi tessellations to perform a Gaussian random walk through the periodic simulation volume, whilst ensuring that the surface cross section is invariant within a specified threshold.

The approach demonstrates that the surface microplasticity is heavily dependent upon the subsurface grain structure, further revealing that small variations in grain shape and relative position give rise to significant changes in the observed strain localisation. This then allows for the uncertainty associated with subsurface microstructure to be quantified in a robust and generalised framework, applicable to a wide range of materials and constitutive modelling approaches.

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Theme: Metallurgy and Corrosion

Year of Study (Presentation Type): Year 3 (Poster)

Time-resolved Characterisation of Corrosion Processes with Hyper Spectral Imaging, LIBS and Raman Spectroscopy

T. Hillman¹, A. Keane², P. Murray², B. Clowes³, R. Bernard³, A. Di Buono⁴, D.L. Engelberg¹

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For the storage of hazardous products, corrosion processes are often linked to health & safety concerns, with the presence of higher-temperatures believed to accelerate degradation and other reaction processes. To be able to detect the very first onset of corrosion at first instance, innovative in-situ analysis and characterisation techniques need to be developed. Hyper Spectral Imaging (HSI) is a rapid and non-destructive macro-imaging technique, which enables imaging of a sample surface over a wide range of wavelengths and increments – substantially more than can be achieved with RGB components of conventional cameras. Application of HSI in corrosion detection and analysis is a fairly new field, with one of the predominant challenges being the establishment of a direct link between images and the ground truth of corrosion processes. The technique was applied to Type 316L stainless steel coupons exposed to simulated marine environment, comprising different concentrations of Na-chlorides. Samples were exposed at room temperature and 75°C under high humidity conditions (>90%RH) for up to 100 days. The sample surfaces containing salts and corrosion products were imaged, and then further assessed by laser confocal microscopy, Raman spectroscopy, and Laser-induced Breakdown Spectroscopy (LIBS). This study aims to explore how much information can be obtained by rapid HSI assessment of exposed coupons, focusing on: (i) presence of salt-type; (ii) identification of developed corrosion products; (iii) and to provide further insight of the effect of cation identity on corrosion. Information obtained via HSI is compared to chemical information obtained by other characterisation techniques. The application potential for HSI to remotely, non-destructively assess corrosion damage is discussed.

The Corrosion Behaviour of Recycled AA6XXX Series Alloy

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Theme: [Metallurgy and Corrosion](#)

Year of Study (Presentation Type): [Year 3 \(Poster\)](#)

Abstract:

The demand for sustainable and eco-friendly materials has driven the increased utilization of recycled aluminium alloys. In terms of market share, recycled aluminium alloys have gained a notable presence in the aluminium alloy market, with a growing acceptance among industries and consumers. The impact of composition, grain texture and stored energy on the corrosion mechanism of 6xxx alloys has not been clearly investigated. The project aims to discover the corrosion mechanism of the recycled 6xxx series aluminium alloy and provide suitable approaches to protect alloys in service conditions.

Predicting Corrosion Inhibitor Performance: Harnessing Computational Drug Discovery Techniques

Name: James Osbiston

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Research Theme: Metallurgy and Corrosion

Year of Study (Presentation Type): Year 3 (Poster)

The use of corrosion inhibitors is well established as they are a potent and cost-effective method of corrosion control. However, the discovery and testing of new compounds for corrosion inhibition is materials intensive and time consuming, due in most part to the trial-and-error based approach in early-stage discovery. This is in direct contrast to early-stage drug discovery, in which a large amount of screening of a compound's efficacy is achieved through computational simulations. This has given rise to several well-established high-throughput methodologies for drug discovery that vastly improve the speed at which compound filtering can be done. On this basis, the goal of this work is to test the transferability of such drug discovery approaches to corrosion inhibitor selection.

Microstructure and Micromechanics of SA508 Steel Electron Beam Welds Subjected to Post-weld Heat Treatment

Chunyang Wen, Daniel Foster, John Francies, Aitor Madariaga, Elizabeth Jennings, Dirk Engelberg,
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Research Theme: (Metallurgy and Corrosion) Microstructure and
Micromechanics of SA508 Steel Electron Beam Welds Subjected to Post-weld Heat Treatment

Year of Study (Presentation Type): Third year (poster)

This study employs electron beam welding (EBW) to investigate the microstructure and mechanical properties of SA508 Gr.3 Cl.1 reactor pressure vessel (RPV) steel. Two different post-weld heat treatments, including (i) stress-relieving and (ii) re-austenitizing were assessed, focusing on microstructure, grain size and low-angle grain boundary fractions. Results showed that strength, toughness, hardness, and ductility of electron beam welded samples after re-austenitization heat treatment were comparable to those of the as-received material. Re-austenitization effectively mitigates the impact of welding on the material's microstructure and mechanical properties. The micromechanical properties were studied using synchrotron XRD, concentrating on the transformation stress from elastic to plastic deformation. Electron beam welded material after stress-relieved heat treatment exhibits a higher value (650MPa) in transformation stress compared with others (450MPa) subjected to heat treatment.

PGR Conference Yr 3 Abstract

Mesoscale Chiral Assembly of Gold Nanoparticles Guided by Cellulosic Scaffolds

Name: Berk Emre Aydemir

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Theme: Nano and Functional Materials;

Year of Study (Presentation Type): Year 3 (Poster)

Abstract

Plasmonic nanoparticles have gained significant interest owing to their unique properties and their intriguing interaction with incident light, including the ability to enhance and even confine it. Moreover, as it was introduced theoretically 20 years ago, inducing asymmetric interactions to plasmonic particles can enable further applications such as chiral catalysis, optical filters and negative refractive index materials. Embedding chiral signatures into plasmonic nanoparticles, particularly those made of noble metals, is a developing field of research. In this respect, chiral assembly of plasmonic nanoparticles within an anisotropic template is an intriguing way to attain strong chiral light matter interactions owing to collective modes of oscillation. This work aims to use cholesteric hydroxypropyl cellulose, as a matrix material to support and guide nucleation and growth of plasmonic gold nanoparticles (AuNPs). The study addresses the water solubility of cellulose through acid-catalysed crosslinking and investigates different approaches for embedding AuNPs into the system to improve nanoparticle uptake and assess the resulting chiroptical properties.

Abstract Template:

Hybrid Graphene-based Composites

Name: Eleanor Jones

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Theme: Select one of the following and delete the rest: [Nano and Functional Materials](#)

Year of Study (Presentation Type): [Year 3 \(poster\)](#)

This work reviews the use of nanocomposites based on the use of graphite, graphene nanoplatelets (GNP), and multiwalled carbon nanotubes in two different thermoplastic polymers, polyamide 6 (PA6) and polybutylene terephthalate (PBT). Melt compounding is used to produce composites made from each individual filler and combinations of two or three fillers. The mechanical properties, thermal properties, electrical properties, gas barrier properties and rheological properties of the composites are tested to produce a hybrid nanocomposite with multifunctional and diverse properties.

Low-drift pH sensing for high-value bioprocessing and pharmaceutical production

Name: Gabriele Kalantaite

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Research Theme: Nano and Functional Materials

Year of Study (Presentation Type): Year 3 (Poster)

In pharmaceuticals industry, pH is one of the crucial factors for chemical reactions as it affects the reaction yield and product quality, with the market of electrochemical sensors increasing annually. pH is used to optimise the production of medicines and ensure drugs are manufactured with the highest standards; thus, it needs to be accurately measured to reduce the chemical waste and ensure that end-products are safe and of the correct composition. The most commonly used electrochemical probes suffer from unpredictable drift, the need to recalibrate every couple of days when using strong bases, requiring a more robust solution to use in bioprocessing. Nanodiamonds, solid carbon sp^3 crystals, are functionalisable to emit light due to the fluorescence of implanted nitrogen vacancies. The intensity of the fluorescence has a strong dependence on the pH, making nanodiamonds ideal for pH monitoring. However, the detonation-based manufacturing methods produce non-uniform nanodiamonds, with varying properties, thus they need to be characterised using TEM or AFM for surface properties, IR spectroscopy for functional groups, and dynamic light scattering or centrifugal particle sizer to determine the size. In this study, the design of nanodiamond-based pH sensor is discussed, and a testing system to imitate the industrial workflow is developed.

Abstract Template:

Acetate Precursors for Lead Halide Perovskites: Stable and Adaptable

Name: Marc Owen

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Research Theme: Nano and Functional Materials;

Year of Study (Presentation Type): Year 3 (Poster)

Abstract body text;

Lead halide perovskite (LHP) devices have undergone unprecedented increases in efficiency and sensitivity in the past twenty years. However, LHPs still present synthetic and stability challenges. Here we report a novel ambient-processible precursor system applicable to both “wet” and solventless syntheses of LHPs. The solventless reaction is characterised and preliminary stability data of thin films presented.

Multifunctional reduced graphene oxide reinforced natural rubber foams

Presenting Author: Pai Peng, Aravind Vijayaraghavan, Maria Iliut

The University of Manchester, M13 9PL, Manchester, UK

pai.peng@postgrad.manchester.ac.uk **Nano and Functional Materials**

Graphene-based nanocomposites have attracted extensive interest due to their exceptional mechanical, electrical, and chemical properties. Reduced graphene oxide (rGO), in particular, is widely studied, with L-ascorbic acid (L-AA) emerging as a sustainable reducing agent that achieves a comparable C/O ratio to traditional chemicals while promoting environmentally friendly synthesis. In addition to its reduction capability, L-AA facilitates the self-assembly of graphene sheets into a three-dimensional (3D) porous hydrogel via π - π interactions, enhancing structural stability. [1]

In this work, we propose a novel one-step approach by directly incorporating a water-soluble latex polymer (polyisoprene rubber) during the reduction process, yielding an RGO/polyisoprene nanocomposite hydrogel (Fig 1.). After freeze-drying, the resultant aerogel exhibits excellent mechanical stability and an RGO loading of up to 17%. Furthermore, Fe_3O_4 magnetic nanoparticles can be integrated into the RGO framework during hydrothermal treatment, expanding its functionality. This method offers a versatile and scalable pathway for fabricating RGO/latex nanocomposites via an AA reduction sol-gel process, with promising applications in advanced material design, particularly for electromagnetic interference (EMI) shielding and multifunctional nanocomposite development.

References

[1] Z.X. Jia, M.F. Zhang, B. Liu, F.C. Wang, G. Wei, and Z.Q. Su, *Journal*, 3(2020) pp. 6140-6252.

Figures

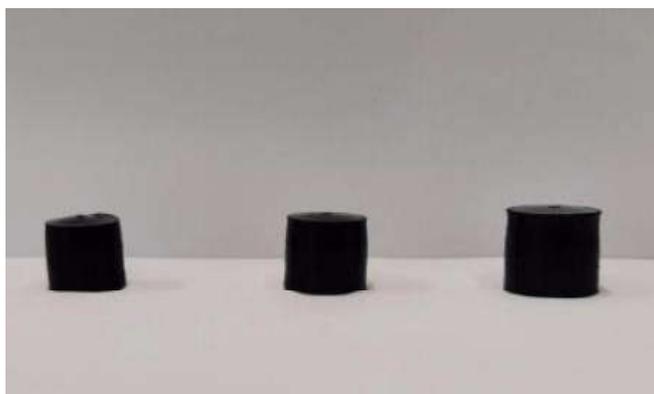


Figure 1: RGO/latex hydrogel nanocomposite

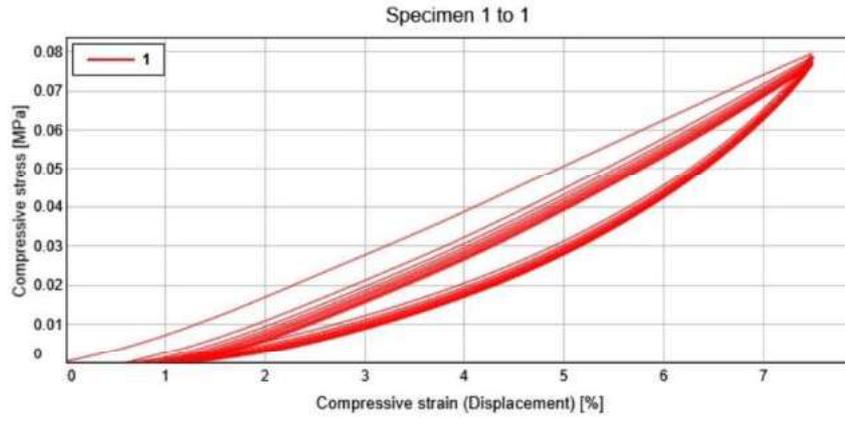


Figure 2: RGO/latex aerogel nanocomposite compression testing result

Fatigue and Fracture of Stretchable Transparent Conducting Films

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Theme: Select one of the following and delete the rest: [Nano and Functional Materials](#)

Year of Study (Presentation Type): Select one of the following and delete the rest: [Year 3 \(Poster\)](#)

Transparent conducting films (TCFs) are layers of material found in devices like photovoltaics and touchscreen displays, which have the relatively rare attribute of transparency to visible light whilst maintaining electrical conductivity. The current TCF market is dominated by materials like tin-doped indium oxide (ITO), which contain rare elements that are extracted by unsustainable processes. Hence, there is a push to find alternative TCFs that are just as effective but whose large-scale manufacturing can be achieved at lower economic and environmental costs. Random networks of nanowires made from silver represent one of the most promising such alternatives and, with the growing interest in wearable and flexible touchscreen technology (for which ceramics like ITO are wholly unsuitable), understanding the fatigue behaviour of such networks remains of real importance. Prior work on these nanowire networks, which can be made by simple and scalable wet chemical methods, suggests an as yet undiscovered set of nano- and microscale deformation behaviours that give them a higher persistence against fatigue. Thus, in this project, following on from prior experimental work done at Manchester, mathematical modelling and simulation will be used to obtain a more detailed theoretical understanding of the mechanisms of fatigue. With a particular focus on the microscale picture, the project will use statistical and percolation-based methods to understand the complex nature of these fatigue behaviours.

Role of the aspect ratio of graphene oxide (GO) on the interface and mechanical properties of vitrimer/GO nanocomposites

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Research Theme:

Nano and Functional Materials

Year of Study (Presentation Type): Year 3 (Poster)

Epoxy vitrimers are raising an increasing interest for the formulation of multifunctional nanocomposites due to their reversible covalently crosslinked network capable of self-arranging upon stimulation without losing integrity, providing them with new properties such as self-healing or shape memory. The incorporation of nanomaterials to epoxy vitrimers can further improve and promote those functions, due to the formation of strong vitrimer/nanofiller interfaces. Herein, how the addition of graphene oxide (GO) flakes with different aspect ratios affects such interface, hence the properties, of vitrimer/GO nanocomposites was investigated and compared to those rendered by their epoxy analogues. An evaluation of the nature of the GO/polymers interface performed by Raman spectroscopy confirmed the existence of stronger interfaces between both GOs and the vitrimer relative to the epoxy, which led to better dispersions of the flakes and enhanced mechanical properties. Thicker GO flakes were found to render stronger interfaces, hence better mechanical properties, than thinner flakes with higher aspect ratio. These findings suggest not only that vitrimer/GO nanocomposites can lead to improved mechanical properties relative to their epoxy analogues, but also that selecting a GO with a specific aspect ratio allows the design of nanocomposites with specific structure and mechanical properties.

Bio-inspired photonics and surface engineering for sustainable energy materials

Name: Jingyi Wang

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Research Theme: Select one of the following and delete the rest:

[Nano and Functional Materials](#)

Year of Study (Presentation Type): [Year 3 \(Poster\)](#)

Abstract body text; (Max. 200 words).

The photoelectrochemical (PEC) cell is a promising technology for converting solar energy into hydrogen fuel through water splitting, enabling high-density H₂ storage. Optimising light absorbers for efficient hydrogen production is a key challenge, involving light-matter interactions, electron-hole excitation, charge separation, and reactions at the electrode–electrolyte interface. Inspired by the biophotonic structures, in this project, we aim to match the photonic and electronic band gap of the electroactive matter (SnO₂, Fe₂O₃ and BiO) to improve the light-harvesting efficiency of photoanodes. The focus of the work is improving light-matter interaction through photonics band gap, extending the electron-hole pair life time and porous architecture to increase the surface area. We investigate the effect of nanostructuring on carrier lifetimes and photocatalytic behaviour. In this poster, I will present our method for fabricating metal oxide photoelectrodes with inverse opal structures. These are created via a self-assembly process using polystyrene nanoparticles as templates, followed by infiltration with a metal salt precursor and in-situ phase transformation. The structural features and PEC performance of these electrodes will also be discussed.

Title: Ultra-high Molecular Weight Polyethylene/ high density polyethylene (HDPE)/ Graphene Nanoplatelets Composites

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Research Theme: Polymers and Composites

Year of Study (Presentation Type): 3rd year- Poster

In recent years, there has been a transition from metallic-based infrastructure to non-metallic in the global chemical industries. This represents a huge challenge due to the dramatically different properties of polymer-based engineering materials over metals. One serious challenge is that polymer-based materials suffer from disadvantages such as creep, deformation under continuous load, and relatively low tensile strength. Using nanomaterials such as graphene nanoplatelets to form polymer nanocomposite materials is one strategy that may mitigate these issues. However, graphene nanoplatelets can suffer from low compatibility or inefficient dispersion in a polymer matrix due to their agglomeration. This study investigates the use of a novel polymeric compatibiliser to enhance the dispersion of graphene nanoplatelets into ultra-high molecular weight polyethylene (UHMWPE)/high-density polyethylene (HDPE) and the improved mechanical and thermal properties that are obtained.

Abstract Template:

Title (Times New Roman Bold, Size 12)

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Research Theme: Select one of the following and delete the rest:

Polymers and Composites.

Year of Study (Presentation Type): Select one of the following and delete the rest: Year 3 (Poster)

Recycling polymers, such as polyamide 6 (PA6), faces challenges due to property degradation over multiple recycling cycles. A potential solution involves adding graphene nanoplatelets (GNPs) to mitigate these effects and enhance the durability of recycled PA6. This method could extend the useful life of polymer-based materials in eco-friendly applications. The materials were processed using a twin-screw extruder, followed by a three-cycle recycling procedure involving injection molding and grinding. X-ray diffraction (XRD) analysis indicated changes in the crystal structure of both PA6 and PA6/GNP after reprocessing. Fourier-transform infrared spectroscopy (FT-IR) detected no significant alterations in chemical composition across multiple reprocessing cycles. Dynamic mechanical analysis (DMA) revealed a decrease in the glass transition temperature (T_g) with reprocessing. Scanning electron microscopy (SEM) images showed improved GNP dispersion at low concentrations, while high loadings (10 wt.%) exhibited continued agglomeration despite reprocessing. Differential scanning calorimetry (DSC) results demonstrated increased crystallinity for both PA6 and PA6/GNP. During reprocessing, higher GNP loadings resulted in improved Young's modulus in the composites, although maximum stress remained relatively stable. However, strain at break decreased with increasing GNP content in both virgin and reprocessed PA6/GNP composites.

Optimising Crystallinity in 3D-Printed PCL Scaffolds for Bone Tissue Engineering

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Research Theme: Polymers and Composites
Year of Study and Presentation Type: 3rd year

Abstract:

In bone tissue engineering, three-dimensional (3D) printing specifically, fused deposition modelling, or FDM offers a revolutionary method for creating scaffolds. This work examines the effects of three critical 3D printing parameters on the mechanical characteristics and crystallinity of polycaprolactone (PCL) scaffolds: deposition speed, screw rotation speed and extrusion temperature.

The evaluation of 27 different processing conditions was done using a full factorial design. While mechanical performance was evaluated using compressive testing, crystallinity and structure were evaluated using Differential Scanning Calorimetry (DSC) and X-ray Diffraction (XRD).

The results highlight how important it is to optimise process parameters to customise. It shows that scaffolds with optimal crystallinity (~61%), increased compressive modulus, and improved heat resistance were created under moderate processing settings, namely an extrusion temperature of 80°C, a screw speed of 15 RPM, and a deposition speed of 10 mm/s.

The results highlighted how important it is to optimise process parameters to customise scaffold microstructure and functionality.

These findings advance our knowledge of the mechanisms underlying polymer crystallisation during 3D printing and how they affect the design of scaffolds in regenerative medicine. To further modify crystallinity and biological performance, future research will use nucleating chemicals like hydroxyapatite, furthering scaffold customisation for patient-specific applications.

Electrically conductive nanocomposites as heating elements for thermoplastics Joule welding

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Research Theme: Polymers and Composites.

Year of Study (Presentation Type): Year 3 (Poster)

This work explores the use of electrically conductive polycarbonate (PC) nanocomposites, filled with carbon nanotubes (CNTs) and graphene nanoplatelets (GNPs), as internal heating elements for Joule welding of thermoplastic substrates. The CNT-based nanocomposites demonstrated superior electrical conductivity and heating capability, enabling effective welding at lower filler loadings compared to GNP-based systems. Welding with 10 wt.% CNTs produced the highest lap shear strength due to the formation of a dense and uniform conductive network, resulting in more efficient and homogeneous heating. Additionally, the study highlights how tuning welding parameters such as time, pressure, and clamping distance can significantly enhance joint performance. These findings underscore the potential of CNT-based nanocomposites as efficient heating elements for advanced thermoplastic welding applications.

Sustainable Polymer Composites

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Research Theme: Polymers and Composites.

Year of Study (Presentation Type): Year 3 (Poster)

Fibre reinforced polymer composites (FRPs) are used for a wide variety of applications, including wind turbine blades, boats and automobiles. However, the vast majority are synthesised using non-renewable feedstocks, and due to a lack of recycling technologies, large quantities of waste are created at their end-of-life. FRPs generally have a thermosetting matrix, limiting their reprocessability and recyclability, but alternative thermosets that offer greater value at end-of-life are those containing dynamic cross-links, which undergo reversible exchange reactions or are chemically depolymerisable. We have developed cross-linked polyesters^{1,2} that achieve both of these goals, thus are more sustainable. We have also made progress in developing an epoxy system which holds promise to meet these goals, as well as having improved thermomechanical properties. This contribution will discuss the relationship between monomer and comonomer performance, lay-up procedure (hand lay-up, vacuum assisted resin infusion, hot press) and reinforcement (glass fibre, carbon fibre) to tune composite performance.

(1) Billington, E. K.; Şucu, T.; Shaver, M. P. Mechanical Properties and Recyclability of Fiber Reinforced Polyester Composites. *ACS Sustainable Chem. Eng.* **2024**, *12* (26), 10011–10019. <https://doi.org/10.1021/acssuschemeng.4c03341>.

(2) Şucu, T.; Wang, M.; Shaver, M. P. Degradable and Reprocessable Resins from a Dioxolanone Cross-Linker. *Macromolecules* **2023**, *56* (4), 1625–1632. <https://doi.org/10.1021/acs.macromol.2c02560>.

Accelerating nanoparticle design: a new approach to screening and self-assembly.

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Research Theme: Polymers and Composites.

Year of study (Presentation Type): Year 3 (Poster).

The synthesis of polymers for biological applications requires rigorous standardisation of polymerisation conditions, purification, and characterization prior to use. Photoregulated reversible addition–fragmentation chain transfer (photoRAFT) polymerisation enables the synthesis of a wide range of polymers even in the presence of oxygen, allowing for rapid reaction condition screening in small-volumes that would be difficult to achieve with conventional RAFT polymerisation. In this work we show how a novel method based on photoRAFT polymerisation leads to nanoparticle formation. These nanoparticles are readily available for gene delivery testing as shown in transfection trials carried out upon completion of polymerisation. As a result, we present a versatile platform that facilitates fast screening of polymers for gene delivery in ultra-low volumes (<200 μL) within a 96-well format. This approach holds significant promise for advancing the design and application of polymers for biological systems.

Development of Multifunctional Natural Rubber Graphene Nanocomposite Foam

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Research Theme: Polymers and Composites.

Year of Study (Poster Type): Year 3

In the pursuit of lightweight, multifunctional materials for modern technological applications, polymer-based nanocomposites have emerged as effective alternatives due to their processability and low weight. Among these, nanocomposite foams have gathered significant attention owing to their versatile structure and properties. This study focuses on optimizing nanocomposite foams by incorporating natural rubber and graphene to enhance mechanical, electrical, and dielectric properties. These results highlight the potential of natural rubber-graphene nanocomposite foam as a lightweight and efficient solution for modern electronics, aligning with sustainability trends. This research advances lightweight, multifunctional nanocomposite foams for next-generation electronic applications and flexible devices. The methodology involves mechanical melt mixing of rubber, controlling the incorporation of graphene nanoplatelets (GNP) and the foaming agent Dinitrosopentamethylenetetramine (DNPT). The different characterization tools used to analyze morphology, microstructure, and the electrical, impedance, and mechanical characteristics. The optimized foam formulation, incorporating graphene masterbatch in natural rubber, achieves a low density of 0.34 g/cc. The foaming of rubber using DNPT forms a conductive network of graphene. This nanocomposite foam exhibits a compressive modulus of 5.21 MPa, electrical conductivity of 10^{-9} S/cm, and a specific EMI shielding effectiveness of 136 dB.cm²/g. Moreover, leveraging its excellent compressibility, the nanocomposite foam can recover 62.5% after 72 hours of constant compression.

Automated 3D Braiding of Branched Structures

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Research Theme: Polymers and Composites

Year of Study (Presentation Type): Year 3 (Poster)

Current braiding technology faces significant limitations in creating branched structures essential for wire harnesses, bicycle frames, and medical stents. Manual branch creation is time-consuming, error-prone, and inefficient. This project presents a fully automated, programmable 3D braiding concept specifically designed for wire harness manufacturing.

The wire harness industry operates at 67% efficiency with 85% manual operations. The project addresses these challenges by developing an automated braiding system which enables automatic branch creation without manual intervention.

The research methodology involves analysing existing braiding technologies; developing a prototype 3D braiding machine with automated branching capabilities; iterative testing to optimise braiding mechanics; and validation through X-ray CT imaging comparison between prototype-produced samples and trial samples.

The prototype will demonstrate automated manufacturing of multi-wire, multi-branch harnesses. Initial results show significant potential for manufacturing complex structures with the help of the new braiding track developed for the prototype.

This work advances automated manufacturing by providing a scalable solution for branched structure fabrication, with immediate applications in the wire harness industry and potential extensions to other fields requiring complex branched structures. The technology represents a significant step toward fully automated production of complex braided components.

The effect of crosslinker concentration on the properties of pH-responsive poly(vinyl amine) microgels and macroscopic gels

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Theme: Polymers and Composites

Year of Study (Presentation Type): Year 3 (Poster)

Poly(vinyl amine) (PVAM) microgels (MGs) and their macroscopic gel networks have attracted significant interest due to their pH-responsive swelling behavior and potential biomedical applications. In this study, we systematically investigate the effect of crosslinker concentration on the physicochemical and mechanical properties of PVAM-based MGs and macrogels. PVAM MGs were synthesized via hydrolysis of poly(N-vinyl formamide) (PNVF) MGs crosslinked with different amounts of 1,3-divinylimidazolidin-2-one (DVIO). The resulting PVAM MGs exhibited tunable pH-responsive behavior, as evidenced by dynamic light scattering (DLS) and zeta potential measurements.

To further explore their mechanical performance, PVAMxD MGs were chemically crosslinked with poly(ethylene glycol) diglycidyl ether (PEGDGE) to form macroscopic gels. Rheological, compressive, and tensile mechanical tests revealed that increasing crosslinker concentration within microgels enhanced gel stiffness, which influenced the gelation process and mechanical properties.

Swelling studies demonstrated that PVAMxD-y/P6-z exhibited pH-dependent expansion, with higher swelling ratios at acidic pH due to increased protonation of amine groups, while at basic pH, the gels contracted due to deprotonation. Additionally, mechanical analyses indicated that gel stiffness was primarily governed by crosslink density, whereas excessive crosslinking led to increased brittleness and reduced ductility.

Modelling the Polymer Resin Flow through Fibres during Resin Transfer Moulding

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Research Theme: Polymers and Composites.

Year of Study (Presentation Type): Year 3 (Poster)

Resin Transfer Moulding (RTM) is a widely used process of manufacturing Fibre Reinforced Plastic (FRP) parts. The resin must infiltrate all the spaces within the preform (reinforcement) to ensure that no void defects will be formed. To optimise the RTM process, Computational Fluid Dynamics (CFD) models can be used in place of tedious and expensive experimental methods. A major challenge here is modelling the dual-scale nature of the preform and its effects on the resin flow. To address this, mesoscale (tow-level) transient flow simulations (as opposed to the steady-state simulations found in literature) were initially carried out to determine the relationship between the rate of tow saturation and the flow variables such as resin pressure and flow velocity. This relationship was then used to define a sink term in the macroscale (preform-level) mass continuity equation for the resin flow, representing the absorption of resin by the tows, and its consequences. The results of the transient simulations visualised the diffused flow front occurring during resin injection due to the non-uniform saturation of the preform. The influence of capillary effects on the formation of inter-tow (between tows) and intra-tow (inside tows) voids was also demonstrated. This is significant because the magnitude of capillary effects varies throughout the flow domain, giving rise to different distributions of voids.

Keywords: Fibre Reinforced Plastics (FRP), Resin Transfer Moulding (RTM), Computational Fluid Dynamics (CFD), Dual Scale Nature, Capillary Effects

Modelling the Polymer Resin Flow through Fibres during Resin Transfer Moulding

Name: Shanthar Rajinth

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Research Theme: Polymers and Composites.

Year of Study (Presentation Type): Year 3 (Poster)

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Keywords: Fibre Reinforced Plastics (FRP), Resin Transfer Moulding (RTM), Computational Fluid Dynamics (CFD), Dual Scale Nature, Capillary Effects

Polymeric Antioxidants for Enhanced Stability and Sustainability in polyethylene terephthalate (PET) Mechanical Recycling

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Research Theme: Polymers and Composites

Year of Study (Presentation Type): Year 3 (Poster)

Antioxidants are essential for mitigating thermo-oxidative degradation during PET reprocessing, yet their leaching raises environmental and health concerns. In our latest study, polymeric antioxidants were synthesized via free radical copolymerisation of styrene (S) and **BHPM** and incorporated into PET via extrusion. Their oxidative stability, thermal stability, and leaching behaviour were evaluated. Compared to polymers based on 2,6-di-tert-butyl-4-hydroxyphenyl methacrylate (**BHM**) that was reported in our previous work, **BHPM**-based additives exhibited superior performance. Oxidative induction time (OIT) tests showed that 10–30 mol% **BHPM**-containing copolymers matched or exceeded the performance of Irganox 1010, a commercial phenolic antioxidant. More importantly, **BHPM**-based polymers demonstrated enhanced thermal stability, enabling better retention of antioxidant activity under high-temperature processing conditions. This improvement is attributed to the propyl spacer in **BHPM**, which provides steric protection against degradation.

Leaching studies further revealed significantly lower solvent extraction for **BHPM**-based polymers. Even low-molecular-weight (ca. 5 kg/mol) **BHPM** variants exhibited reduced leaching compared to higher-molecular-weight (ca. 12 kg/mol) **BHM**-based counterparts, ensuring better additive retention in PET. These results establish **BHPM** as a highly effective alternative, offering both improved stabilisation and lower

environmental impact. Our current and previous studies provide key insights for designing next-generation polymeric antioxidants to enhance the durability and sustainability of recycled PET, particularly under high-temperature processing conditions.

**Electro-responsive graphene-based
membrane for removal of pathogenic
bacteria in sewage treatment
——Fabrication and characterization of
electrospun PLLA and PLLA/PANI
membranes**

Supervisor: Jiashen Li

Student : Yiwon Zhang

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**Electro-responsive graphene-based membrane for removal of pathogenic
bacteria in sewage treatment**
**—Fabrication and characterization of electrospun PLLA and PLLA/PANI
membranes**

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Theme: Polymers and Composites

Year of Study (Presentation Type): Year 3 (Poster)

Abstract:

This study investigates the fabrication and characterization of electrospun poly (L-lactic acid) (PLLA) and PLLA/polyaniline (PANI) composite membranes for wastewater treatment applications. The membranes were prepared using a dual-solvent system (DCM: DMF) and characterized via SEM, FTIR, mechanical testing, conductivity measurements, and contact angle analysis. Results demonstrated that PANI incorporation enhanced membrane conductivity (0.07–0.41 kS/m), hydrophilicity (contact angle reduced from 140° to 54°), and mechanical properties, while maintaining structural integrity. FTIR confirmed successful PANI doping, and SEM revealed uniform fiber morphology at optimal PLLA concentrations (2.1 wt%). The study highlights the potential of PLLA/PANI membranes as multifunctional materials for efficient pollutant removal, leveraging PANI's adsorption capabilities and electrochemical responsiveness. Future work will explore graphene oxide (GO) integration to further improve antimicrobial and adsorption performance, advancing sustainable wastewater treatment solutions.

KEY WORDS: electrospinning; electro-responsive membrane

**Electro-responsive graphene-based membrane for removal of pathogenic
bacteria in sewage treatment**
**—Fabrication and characterization of electrospun PLLA and PLLA/PANI
membranes**

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Theme: Polymers and Composites

Year of Study (Presentation Type): Year 3 (Poster)

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KEY WORDS: electrospinning; electro-responsive membrane

Structure–Property Relationships in Lightweight Composites: Simulating Heat Transfer from Fibrous Networks to Material Function

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Research Theme:

Polymers and Composites.

Year of Study (Presentation Type): Year 3 (Poster)

Understanding how microstructural features influence macroscopic properties is essential for designing high-performance lightweight composites. This work simulates heat transfer in fibrous networks to explore structure–property relationships using a stochastic structural modelling approach coupled with multiphysics simulation. Three-dimensional fibre structures with tunable porosity, shape, and spatial arrangement were generated in *Mathematica* and analysed in *COMSOL Multiphysics* across a wide temperature range, incorporating conduction and radiation through multiple modelling approaches.

Results show a strong negative correlation between porosity and effective thermal conductivity. Fibre diameter has a smaller but consistent influence, while structural connectivity significantly affects conductive pathways. At elevated temperatures, radiation becomes the dominant mechanism, overriding the effect of structure and leading to nonlinear thermal behaviour.

Sensitivity and reproducibility analyses validate the robustness of the approach. While focused on thermal transport, the methodology developed here offers a general framework for investigating additional structure-driven properties. These insights contribute to the intelligent design of next-generation multifunctional composite materials.

Title: Graphene-based sensor for SHM applications in FRPC

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Research Theme: Textiles and Apparel

Year of Study (Presentation Type): Year 3 (Poster)

The innovation and application of advanced functional materials have significantly contributed to sensor fabrication in structural health monitoring (SHM) applications. Graphene-based sensors have emerged as highly promising owing to their remarkable mechanical, thermal, and electrical properties. These sensors offer high sensitivity, excellent stretchability, and multifunctional capabilities for detecting various structural parameters. This study explores the fabrication and application of graphene-based sensors for SHM applications of composite structures. For this, a graphene ink is formulated, and sensors are printed on the surface of the composites and encapsulated to ensure their functionality and stability under ambient environmental conditions. The flexibility, stability and durability of the sensors are assessed through cyclic loading tests, demonstrating excellent flexibility and repeatability. The sensors have shown superior sensitivity in low strain, rendering them suitable for detecting minor structural displacement. This approach facilitates real-time SHM, an easy, power-efficient, and non-intrusive solution for in situ health monitoring of composites. Their integration into SHM systems has the potential to manufacture lighter structures and enhance structural safety with diminished maintenance costs.

Interpreting human body leg cross-section curvature and its application in compression prediction for sports garments

Name: Zeeshan Azam, Kristina Brubacher, Simeon Gill, Anura Fernando

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Theme: Textiles and Apparel

Year IV (Poster)

The Sports compression garments (SCGs) are tight-fitting garments that apply pressure to the body through the restoring force of elastomeric yarn stored in them during wearing. It is possible that athletes aren't getting the full advantage of post-workout recovery because of poorly fitting clothes made using controlled dimensions, traditional sizing techniques, and assuming the body shape is circular. Variation in human body shape leads to different pressures across the body's curvature. This study aims to develop a methodology for quantitatively classifying leg curvature to understand leg shape variation better and compare leg shapes. Leg shapes were obtained using 3D body scanning, and the curvature of leg shape was divided into sections with the same inclination. Secondly, the radius of curvature was measured at each section of the curvature. The variation in leg shape circularity is quantitatively evaluated and correlated with variations in compression. Shape difference was quantitatively identified, and explaining the variation in compression leg curvature across different shapes at one or more curvature points validates the variation results. The outcome of this study will help make the necessary adjustments at the design stage of compression garment manufacturing to achieve the required compression and improve the experience for the athletes.

Keywords: Sports Compression Garments, leg shape, 3D body scanning, leg curvature

Developing in Pattern Engineering for Adolescent Girls Bras

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Theme: Textile and Apparel

Year of Study (Presentation Type): Year 3 (Poster)

The transition from childhood to adolescence is marked by significant physical, emotional, and psychological changes, specifically in females. During this period, physical development is very complex, especially for females. Meantime, inconsistent sizing systems from different retailers and the lack of necessary consideration for girls' changing body shapes add more confusion for adolescent girls when selecting a suitable bra. As a result, the current market bras do not adequately meet the specific needs of this age group. Also, there is limited research has been done on bras' patterns specifically designed for adolescent girls. Therefore, this research develops methodologies of bra pattern engineering that conforms to the body structure of adolescent females based on Armstrong's bra making theory. Qualitative research, 3D body scanning technologies and anthropometric data analysis were employed to develop the bra pattern. The outcomes of this research contribute insights into females' confusion from bras during puberty, body scanning technologies in improving fit and comfort. This research provides new directions and further refinement in designing bras for adolescent girls.

Key Words: Breast Growth, Adolescent Girls, Pattern Engineering, Qualitative Research, 3D Body Scanning, Anthropometric Data Analysis.

Abstract:

Title (Investigation for developing knitted biosensor integrated engineered compression garments)

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Research Theme: Textiles and Apparel

Year of Study (Presentation Type): Year 3 (Poster)

Compression stockings and sleeves are some of the mostly prescribed wearable medical products available in the industry. They are available in various forms, designs and are manufactured using many different techniques according to the standards specific to a country. However, research into the world of wearable e-textiles, specifically sensor integrated compression garments is limited. This research looks at how compression garments integrated with pressure, temperature and odour sensors will provide the patient with health monitoring information, for better management of their condition, thus improving their quality of life. The requirement of pressure sensing, temperature sensing, odour sensing is important in this type of garment as it can give an indication of quality of life, treatment feedback or information on the efficacy of the compression garment, to the clinicians. Pressure information is given to the clinicians to view if the garment is working as required, odour information is an indication of quality of life and of the wearer to better manage their condition, it is also feedback to the clinician and temperature sensing again is information for both the clinician and wearer to know the efficacy of the compression stocking. However, the market gap in this field of research is that there is no compression garment therapy that can show the combined values of pressure, temperature and odour of the wearers skin condition. The current stockings available in the market do not give pressure information, interface pressure, interface temperature information or information on the presence of oedema on the leg real time without interfering with the stocking. Proposed research aims to support wearers having chronic conditions resultant from venous insufficiency and lymphoedema with this data to better manage their conditions before they worsen, all the while using bio-compatible materials, and non-energy exhaustive methods.

Elucidating the effects of cellulase treatment on cotton textile friction

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Research Theme: Select one of the following and delete the rest:

Textiles and Apparel

Year of Study (Presentation Type): Select one of the following and delete the rest: Year 3 (Poster)

Mechanical recycling of textile waste is a promising route to reclaiming fibres back into the textile industry. Textile waste is collected and shredded into fibres using a tearing machine. During the process, textile/textile and textile/metal friction greatly impact the properties and quality of the collected fibres. In the case of short-staple fibres such as cotton, the frictional forces involved break and damage the fibres resulting in lengths that fall below the desired range (> 12.7 mm) required for short-staple fibre spinning.

Previous studies have shown that there is a relationship between fabric areal density, fibre number and the frictional properties of textile materials. Enzyme treatments using cellulase are used industrially to modify the surface features of cellulosic textiles. Cellulase enzymes break down cellulose to produce oligomers and glucose. These treatments can modify the number of fibres in yarns, altering the fabric areal density.

In this work, the effects of mild cellulase treatments on the frictional properties of cotton fabric are studied. The macroscopic friction of cellulase-treated cotton was measured in terms of the resistance to yarn slippage, using the edgecombe resistance (ER) test. Reductions in the ER of up to 16.4 ± 2.1 % occurred after 24-hour treatments. The yarn twist-tenacity curves of cellulase-treated cotton shifted downwards after 6 hours of treatment, indicating alterations in the fibre cohesion and mesoscopic friction. Analysis of stick-slip patterns from yarn tenacity tests revealed the presence of fibre slippage. There was an increase in stick-slip behaviour as the treatment time increased due to a rise in fibre slippage as compared to fibre breakage. This initial study has demonstrated that cellulase treatments can have positive effects of lowering the frictional properties of cotton. Optimisation of these cellulase treatments will increase their potential as pre-treatments for mechanical recycling, decreasing frictional forces and increasing the average lengths of reclaimed fibres.

Designing an Adjustable Textile Recycling Machine to Investigate the Impact of Machine Settings on Recovered Fiber Quality

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Theme: [Textiles and Apparel](#)

Year of Study : [Year 3 \(Poster\)](#)

The rapid growth of the textile industry has led to significant environmental challenges, particularly due to textile waste. Mechanical textile recycling, which converts textile waste into recovered fibres, is a promising solution. However, the quality of recovered fibres is often compromised due to fibre shortening during the process. The settings of the recycling machine, which directly control the shredding of textile waste into fibres, are likely to have a significant impact on fibre quality. This study addresses this critical factor by designing a laboratory-scale textile recycling machine with adjustable settings, including the speed of the opening roller, the speed of the feeding system, and the distance between the feeding system and the opening roller. The machine integrates a precision-controlled feeding system and a shredding unit with a customized opening roller, enabling controlled experimentation to investigate the impact of machine settings on fibre quality. The findings aim to provide valuable insights for optimising mechanical recycling processes, advancing more efficient and sustainable textile recycling technologies.

Integrating the ESPR DPP with Product Environmental Footprint (PEF) Methodology

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Research Theme: [Textiles and Apparel](#);

Year of Study (Presentation Type): [Year 3 \(Poster\)](#)

Abstract Digital Product Passports (DPPs) are emerging as powerful tools to enhance sustainability, traceability, and transparency in textile supply chains. Aligned with the EU's Ecodesign for Sustainable Products Regulation (ESPR) and Product Environmental Footprint (PEF) methodology, DPPs offer standardized environmental data across a product's life cycle. This study explores the integration of DPPs with ESPR and PEF frameworks to improve environmental accountability and support informed decision-making. To illustrate their practical application, we assessed the environmental performance of an 80/20 wool/lyocell fabric produced in East China, focusing on fiber dyeing, spinning, weaving, and finishing stages. Results highlight how combining DPP and PEF can close regional data gaps and support the shift toward a more transparent and sustainable textile industry.

Title: Exploring how consumers evaluate and assign value to digital fashion for on-screen bodies

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Research Theme: Select one of the following and delete the rest:

[Fashion Management and Marketing;](#)

Year of Study (Presentation Type): [Year 3 \(Poster\)](#)

Prior research has largely focused on digital fashion for avatars within the metaverse context; however, there is a lack of understanding of how consumers evaluate and assign value to digital fashion for on-screen bodies. This research explores how consumers evaluate, assign value to, and develop psychological ownership of digital fashion for on-screen bodies. The thesis comprises two qualitative studies. Study 1 explores how consumers link the product attributes of digital fashion for on-screen bodies, including AR-filtered, superimposed image-based, and AI-generated formats, to perceived consequences and consumption values by applying the Means-End Chain theory, integrated with the Theory of Consumption Values. Twenty-five soft laddering interviews were conducted with participants who had experience using digital fashion for on-screen bodies. Three Hierarchical Value Maps of AR-filtered, superimposed image-based, and AI-generated will be created to visualise and compare the links between product attributes, perceived benefits, and consumption values. Study 2 focuses specifically on AI-generated digital fashion, aiming to explore how value perceptions and unique product attributes influence the formation of psychological ownership and the adoption behaviour of AI-generated digital fashion. Together, two studies offer a nuanced framework for understanding the adoption of digital fashion for on-screen bodies and provide actionable insights for brands seeking to enhance value positioning of digital fashion for on-screen bodies.

Abstract Template:

Generation Z And Fashion Brands: Exploring Brand Value Creation, It's Erosion And A Model For Recovery

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Research Theme: [Fashion Management and Marketing](#)

Year of Study (Presentation Type): [Year 3 \(Poster\)](#)

Strong and successful brands can represent a large proportion of a company's market capitalisation or market value, and thus are important and valuable assets (Mizik, 2014). This study aims to explore how this value is created by brands, disentangling the concept of brand value and adding depth to current theoretical frameworks where uniformity is scarce (Raggio and Leone, 2009). Furthermore, the present study aims to explore how brand value is eroded, given there is a scarcity of studies that focus on declining brands (Thomas and Kohli, 2009). The exploration of how brands can recover their value is the final aim of the research, with the creation of a conceptual model for brand value recovery. Qualitative research will be undertaken that presents both the consumer and the company perspective utilising focus groups and in-depth interviews, with the focus being UK fashion brands and the generation Z consumer. This context furthermore enhances the opportunity to add to current academic research with to date no model providing a comprehensive view of brand value creation, erosion, and recovery within a fashion context. The digital context within which generation Z experience brands adds further validity to the context in which the present study will be undertaken (Halim et al., 2023). The research seeks to also provide brands with strategic insight that will be applicable in practical terms for brand management.

How many clothes are enough? The right to adequate clothing.

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Year of Study (Presentation Type): Year 3 (Poster)

Clothing is essential and forms a fundamental part of our everyday lives. It is perhaps because of this familiarity that it is often taken for granted. The right to adequate clothing is a basic human right, listed under Article 11 of the International Covenant on Economic, Social and Cultural Rights (ICESCR) 1966, which recognises everyone's right to an adequate standard of living. This means that adequate clothing should be available and accessible for consumption by all. However, despite billions of new garments being produced, consumed and disposed of each year, clothing deprivation and inadequacy is a problem faced by many. The research seeks to offer an approach to environmentally sustainable fashion which not only has sustainability benefits but also increases clothing accessibility for the clothing deprived. Using qualitative semi-structured interviews with individuals who have experienced clothing deprivation, as well as those who support those in need, the research explores the meaning of clothing (in)adequacy, its impact and possible solutions. The Circular Economy (CE) is presented as a potential solution; however findings suggest that the CE has predominantly focused on its environmental and economic value, overlooking social implications with little consideration for improving clothing access for the deprived.

Abstract Template:

Title: **Social Media Influencers as Minority Change Agents: A Behavioural Theory Approach to Nudging Sustainable Fashion Consumption Among Saudis on Instagram**

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The United Nations has drawn attention to the environmental challenges posed by the fashion industry, highlighting the consequences of overconsumption and excessive fashion waste. Parallel to this, nudges offer a potential solution as subtle interventions that guide individuals toward desirable behaviours while preserving their freedom of choice (Thaler & Sunstein, 2009). The application of nudging strategies through social media influencers' (SMIs) varied types of content—visual, verbal, and hybrid—remains underexplored, despite the recognized importance of SMIs in shaping behavioral change (Vladimirova et al., 2024). This oversight is particularly significant in the context of sustainable fashion advocacy, where SMIs utilise visual-centric platforms like Instagram to showcase sustainable fashion practices as a minority perspective. This challenges mainstream consumption patterns of the majority which underscores a critical gap in the literature and requires further investigations (Chwialkowska, 2019). Thus, this study explores how SMIs, as minority advocates, nudge fashion repurposing utilizing a two-phase research design.

The first phase utilises the "Nudge Plus" framework, which integrates automatic nudging with conscious reflection (Banerjee & John, 2024) in a survey experiment to examine the impact of SMIs' —visual, verbal, and hybrid— content on promoting fashion repurposing. First, it examines how personal conscious characteristics—specifically **fashion consciousness and environmental consciousness**—influence the practice of fashion repurposing. Second, it examines how perceived nudge effectiveness and nudge acceptability moderate the relationship between these personal characteristics and fashion repurposing depending on the type of nudge (visual, verbal, or hybrid). The second phase focuses on understanding how SMIs, as minorities who possess a minority view, nudge fashion repurposing. Using semi-structured interviews, this phase delves into their unique role in shaping sustainable fashion consumption and their influence on fostering the adoption of fashion repurposing. The findings of this study's multidimensional framework that examines both the content and personal characteristics of

SIMs will advance the literature by offering an integrated understanding of how minority advocates influence sustainable practices. Also, it offers practical insights for marketers, influencers, and policymakers to design digital campaigns that encourage a minority view like fashion repurposing through strategic nudge format.

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Circular Economy Approach to Recycling of Post-Consumer Textiles

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Year of Study (Presentation Type): Year 3 (Poster)

Abstract

The operationalisation of sustainable development remains a significant challenge, and while the circular economy (CE)-particularly post-consumer recycling is gaining traction as a potential solution, its application in Asian developing countries like Bangladesh is still emerging and unexplored in academic literature. While post-industrial textile recycling has gained significant focus, the infrastructure and logistics for collecting, sorting, and recycling **post-consumer textile waste** remain underdeveloped. However, the informal sector plays a critical role in managing textile waste, yet its integration into formal CE frameworks has not been thoroughly examined.

Although Bangladesh has introduced policies for waste management, there is limited research on how specific regulations influence textile recycling and broader circularity practices. With an emphasis on post-consumer textile recycling, this study investigates how global innovations in textile -to-textile (T-T) recycling is being adopted across local context and examines the roles of key stakeholders in driving inclusive and scalable CE initiatives. Likewise, compared to other nations consumer behaviour towards circular fashion—awareness, attitudes, and participation—remains incomprehensive. In addition, this research highlights collaborative approaches to overcome intrinsic barriers and foster innovation-driven recycling practices tailored to Bangladesh's distinguished challenges and opportunities by integrating the stakeholder engagement theory and the quadruple helix model for the first time in CE related study.

Birds of a Feather eWOM Together? How Similarities between Influencers and Consumers Affect Positive Electronic Word-of-Mouth

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This research examines how similarities between influencers and consumers can positively affect eWOM intentions—a promising but underexplored area, given that similarity has been shown to influence outcomes such as purchase intention in influencer research (Naderer et al., 2021), but its role in shaping eWOM remains unexamined. Specifically, the research focuses on UK Gen Z lesbians—a digitally native and identity-conscious group within youth culture (Ngo et al., 2024)—because of their strong presence in online word-of-mouth, their market relevance in LGBTQ+-targeted influencer campaigns, and the lack of academic attention to their unique experiences (Lewis et al., 2025; Li, 2022; Coffin et al., 2019).

This research presents three interrelated papers and proposes a new framework to understand how social media influencers drive positive eWOM by operationalising similarity through source credibility, tie strength, and homophily. It integrates the Online Social Network (OSN) model and the Theory of Planned Behaviour (TPB) to examine how these factors—well-studied in psychology and communication but rarely applied to eWOM—shape consumer responses to micro-influencer campaigns targeting LGBTQ+ communities. The study highlights both theoretical and practical implications, especially for fashion brands seeking to strengthen engagement with youth culture audiences through more authentic and effective influencer campaigns.

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Technology Enhanced Methods to Improve Pattern Drafting of Sleeves

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Year 3 (Poster)

Abstract

This study investigates technology-enhanced methods to improve the accuracy and adaptability of sleeve pattern drafting for diverse female populations. Conducted in three phases, the research first evaluates existing sleeve drafting methodologies using CAD software and virtual fit simulations to identify their strengths and limitations. In Phase 2, a comprehensive analysis of 670 3D body scans—narrowed to 50 representative samples—was conducted to examine correlations between key anthropometric variables such as shoulder height to underarm height and outer arm circumference. These variables were used to classify participants into two distinct groups representing extreme body types. Phase 3 empirically explores the adaptability of current drafting methods—including Aldrich and Armstrong—by applying them to real scan data and assessing their fit and functionality. The findings reveal significant limitations in traditional systems, including rigid dart placement, inaccurate scanner measurements, and poor integration of bodice and sleeve components. The study recommends a shift towards parametric and body-specific drafting approaches, emphasizing the need for manual adjustments to scan data and integration of correlated body measurements. This research contributes to the development of more inclusive, precise, and adaptable sleeve patterns, advancing both academic understanding and practical applications in garment engineering.

Keywords: Sleeve Pattern Drafting, 3D Body Scanning, CAD Software, Garment Engineering.

The Potential of Modular Fashion for Promoting Sustainable Fashion: An Exploration of a New Business Model

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The fashion industry, dominated by fast fashion, has received increasing criticism as the dominating linear process (take-make-waste) is inherently unsustainable. To against this, more innovative practices are being proposed and systematic shifting toward a more sustainable future is being initiated. In this context, modular design in fashion is suggested as a creative practice with the potential to prolong garment lifetime and even to lead to a less consumptive fashion pattern, in which the individual module is the basic unit. However, research on this topic is underdeveloped.

Based on a critical literature review, this research proposes modular fashion as an innovative business model centred on modular garments, which are clothing assemblages made up of a group of interchangeable parts without sewing. By conducting qualitative research, this research project aims to explore the sustainable potential of modular fashion from multiple perspectives, including those of industry experts and consumers. This research project is expected to contribute to expanding the research field of modular fashion with a theoretical framework building up with a refined definition, identified challenges, consumers' attitudes and future direction for early adoption and future research.