I·M3 Institute of Materials, Minerals & Mining

Future Materials, Minerals & Mining Conference 2023

MTC, COVENTRY, UK

12 DECEMBER 2023

Sustainable future

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Hello and welcome to the

Future Materials, Minerals & Mining Conference 2023

We are very excited to welcome you all to spend the day networking, learning something new and finding out what fantastic work is being carried out by those here.

This conference series, organised by the Institute of Materials Minerals & Mining (IOM3) Student & Early Career Group (SEC Group), is intended to be a forum for early career scientists and engineers from across the UK to come together and present their research, developments, and work. Aiming to improve presentation skills, along with initiating collaboration between research groups, industry, and academia. It is also a way of helping researchers and industry workers see how their work fits into the bigger picture of future materials, minerals and mining. With this in mind, we encourage open and friendly discussions, networking, and collaborations.

Our thanks go out to those who have helped to organise this event led by our Conference Chair Liz Scoffins. It can be a struggle to align the calendars of two friends so you can imagine the effort that has gone into organising speakers, venue, catering, and anything else I have missed. I would also like to thank our sponsors who have made this day possible. Without their generous contributions we wouldn't be able to host events like this which help nurture future talent.

And finally, thank you to you. Without your support and being here, this conference wouldn't happen. I look forward to chatting with you all during the day.

Dr Aimee Goodall CEng CSci MIMMM
SECC Chair

Liz Scoffins CEng CEnv MIMMM
Conference Chair

About the SEC Group

The SECC represents the views of student, younger and early career* members to the Institute's Executive Boards and Advisory Council. We aim to represent the diverse range of members by ensuring Council representatives cover the different disciplines, regions and career pathways of student and early career members.

Since the Committee was founded in 1967 (as the Younger Members' Committee), we have developed a range of events to encourage networking and early career members' involvement with IOM3. Our greatest successes to date include the Young Persons' Lecture Competition, Matopoly, Professional Development events and Future Materials Conference. While we have been successful in the past, we aim to provide more events in the future. These include regular informal networking opportunities, along with new skills seminars, conferences and regional events.

bit.ly/IOM3_SECC

** The Institute defines 'early career' as meaning someone who is, as of 1 September 2020 (and allows for career breaks, e.g. parental leave):*
1. within 10 years of the start of their first employment (or self-employment) in a materials, minerals or mining related role, or
2. within 6 years of completing their PhD (in a relevant subject), whichever is sooner.
Note - the 10 years from the start of first employment would not normally include any apprenticeships (or equivalent training scheme).

GRAPHENE ENGINEERING INNOVATION CENTRE

Graphene Engineering Innovation Centre, University of Manchester

At the GEIC, we do something that isn't replicated elsewhere in UK academia. We are a state-of-the-art translation centre, which accelerates lab-to-market development, enabling companies to fast-track Technology Readiness Levels and launch new technologies, products and processes that exploit the truly remarkable properties of graphene and 2D materials. In ten years, we have helped more than 350 companies – from large corporations to spin-outs – secure the competitive edge they need, accelerating their growth by developing help for a strong product, crafting a well-researched go-to-market strategy, and offering access to a strong organisation culture.

www.graphene.manchester.ac.uk/geic/

HENRY ROYCE INSTITUTE

Henry Royce Institute

The Henry Royce Institute is the UK's national institute for advanced materials research and innovation. Royce was established to ensure the UK can exploit its world-leading expertise in advanced materials and accelerate innovation from discovery to application. With investment of over £300 million, and ongoing long-term support from the Engineering and Physical Sciences Research Council, Royce is ensuring that both the UK academic and industrial materials community have access to world-class research capabilities, infrastructure, expertise, and skills development.

From future cities and their energy supplies, to computing, manufacturing and medicine, the research and innovation facilitated by Royce has the potential to significantly impact peoples' lives. With its Hub in Manchester and with capability distributed across nine founding Partners, Royce works collaboratively to create real solutions and make a fundamental difference to the UK economy.

Through a variety of access grants, Royce offers students, academics, and industry world-class equipment, expertise and training, to support their advanced materials research.

www.royce.ac.uk

East Midlands Materials Society

Affiliated with IOM3

East Midlands Materials Society (EMMS)

East Midlands Materials Society is proud to continue to support the UK final of the Young Person's Lecture Competition. We have run a local heat for well over fifteen years now, and our winners have had some success in the finals.

EMMS is a Local Society affiliated to IOM3 which has technical meetings in Derby, Leicester, Loughborough and Nottingham and has been in existence since 1950. We have also run successful conferences with the next one scheduled for 2024 and is to be focused on a surface engineering theme. Our last, 'Energy and the Environment – Materials Making the Difference', was organised in conjunction with the IOM3 Energy Materials Group. It was well received and enjoyed a wide range of support. We are fortunate to receive support from Rolls-Royce and the Universities of Derby, Leicester, Loughborough Nottingham and Nottingham Trent. Our attendees include people from local industry, colleges and the universities. We do much to support our local students, sponsoring many of them to become members of IOM3. We also refund travel expenses for students travelling to meetings and give financial support for students to attend and present papers at conferences. We also support local schools, sponsoring the Loughborough University outreach programmes and Materials Matter in the past.

We are always looking at new initiatives. We are intending to organise our first lunchtime seminar next season. We have met the challenge of running virtual events. As part of our annual programme, we now include virtual only talks in the winter months and, for talks we hold physically, these are live streamed as well. Holding meetings virtually has allowed participation of those that find it difficult to physically attend. Virtual only meetings allow us to have international speakers. Next season we are hoping to have a talk on a Superhero theme from the Colorado School of Mines.

Most of our committee members have full-time careers, so we run the society with a minimum number of committee meetings, doing most of our business by electronic communication. We are a lean, well run Local Society, making a significant contribution to the region.

Dave Evetts CEng FIMMM
Honorary Secretary, EMMS

www.iom3.org/group/east-midlands-materials-society-emms.html

Coventry & Warwickshire Materials Society

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Coventry & Warwickshire Materials Society (CWMS)

Coventry and Warwickshire Materials Society promotes interest in materials by bringing together scientists, engineers, technicians and other professions in the Coventry and Warwickshire area by arranging talks, lecture competitions, discussions, works visits and social activities. Our talks cover a wide range of subjects relevant to materials and how they contribute to the challenges we all face today and which contribute to continuing professional development for IOM3 members. Of course, those who are not members of IOM3 are also welcome to participate in our activities. Our members include university staff and students, employees from local industries and professions and members of the general public.

Rod Vanstone CEng FIMMM
Secretary, CWMS

www.iom3.org/group/coventry-warwickshire-materials-society-cwms.html

Birmingham Metallurgical Association (BMetA)

Affiliated with I·M3

Birmingham Metallurgical Association (BMetA)

The BMetA is based in the School of Metallurgy and Materials at the University of Birmingham. The aims of the association are:

- To promote the standing of both Materials Scientists and Engineers within both industry and the wider community.
- To disseminate information on materials processing and properties to industry and academia in the West Midlands region primarily through a series of evening lectures.
- To encourage membership of the IOM3 from student to higher levels including Professional and Fellowship grades.
- To support and encourage young people, students and those in their early career in the pursuit of Engineering and material science.
- To explore and promote awareness of the hugely significant historical role of Birmingham in the development of science and engineering.

These aims are carried out primarily through a series of free to attend evening lectures and through providing sponsorship and support for events targeted at young people, students and those in their early careers. Special events may be planned from time to time.

Prof David Brown FIMMM
Secretary, BMetA

www.iom3.org/group/birmingham-metallurgical-association-bmeta.html

Programme at a Glance

9.00	**Registration/Coffee**
9.30	**Welcome** Liz Scoffins CEng CEnv MIMMM | Conference Chair
SESSION 1 | Liz Scoffins CEng CEnv MIMMM	
9.40	**KEYNOTE:** *The waterless furnace* Stefan March | Technical Specialist for Casting & Processing, MTC
10.00	**KEYNOTE:** *Innovation through collaboration: Use of advanced diffraction techniques towards understanding engineering alloys* Dr Katerina Christofidou MIMMM | Associate Professor, University of Sheffield
10.20	*Improved understanding of steel coil consistency through data-driven machine learning investigation of run-out table cooling profiles at the hot strip mill, TATA, Port Talbot* Robert Gibbs, Cinzia Giannetti, Thomas Baynes & Cameron Pleydell-Pierce
10.35	*The influence of composition on the cast microstructure for different casting technologies* Ajitesh Sharma*, Carl Slater & Claire Davis
10.50	*FexO containing material dissolution in Hlsarna slag and hot metal* Bharath Sampath Kumar*, Zhiming Yan, Koen Meijer, Johannes Hage & Zushu Li
11.05	**Coffee break & networking**
SESSION 2 | Dr Michael Kenyon MIMMM	
11.30	*Developing a synthesis route for potential p-type transparent conducting material, YScS3* Eleanor Teather* & Polina Komar
11.45	*Engineering thin film properties by atomic layer deposition* Sophie Pain*, Ailish Wratten, Anup Yadav, Nicholas Grant & John Murphy
12.00	*Rotational Moulding and Post-Consumer Recyclate (PCR): The opportunity and the challenge* Jake Kelly-Walley
12.15	*Comprehensive understanding in micro/nano-structural characterisations in a next generation polycrystalline Ni based superalloy* Hiroto Kitaguchi*, Ian Jones, Yu-Lung Chiu, Mark Hardy & Paul Bowen

12.30	**Institute of Materials, Minerals & Mining (IOM3)** Sarah Boad CEng FIMMM | Membership Development Manager, IOM3
12.45	**LUNCH & NETWORKING**

SESSION 3 | Dr Ilija Rasovic MIMMM

14.00	**KEYNOTE:** *The evolution of graphene and other 2D materials: From the lab to the marketplace* John Whittaker CEng MIMMM | Engineering Director, Graphene Engineering Innovation Centre
14.20	**KEYNOTE:** *Engineering a better future: Weaving EDI into Materials Science* Avery Cunningham AIMMM | University of Birmingham
14.40	**KEYNOTE:** *The innovation journey and 15% culture: Materials Science applied to life at 3M* Dr Antonio Pagliuca | Senior Specialist, 3M Automotive & Aerospace
15.00	*A new trend in materials development: The importance of sustainable progress* Maitheya Riva* & Maciek Hulme
15.15	*Discover materials* Chris Hamlett
15.30	**Coffee break & networking**

SESSION 4 | Dr Aimee Goodall CEng CSci MIMMM

16.00	*Transition from IN718 to ALSi10Mg for LPBF rocket thrust chamber* Oliver Dew, Dominic Callister, Henry Saunders, Denisse Pasco & Alistair John
16.15	*Individual extraction of rare earth elements (Neodymium and Europium) from coal ash of Punjab, Pakistan using novel Deep Eutectic Solvent* Hammas Khalid*, Mihammad Hafas Shafiq, Muhammad Hamza Shafiq, Mihammad Junaid Murtaza & Muhammad Badar Hayat
16.30	*Quantitative structural health monitor of composite materials* Matthew Gee*, Mayorkinos Papaelias, Farzad Hayati, Sanaz Roshanmanesh & Xiaoying Li
16.45	**Student & Early Career Group** Dr Ilija Rasovic MIMMM, SECC Vice-Chair
17.00	**Closing remarks** Dr Aimee Goodall CEng CSci MIMMM, SECC Chair
17.15	**End**

Full Programme & Abstracts

9.00 **Registration/Coffee**

9.30 **Welcome**
Liz Scoffins CEng CEnv MIMMM | Conference Chair

SESSION 1 | Liz Scoffins CEng CEnv MIMMM

9.40 **KEYNOTE: *The waterless furnace***
Stefan March | Technical Specialist for Casting & Processing, MTC

Water is commonly used as the coolant for Vacuum Induction (VIM) Furnaces for the coil, power lead-throughs and seals (see picture on next slide). What if the material you are melting required, from a safety case perspective, that there were no water or hydro-carbon liquid cooling allowed in close proximity to the metal when at elevated temperatures? This was the challenge we faced ! We needed to prove we could operate a waterless Furnace safely meeting all the existing requirements for casting and at least maintaining the existing metallurgical characteristics.

The MTC Solution was enabled by Teamwork between ourselves, the Customer, University of Birmingham and a leading Vacuum Furnace manufacturer.

10.00 **KEYNOTE: *Innovation through collaboration: Use of advanced diffraction techniques towards understanding engineering alloys***
Dr Katerina Christofidou MIMMM | Associate Professor, University of Sheffield

Innovation is pivotal within the engineering disciplines and successful innovation relies on collaboration through diversity and plurality of ideas and experiences. In this talk we'll interactively explore the role of diverse collaborations in accelerating innovation. Furthermore, I'll discuss my own experiences collaborating in diverse teams through a range of projects from alloys for turbine disc components, to deformation on machined surfaces and the manufacturing of components through laser powder bed fusion, all through the use of advanced diffraction methods.

Advanced diffraction methods offer a powerful tool, comprising unique capabilities, in the study of engineering components that can be applied to destructive and non-destructive evaluations both ex situ and in situ; for example, in understanding the evolution of mechanical performance under tensile loads or the evolution of microstructures under prolonged exposures at high temperatures.

10.20 ***Improved understanding of steel coil consistency through data-driven machine learning investigation of run-out table cooling profiles at the hot strip mill, TATA, Port Talbot***
Robert Gibbs, Cinzia Giannetti, Thomas Baynes & Cameron Pleydell-Pierce

The material properties of finished steel strip from the Hot Strip Mill at TATA Steel, Port Talbot are determined by microstructure formation, dependent upon the cooling profile of the strip on the run-out table, decided before the coil-run by a physics-based simulation. Working with the MATLAB machine-learning toolbox, this presentation details the process of developing an accurate (best final Pearson Coefficient = 0.8780) data-driven prediction of the two-phase transition of steel from Finishing Temperature to final Coiling Temperature. Though trained on practical events resulting from the physics-driven control system, the data-driven results are isolated from the direct

assumptions made within that existing simulation - to affirm and provide improving insights into those established assumptions. The results of the multi-variate machine-learning analysis inform dimensionally reduced interpretations and novel visualization of the complex datasets, providing clear illustration of the important relationships to industrial partners and materials experts. The resulting insight; that the cooling can be well approximated as a two-phase linear process, has implications to the assumptions made about the completeness and metallurgical transition point of the steel within the current physical model. The gauge of the strip, as determined by the finishing mill, is found to be a critical intrinsic factor affecting final coiling temperature after the run-out table. Labelling by gauge highlights unusual coils and aids further expert investigation of the underlying causes of process-error. The foundations are laid for methods and analysis important to the development of process certification, material fingerprinting concepts and future digital material passport frameworks.

10.35 ***The influence of composition on the cast microstructure for different casting technologies***
Ajitesh Sharma*, Carl Slater & Claire Davis

Next generation casting technologies such as thin slab, belt or strip casting have gained popularity due to the reported energy saving, which can be as high as 1.6 GJ/tonne when compared to conventional thick slab casting. However, these casting approaches result in changes in cooling rate during solidification and in thickness reduction to the required product geometry, both affecting the final microstructure and properties. The steel industry is moving to utilise greater amounts of scrap steel as feedstock and it is important to understand if the consequent increased levels of residual elements affect microstructural development. In this work the secondary dendrite arm spacing (SDAS) and micro-segregation levels for the range of cooling rates relevant for different casting technologies (1 to 10 °C/s) have been assessed using Confocal Laser Scanning Microscopy (CLSM). SEM-EDX line scans have been used to characterise micro-segregation levels. S275 and DP800 grade steels were chosen as baseline materials before residuals were added. The segregation ratio is calculated from the Mn spatial distribution values as 95th % percental value / average Mn content. It was found that as the cooling rate decreased the segregation ratio increases. Mn dominated this behaviour with ratios increasing from 1.25 to 1.38 at the lowest cooling rate. There is a balance between the time to allow for back diffusion and the distance over which diffusion needs to take place (both of which give non-linear cooling rate sensitivities) with the grades assessed showing a greater effect of diffusion distance for the cooling rates examined.

10.50 ***FexO containing material dissolution in HIsarna slag and hot metal***
Bharath Sampath Kumar*, Zhiming Yan, Koen Meijer, Johannes Hage & Zushu Li

The HIsarna technology is a low carbon and high energy efficient alternative ironmaking process. The HIsarna off-gas contains CO_2 in high concentrations, making it CCS/CCU ready. It will emit limited amount of dust; the hot metal contains low phosphorous, and this one-step approach significantly reduces capex and opex. The HIsarna pilot plant experienced sudden and uncontrolled slag foaming. Slag foaming incidents are unwanted and may disrupt the production. One theory of these foaming incidents is due to accretions containing FeOx falling in the liquid bath. High temperature laboratory experiments were done and analysed using various techniques like SEM and Confocal. Slow dissolution of solid FeOx in a non-foaming HIsarna slag and hot metal was

observed, with gas evolution analysis and dissolution kinetics, which is to be interpreted for slag foaming in HIsarna process. Accretion falling in the liquid bath seems not to be the main cause of slag foaming due to limitation in solid-liquid mass transfer.

11.05 Coffee break & networking

SESSION 2 | Dr Michael Kenyon MIMMM

11.30 ***Developing a synthesis route for potential p-type transparent conducting material, YScS3***
Eleanor Teather* & Polina Komar

Transparent conducting materials (TCMs) are an important group of semiconductors used in solar cells and touchscreens. Several excellent n-type TCMs exist, but there are difficulties producing p-types. Oxides have primarily been explored for p-type TCMs, because they are affordable and easy to synthesise. However, oxygen has a fairly high, negative electron affinity (-0.562 eV)1, which increases the hole effective mass and thus reduces conductivity. As a solution to this issue, alternative anions are being explored. In particular, sulphides are of interest, as sulphur is relatively Earth-abundant but has a positive electron affinity of 0.68 eV1 and thus lower effective hole masses2. YScS3 has been proposed as a possible p-type TCM by Zhang et al.3. Powders and single crystals of YScS3 were reported in the late 1960s, but have not been explored since4. Our group has been exploring pathways to produce phase-pure powders of doped and undoped YScS3. This has been achieved by reacting Y2O3 and Sc2O3 under flow of CS2 gas. This will enable us to now determine whether YScS3 is a TCM and demonstrates the optimal ways to use CS2 to produce ternary sulphides.

11.45 ***Engineering thin film properties by atomic layer deposition***
Sophie Pain*, Ailish Wratten, Anup Yadav, Nicholas Grant & John Murphy

Engineering the properties of dielectric thin films according to desired applications will allow development of next generation semiconductor devices. For example, to achieve high efficiency solar cells, high charge carrier lifetimes are needed, which require thin films with high passivation quality. Semiconductor manufacturing often involves deposition and selective removal of thin films, hence controllable etch resistance is desirable. Passivating contacts, a key technology for next generation solar cells, need to be selective for hole/electron transport, hence tuneable fixed charge polarity of a dielectric is advantageous. Control over these properties can be achieved by varying film growth conditions. Atomic layer deposition (ALD) is one means to do so and is based on sequential self-terminating reactions. ALD, which is growing in industrial popularity, offers Angstrom-scale thickness control with a high degree of uniformity and conformality, even for complex surface geometries. In addition, ALD allows a large degree of flexibility in growth conditions, including precursors, co-reactants, and thicknesses. The most common passivating dielectrics are SiO2 and Al2O3, but recent studies have identified HfO2 as a potential ALD-grown alternative. There is a lack of consensus on the properties of HfO2, with claims that it is both positively and negatively charged, and mixed reports on its passivation quality. In this work, I demonstrate the versatility of HfO2 as a passivation layer and demonstrate means to achieve desired material properties. Varying thickness and annealing temperature can control overall passivation level and etch resistance, while varying co-reactant and post-deposition annealing conditions alters chemical and field-effect passivation contributions.

12.00 ***Rotational Moulding and Post-Consumer Recyclate (PCR): The opportunity and the challenge***
Jake Kelly-Walley

The utilisation of recyclate materials is paramount in advancing sustainability within the polymer industry and addressing plastic waste challenges. Action of this nature is crucial in meeting the United Nations Sustainable Development Goals (SDGs), particularly SDG 12 (Responsible Consumption and Production). The use of recyclate contributes directly to SDG 12 by having greater efficiency with valuable resources and reducing waste. Rotational moulding (RM), known for manufacturing large hollow products, holds great potential to significantly contribute to this sustainability focus. The process is extremely diverse, and fundamentally different from other polymer processing techniques. As a result of the unique characteristics of RM, the adoption of recycled plastics in rotational moulding presents very unique challenges. While many studies have highlighted the benefits of using post-consumer recycled (PCR) materials in processes like blow moulding and injection moulding, the availability of specially designed PCR grades for rotational moulding is limited in industry and literature. This presentation aims to shed light on the challenges and opportunities in the relationship on RM and PCR. Offering a review of current approaches in academic literature on sustainable materials for rotational moulding, whilst outlining industrial development studies which have tackled such sustainable development directly. Ultimately, the discussion will portray a set the scene for and offer a glimpse of polymer based research which will enable progress towards sustainable material solutions for the future of Rotational Moulding.

12.15 ***Comprehensive understanding in micro/nano-structural characterisations in a next generation polycrystalline Ni based superalloy***
Hiroto Kitaguchi*, Ian Jones, Yu-Lung Chiu, Mark Hardy & Paul Bowen

We have been focusing on high resolution analyses in material characterisations; detailed microstructural analyses, which are indeed significant to determine physical properties, nevertheless, it is necessary to investigate representative phenomena occurring in the materials. The mission described above is explored by multi-scale quantitative microstructural characterisations using a next generation polycrystalline Ni based superalloy.

12.30 **Institute of Materials, Minerals & Mining (IOM3)**
Mrs Sarah Boad CEng FIMMM | Membership Development Manager, IOM3

12.45 **LUNCH & NETWORKING**

SESSION 3 | Dr Ilija Rasovic MIMMM

14.00 **KEYNOTE:** ***The evolution of graphene and other 2D materials: From the lab to the Innovation Cetnre***
John Whittaker CEng MIMMM | Engineering Director, Graphene Engineering Innovation Centre

14.20 **KEYNOTE:** ***Engineering a better future: Weaving EDI into Materials Science***
Avery Cunningham AIMMM | University of Birmingham

Equity/Equality, Diversity, and Inclusion (EDI) are more than just buzzwords in the modern world; they are crucial elements for fostering innovation and growth. Here, Avery will talk about what EDI truly means, why it should be a central concern for

every professional/student, and the profound impact it can have on both individual careers, the broader field and the future of people coming into the profession. We will hear how Avery developed their own work into EDI, first as an undergraduate student in nuclear and materials science, into his current work as a widening participation outreach officer, working to encourage the next generation of material scientists as well as actionable steps we can all take to make our workplaces, our lives and spaces for the people around us a better place. Attendees will be equipped with knowledge and resources to actively promote and contribute to an equitable, diverse, and inclusive culture in their respective fields. The aim is to inspire a commitment to EDI, paving the way for a future where materials science not only advances technologically but also becomes a leading example of societal progress and inclusivity.

14.40 **KEYNOTE:** ***The innovation journey and 15% culture: Materials Science applied to life at 3M***
Dr Antonio Pagliuca | Senior Specialist, 3M Automotive & Aerospace

Antonio's talk will revolve around how engineers and scientists at 3M use the 15% culture to innovate and how cross fertilization is essential for successful innovation and new product launches. He will also discuss how a material scientist can use the innovation process to deliver impactful change.

15.00 ***A new trend in materials development: The importance of sustainable progress***
Maitheya Riva* & Maciek Hulme

The development of new technologies and new materials is following a trend of increasing acceleration. More and more substances have been found to be hazardous after decades of use and resultingly, the world of industry is shifting towards a "safe be design" approach. This risk-based approach, founded on the study of legislative requirements for safe material selection and best industry practice from the onset, is now leading the way towards new and more conscientious development. We will discuss how regulatory compliance can help rather than hinder in the development of new technologies. Presenting case studies from the fields of Nanomaterials development and the challenges of this still relatively unknown subject, and in the mining industry and the strive to develop a more sustainable process for secondary extraction of ores technologies.

15.15 ***Discover materials***
Chris Hamlett

Discover Materials is a working group from ten UK universities aimed at promoting Materials Science and Engineering to school pupils and both their families and teachers. This talk will give an overview of Discover Materials, our journey so far and our ambassador scheme which anyone can sign up to and help us inspire the next generation of Materials Scientists and Engineers.

15.30 **Coffee break & networking**

SESSION 4 | Dr Aimee Goodall CEng CSci MIMMM

16.00 ***Transition from IN718 to ALSi10Mg for LPBF rocket thrust chamber***
Oliver Dew, Dominic Callister, Henry Saunders, Denisse Pasco & Alistair John

The University of Sheffield's student rocketry team Project Sunride recently tested the UK's first regeneratively cooled, additively manufactured rocket at the Race to

Space UK event this summer. Despite damage to the cooling channels, data from the test fire indicate the presence of combustion instabilities and boiling of the coolant fuel. With these insights, the team are modifying the geometry of the engine and selecting alternative material. Whilst IN718 provides excellent thermal stability, its poor conductivity and propensity to crack has encouraged the selection of AlSi10Mg for its high conductivity. Nonetheless, AlSi10Mg poses many new challenges such as its poor strength at elevated temperatures. Here we discuss the key points which shaped our material choice.

16.15 ***Individual extraction of rare earth elements (Neodymium and Europium) from coal ash of Punjab, Pakistan using novel Deep Eutectic Solvent***
Hammas Khalid*, Mihammad Hafas Shafiq, Muhammad Hamza Shafiq, Mihammad Junaid Murtaza & Muhammad Badar Hayat

Rare Earth elements are of great importance owing to their essential role in green technologies and defense applications. Coal ash waste is a potential source of Rare Earth elements, which are 17 in number. Techniques such as chemical leaching using mineral acids are applied for the extraction of REEs from coal ash. It is widely known that mineral acids are not environment friendly and emit a lot of poisonous fumes upon leaching and extract Rare Earth elements in composite form. For selective leaching of REEs, organic acids are used but these can cost a lot to selectively leach a single element. This study focuses on the selective individual extraction of rare earth elements from the coal ash of Trans-Indus region Khushab, Punjab, Pakistan by using Novel Deep Eutectic Solvent (DES). For this purpose, a novel DES was synthesized, composed of cinnamic acid and choline chloride, one being the hydrogen bond donor and the other being hydrogen bond acceptor respectively. By applying the combination of a jaw crusher, roller crusher and disc mill the particle size of coal was reduced to -325 mesh. The coal was subjected into oven at 750 degrees Celsius for 3 hours for preparing coal ash. Alkaline leaching of coal ash was performed using 8M NaOH solution. The prepared DES was then mixed with coal ash, and the leaching process was conducted at varied temperatures, molarities and stirring speeds to promote efficient extraction. The leachate obtained after the leaching of coal ash with the Deep eutectic solvent was filtered with the Whatman filter paper 42. Centrifugation was performed on the concentrate for 20 minutes at 5000 RPM. A comparison has also been conducted between the leaching efficiency achieved using sulphuric acid and the efficiency achieved using our Deep eutectic solvent. The resulting samples were sent for inductively coupled plasma mass spectrometry for the authentication of the proposed results. We are anticipating that our synthesized Deep Eutectic Solvent has selectively extracted neodymium and europium metal more than 80% from the coal ash and is more competent than sulphuric acid.

16.30 ***Quantitative structural health monitor of composite materials***
Matthew Gee*, Mayorkinos Papaelias, Farzad Hayati, Sanaz Roshanmanesh & Xiaoying Li

Highlighted by the increased demand for wind turbines for power generation under government legislation, departure from current inspection methods for structural health monitoring to an on-line approach is key for efficiency. Various fibre reinforced polymers are to be used, with varying fibre and matrix combinations; however, particular focus is to be applied to carbon fibre reinforced polymers, due to its preferential properties and application scope beyond usage in wind turbine blade construction. The use of acoustic emission monitoring, through a customized acquisition system, coupled with

signal processing techniques currently applied through MATLAB allow for identification, characterisation and quantification of damage during tensile and flexuralloading. Acoustic emission energy alongside with the root mean square of the waveform, currently show to be very promising in quantifying damage and offering the possibility of predicting further degradation before delamination actually occurs. Currently, with user input, it is possible to successfully pinpoint and isolate the precise waveform relating to delamination itself. Future development of the researched methodology look towards the implementation of machine learning to complete unsupervised online structural health monitoring for the identification and quantification of damage initiation and propagation so as the potential for delamination can be predicted with an acceptable degree of certainty, such that replacement of damaged blades can be carried out within an acceptable timeframe.

16.45 **Student & Early Career Group**
Dr Ilija Rasovic MIMMM, SECC Vice-Chair

17.00 **Closing remarks**
Dr Aimee Goodall CEng CSci MIMMM, SECC Chair

17.15 **End**

Posters

Carbon Dioxide Adsorption by Carbon Dots: A Prospective Approach for Mitigating Global Climate Change
Jyoti Rani, B C Choudhary, R K Sharma, X Ke & T Prior

Climate change has become one of the significant challenges facing our planet in recent times. CO_2 emissions in the atmosphere are widely recognized as a significant driver of global warming. To mitigate the negative impacts of excess CO_2, it is crucial to develop advance materials for the adsorption of gas. Adsorption is a process that occurs on the surface of a material and is greatly influenced by its surface properties and functionalities. One of the most critical factors influencing a gas adsorption process is its specific surface-to-volume ratio. Carbon-based materials have shown great potential for gas adsorption applications due to their unique structural and chemical properties Nowadays, a number of porous materials has been used for adsorption application. Carbon dots (CDs) have garnered significant attention in recent years due to their unique properties, including high fluorescence, low toxicity, biocompatibility, and versatile surface functionality. This high surface area provides a large number of active sites for gas adsorption. The porosity contributes to increased gas adsorption capacity by providing additional surface area and accessible pore spaces for gas molecules to be adsorbed. These properties have led to intensive research and exploration of CDs for gas adsorption applications. The CDs are analysed by using various characterization such as FTIR, XRD, EDS, SEM. For the analysis of CO_2 adsorption BET and TGA characterization techniques are used. The TGA results show a change in the initial weight of CD in the CO_2 gas atmosphere showing the adsorption of gas.

Enhancing photocatalytic activities of PAN electrospun membrane via well-dispersion TiO2 nanoparticles
Xuang Huang

Wastewater treatment is a critical aspect of environmental sustainability and public health. However, the diversity of filtration targets, ranging from aquatic microorganisms, bacteria, heavy metal ions, to dyes, engendering limitations in the practical applicability of traditional ultrafiltration membranes. To address the growing challenges in this field, photocatalytic membrane technologies have emerged as a promising solution. This study presents the application of photocatalytic electrospun membrane for efficient wastewater treatment. The membrane design combines the benefits of high fouling resistance and improved pollutant removal efficiency. In the study, the hydrophilic material PAN (Polyacrylonitrile) was chosen as the base material for the membrane. The study endowed the PAN nanofiber membrane with photocatalytic properties through immobilising the photocatalytic TiO2 nanoparticles onto the nanofibers, enabling multiple recoveries and recycling, also expanding the effective application of filtration including antifouling, removal of heavy-metal ion, and removal of dyes. Moreover, the issue of nanoparticles agglomeration existing in the past research is also solved by introducing a certain amount of dispersant; it not only alleviated the problem of nanoparticle precipitation during electrospinning but also significantly improved the even distribution of nanoparticles on the nanofiber membrane. The efficiency of pollutant removal is simulated through the degradation of methylene blue, with the efficiency showing a significant improvement from 23% to 99%. The development of this technology has opened a new avenue in the realm of filtration membrane technology, offering novel and more effective tools for wastewater treatment. This innovation addressed some of the bottlenecks in the development of photocatalytic membrane technology.

The synthesis, characterisation and air/moisture stability strategy of O3 and biphasic P2/O3 layered transition metal oxide cathodes for sodium-ion batteries
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Energy consumption in today's time is ever-increasing and with fossil fuels running low research is focusing on renewable and sustainable forms of energy. Lithium-ion batteries are commercially successful and demand for lithium-ion batteries is increasing especially with the use of electric vehicles, but lithium is not abundant throughout the world, and elements like cobalt that are used in lithium-ion batteries are toxic. Therefore, alternative forms of energy need to be explored and sodium-ion batteries are considered as promising candidates, due to the similar chemistry between sodium and lithium and because of the easy synthesis method. Unfortunately, sodium-ion batteries suffer from poor air and moisture stability and their electrochemical performance needs to be improved before they can be used commercially on a large scale. In this study we synthesised biphasic P2/O3 and pure O3 layered transition metal oxide cathode materials for sodium-ion batteries using a solid state method. We then carried out materials characterisation which included XRD, SEM, EDS and FTIR analysis, followed by electrochemical characterisation. We also review strategies to improve the air and moisture stability of layered transition metal oxides used as cathodes for sodium-ion batteries.

Phase transitions of fluorotelomer alcohols at the water/alkane interface studied via molecular dynamics

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Fluorinated surfactants are by-products of numerous industrial processes and long-lasting pollutants in the environment and human body. As amphiphiles, they are naturally present at interfaces such as aerosol droplet surfaces and cell membranes. Accurate theory and simulation methods are needed to guide future mitigation and removal strategies. Here we perform molecular dynamics simulations of two fluorotelomer alcohols (with one or two methylene groups adjacent to the alcohol—7:1 FTOH and 6:2 FTOH, respectively) at the oil-water interface at varying area per molecule. Analysis of surfactant packing and coordination showed visual evidence of a phase transition between a hexagonal crystalline monolayer and a disordered liquid expanded phase, which is confirmed by the radial distribution functions and the interfacial pressure isotherm. The model also reproduces the divergent behaviour of fluorotelomer alcohols with differing numbers of fluorinated groups, with 6:2 FTOH remaining in a disordered liquid-expanded phase at a small area per molecule. Despite correctly reproducing this phase transition, analysis of the surface pressure isotherm indicates the force field overestimates adhesive forces between surfactants in the crystalline phase. This knowledge will allow development of improved force fields for fluorinated amphiphiles.

Controlling the distribution of antibacterial photosensitisers in binary colloidal coatings

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What are the serious consequences of dirty surfaces? People can die. Microbes accumulated on surfaces cause problems. An infection occurs when they overgrow and invade your body, going to where they're not supposed to be. Their resistance to drugs, a global health crisis, is accelerated when these infections are mistreated. In the future, something as simple as a throat infection could end up killing millions and costing the under-pressured NHS lots of resources annually. We keep hospitals safe by frequently disinfecting surfaces. Using waterborne coatings generates more sustainable solutions. Watching paint dry is one of the key strategies we can adopt to reduce surface contamination and combat antimicrobial resistance. This work provides valuable knowledge into optimising the biocide distribution within antibacterial surface coatings. Microscopic data in our research provides macro insights for academics, clinicians, and industrialists to help reduce hospital-acquired infections.