



METALLURGY AND MATERIALS

Research Newsletter

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Welcome to your research newsletter

The purpose of this newsletter is to share information and promote key research and research-associated activities that have taken place within the School. The newsletter will be distributed on a quarterly basis; contributions and ideas are welcomed from all members of staff and research students. If you have any feedback or items that you would like to share in future editions you can do so by emailing Hanshan Dong (Director of Research) at H.Dong.20@bham.ac.uk and James Keatley (Research Administrator) at J.Keatley@bham.ac.uk.

This edition of the newsletter features news, items and information from the current academic year (between January and March 2019).

Grants and Awards News

Since the turn of the year, colleagues have been successful in obtaining new funding or receiving extensions to existing awards. Total awards to February 2019 stood at almost £6m, with 36 applications for funding submitted which is in line with the average over the previous three years. The total submission value at the end of February 2019 stands at over £14m. The Research and Knowledge Transfer Committee, chaired by Hanshan Dong, has recently established a list of project pipeline bids in order to maintain an overview of activity that could arise in future should bids be successful. Amongst those submitted were a Faraday Challenge Wave 2 bid from Emma Kendrick, and Sandy Knowles was successful at the College level panel for his bid to the UKRI Future Leaders Fellowship. Other proposals currently being prepared include EPSRC New Investigator Awards, EPSRC Established Career Fellowships and applications to the Philip Leverhulme Prize.

Recent new awards and grant news from the past three months include:

SUSMAGPRO

Allan Walton, Rustam Stolkin, Mike Jenkins and Richard Sheridan are co-investigators on this Horizon 2020 funded project, due to commence mid-2019. The core aim of the project will be the production of permanent magnets made of recycled material. SUSMAGPRO will provide the technology to mine the tons of magnets present in millions of devices in Europe and ensure that they are recycled effectively and competitively. Four pilot plants that cover the entire value chain of reprocessing - from robotic sorting, separation and magnet / alloy production to new permanent magnets made of recycled material - will be developed.

The project consists of 20 European partners and will run for 4 years, with total consortia funding of almost €15m. The project bid scored 15 points when evaluated by the European Commission, the maximum score available. The project will be coordinated by the Institute for Strategic Technology and Precious Metals / Jewellery Technology Institute (STI) of the University of Applied Sciences Pforzheim.

AMCASH

An application was made for the extension of the Advanced Materials Characterisation and Simulation Hub ([AMCASH](#)) project. This was successful in the competitive outline stage for c.£1.2m from two Local Enterprise Partnerships (Black Country and Coventry and Warwickshire). A full application will now be submitted in early May. The informal feedback received from other LEPs has been positive and the whole AMCASH extension is expected to be around £6m for 3 years, to support the R&D in the region. Contact [Yu-Lung Chiu](#) for further information.



Use of Liberty Blue peptide synthesiser to synthesise antimicrobial peptides

Artemis Stamboulis has been awarded funding from the Midland Neuroscience Teaching and Research fund to explore the synthesis and immobilisation of two peptides (RRRRRRGALAGRRRRRRGALAG and KRIVQRIKDFLR-RKLPDA) on polymeric surfaces. The surfaces will be UHMWPE, PU, PE and PLA and prior to peptide immobilisation the polymer surfaces will be modified by active screen plasma nitriding. The treatment will result in chemical bonding between the surface rich in -NH groups and the carboxyl end terminus of the peptides. The antimicrobial behaviour of the polymer surface will then be studied and the surface will be characterised by XPS. The project will run from January 2019 to January 2020.

Net shape manufacturing of complex titanium structure

Moataz Attallah has received funding for a PhD project co-funded by TWI Ltd and Innovative Metals Processing CDT on the development of powder HIPping technology for Ti-based metal matrix composites with enhanced performance.

Enhancement of Creep Performance of Laser Powder Bed Fabricated MAR-M509 using Post-Processing

Moataz Attallah has also received an Impact Acceleration grant, co-funded by Sulzer and EPSRC, on the optimisation of post-processing routes for a Co-superalloy (Mar-M509) processed using laser powder bed fabrication. The project investigates the use of hot isostatic pressing as a way to improve the creep behaviour of the builds.

Investigation into the manufacture of Ceramic Matrix Composite (CMC)

CEMTEC(M) is a new research programme that is focused on demonstrating the capability to manufacture an oxide-oxide (Ox-Ox) ceramic matrix composite (CMC) and to provide technical support to Rolls-Royce to develop designs for such materials with enhanced properties.

The introduction of ceramic matrix composites (CMCs) for structural applications in the hot section of a gas turbine provides many potential benefits over conventional alloy materials, including facilitating elevated operating temperatures. This project is focused on developing a simple, low cost processing method involving slurry impregnation and subsequent consolidation and densification followed by full characterisation. The end-goal is to produce a suite of materials that offer a range of different property characteristics in terms of features such as maximum temperature capability, strength and electromagnetic performance. Contact Jon Binner for further information.



Did you know...

More than 25 members of staff in Met & Mat are Award Holders of externally funded research grants.

Accelerated Degradation of Samarium Cobalt Magnets for Aerospace Applications

Funded by the Impact Acceleration Account (EPSRC), this 12 month Strategic Placement Fund gives a Research Fellow (RF) an opportunity to work alongside a large company (in this case Rolls-Royce). Amongst other things, the RF has the opportunity to undertake secondments within the company, being integrated into their team. The aim of this is to increase the chances and opportunities of the RF being offered a job by the company and to give them valuable industrial experience. In this case, Alex Campbell will be going to Rolls-Royce once a week and will attend important meetings regarding the move towards hybrid-electric aircraft.



This project is looking at degradation of samarium-cobalt magnets in hostile environments to determine their suitability for use in aerospace motor and generator applications. The project will strengthen the link between the Magnetic Materials Group (MMG) and Rolls-Royce and will allow a research fellow (RF) to investigate the effect of aggressive operating environments on samarium cobalt magnets, both at the UOB and at Rolls-Royce. This has become increasingly important as aircrafts move towards electrification, where power will be provided by samarium cobalt magnet motors, which are exposed to operating temperatures $>150^{\circ}\text{C}$ in a range of environments (e.g. air, oil, salts, de-icers), all of which are likely to have a negative impact on the physical and magnetic properties, leading to a potential decrease in performance in a highly critical device. Contact Richard Sheridan for further information (R.S.Sheridan.1@bham.ac.uk) or visit the EPSRC website for further information on [Impact Acceleration Accounts](#).

Turing Fellowship

Biao Cai was awarded an Alan Turing Fellowship from the Alan Turing Institute (ATI). ATI is the UK's national institute for data science and artificial intelligence. The fellowship focuses on utilizing computer vision and machine learning tools in 4D materials science (3D tomographic data evolving with time).

Energy Materials Group

Emma Kendrick has secured further funding on the Faraday Multiscale Modelling Project for two 18-month PDRAs and equipment and has also seen two new Innovate UK projects awarded:

- SUPERB (£364k): Emma Kendrick, Peter Slater with UCL, QinetiQ, William Blythe - High Power Batteries for Auto-Motive
- HESTIA (£200k): Emma Kendrick, Granta and Itellegens

Further award news

Congratulations to **Gavin Harper** who was recently awarded funding from the EPSRC IAA Developing Leaders scheme, **Mike Jenkins** who has received funding for work on "Understanding the effect of High Speed Sintering processing on physical and chemical properties of materials" and to **Paul Withey** who has successfully obtained sponsorship for work on "Furnace With No Services Requiring Water".

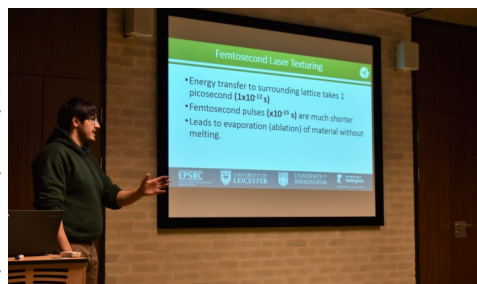
If you would like your award news to feature in future editions please contact James Keatley. Congratulations to all colleagues who have been successful in securing external funding for their research projects.

Research News and Events

See below for information about selected conferences, events (previous and upcoming) and other research-related activities that colleagues and researchers from across the School have participated in, hosted or organised this academic year.

7th Materials Forum of the School of Metallurgy and Materials

The 7th Materials Forum of the School of Metallurgy and Materials, organised by the Postgraduate Staff Student Liaison Committee (PSSLC), took place on Tuesday 29th January. The Materials Forum has become a yearly tradition where postgraduate students can share their research results in a familiar atmosphere. Every year the forum attracts students from different areas of Materials Science to exchange their knowledge, insights and to share experiences.



The forum involved a series of student presentations around their chosen research topic, judged by a panel of academic and research staff from across the School. A poster presentation session followed where all attendees were invited to vote for their favourite poster.

Congratulations to Benham Dashtbozorg (pictured right) who was awarded the first place prize for best presentation, titled "Development and characterization of novel-lasting antibacterial stainless steel surfaces", and to Katherine Franklin who was awarded the first place prize for best poster, titled "Friction Welding of Future Disk Alloys". The next Materials Forum will take place in early 2020. If you would like further information about the forum please contact [Fabian Burkhardt](#), Chair of the PSSLC.

CASTEP Users Workshop

The first annual [CASTEP](#) Users Workshop took place at the Edgbaston Park Hotel on 18th and 19th March. More than 50 participants attended the two days from universities in the UK and overseas.

CASTEP is a leading code for calculating the properties of materials from first principles. Using density functional theory, it can simulate a wide range of properties of materials proprieties including energetics, structure at the atomic level, vibrational properties, electronic response properties and so on. In particular it has a wide range of spectroscopic features that link directly to experiment, such as infra-red and Raman spectroscopies, NMR, and core level spectra.

The workshop was an opportunity for CASTEP Users to present and discuss their research in an informal environment. There was a lively informal atmosphere across the two days with plenty of opportunities for discussion and networking. There was also a poster competition with all participants encouraged to submit a poster and abstract to promote conversations. More than 50 participants attended the workshop from across the UK and Europe.

Angela Harper from the University of Cambridge was awarded the prize for best PhD/PDRA poster titled "Electronic Structure and Properties of Transition Metal Phosphides, and Ben Huddart from Durham University was awarded the runner up prize for his poster "An efficient method of calculating muon stopping sites using symmetry considerations".

If you would like any further information about CASTEP or the event please contact Andrew Morris or James Keatley.



Help and advice to commercialise your research

In January our Royal Society Entrepreneur in Residence, Dr Adrian Burden, started a series of Tech. Entrepreneurship seminars at which invited guests have been speaking about their own experiences of starting and growing technology-based ventures.

Adrian explains, "Often the best way to learn about entrepreneurship is to hear about the mistakes, the strategies and the successes of other founders and business leaders. Even if they have been involved in very different businesses to the one you are working on, their insights will be invaluable and much of what they have learnt will translate usefully to your own unique situation."

In January we heard from Melissa Snover about the growth of her 3D-printing candy-becoming-nutraceutical business that had recently featured on BBC's Dragons' Den. During February we were joined by Neil Pennington who explained how he had started a high technology consulting business focused on energy management and the rise of blockchain. And in March we hosted Dr Eric Mayes the CEO of Endomag who took us through his serial entrepreneurship career involving the commercialising of nanomagnetic materials for a variety of applications.

There will be many more such seminars coming up in May, June and July. For those interested in the nuts-and-bolts of founding and running a startup company Adrian will also be hosting a rolling series of informal sessions in Met & Mat called Tech. Entrepreneurship 101. Contact a.burden@bham.ac.uk for more details about these events or to simply have a chat about your own fears and aspirations of commercialising your research.

Met & Mat PhD student to represent UK in the European 'Student Speech' competition



The European Ceramic Society, [ECerS](http://www.ecerS.org), holds a major conference every two years, the venue moving around Europe. The next meeting will be held in June 2019 in Turin, Italy. One of the features of this conference is a '[Student Speech](#)' competition in which one PhD student representative of every country who is a member of ECerS takes part; this means that there are nearly 30 entrants each time.

In March the UK held its heat at Imperial College to determine who would represent the UK, with most UK universities who undertake ceramics research putting forward a candidate. We are delighted to say that Guoyang Ye (pictured left) from Metallurgy and Materials, otherwise known as Victoria, was successful with her 15-minute talk entitled "KNN Piezoelectric Ceramics Fabricated By Two-step Sintering For An Energy Harvester". She will now go to Turin to represent the UK. Earlier she had defeated other rivals from within UoB in order to get the chance to represent Birmingham during the event in Imperial. The last time that a UK candidate won the European event was back in 2013.

Student Successes at Nanomechanic Testing Conference

Congratulations to PhD student Shanshan Si, who recently won the best poster award at the Nanomechanic Testing Conference (Nanobrücken 2019) which was held in Berlin in February. At the same conference, one of our Y4 undergraduate students, Uthman Mahmud, won a prize for his oral presentation, based in part of his final year project. Congratulations, Uthman!

MIDSEM2019

The next MIDSEM meeting will take place on Wednesday 11th September 2019. This will follow the same format as previous years; further details will be circulated in the next edition of the newsletter. The meeting is intended to be an interesting and informative day for everyone with an interest in SEM.

New Core PI Session

A 90-minute EPS specific presentation for Principal Investigators to provide an overview of the New Core functionality, covering topics such as; purchase requisitions, expense claims, financial reporting and approving requests from direct reports will take place on **Tuesday 9th April, 11:30-13:00** in Mechanical & Civil Engineering, Lecture Theatre G34. All PIs are encouraged to attend.

The logo for 'newcore' is displayed in white text on a dark blue rectangular background.

School Equipment

The School is currently compiling a list of “nice to have” research facilities, including upgrades and modifications to existing kit. The focus is on “School” facilities, not facilities solely for individual research groups. This could include small expenditure items (a few £k) for optimising existing kit, or larger expenditure for new items. In the event that funds do become available we aim to be in a position to move quickly to purchase some items.

Yu-Lung Chiu has agreed to take this forward, if anyone has any ideas or requests for upgrades or new pieces of equipment, please send information to Yu-Lung (including supporting information and quotations), copying in James Keatley who will keep a record of requests. Please also specify if your request is teaching or research related.

REF Outputs: accompanying 100 words informal workshop

Monday 1st July 10 – 12 noon, Room 2C30



This workshop will provide participants with another opportunity to write and optimise their accompanying 100 word statements for proposed REF outputs.

Prof. Moataz Attallah, Prof. Hanshan Dong and Ruth Craven will be there to provide support and advice. Further details will be emailed out to the School to organise one-to-one slots for tailored advice alongside an opportunity to compose your 100 words in an informal and collaborative environment. Any questions, please contact Ruth Craven (r.craven@bham.ac.uk) or James Keatley (j.keitley@bham.ac.uk).

Batteries Included: The Birth, Life, Second-Life and Death of Electric Vehicles

Prof. Robert Elliot from the Department of Economics hosted an interdisciplinary workshop took on the 26th March covering a range of topics on the business and economics of electric vehicles (EVs). This covered topics such as the mining of raw materials to making the batteries for EVs, likely demand for EVs, the second-life storage options for EV batteries, and how batteries may be recycled as part of the circular economy. Speakers from the **Centre for Responsible Business, Economics, Met and Mat** and **Chemical Engineering** shared their experience, knowledge and research from this area. Gavin Harper from Met and Mat presented on “Recycling batteries from electric vehicles: An overview”



Strategic Elements and Critical Materials

A submission made to the House of Commons Science and Technology Committee on the subject of strategic elements and critical materials by the Birmingham Centre for Strategic Elements and Critical Materials (BCSECM) has been taken up by the Parliamentary Office of Science & Technology. They will examine current and future demand, the state of recycling, and future demand for critical materials and materials of high economic importance whose supply is at risk. Allan Walton and Paul Anderson (School of Chemistry) are co-directors of BCSECM.



New Staff

The newly formed Energy Materials group welcomed several new starters in March:

Lin Chen

Lin Chen received her Ph.D. degree in Sciences and Technologies in Chemistry and Materials in Istituto Italiano di Tecnologia (Genova, Italy). She is currently holding a Research Fellow position in Prof. Emma Kendrick's group in Metallurgy and Materials, conducting research on the development of materials for electrochemical devices like Na and Li ion batteries.



Brij Ksihore

Brij Kishore received his Ph.D. degree from Indian Institute of Science, Bengaluru, India. He joined as a research fellow in the Energy Materials Group with Prof. Emma Kendrick on 1st March 2019. He is currently working on an Innovate UK project (NATIVE) which looks into Na-ion batteries for automotive power applications. His research interests are development of novel electrode materials and electrolyte additives for Na-ion batteries.



Scott Gorman



Scott is a Research Fellow in the recently formed Energy Materials Group. His research interests are focused on the development and scale-up of new materials, manufacturing processes, and testing for energy storage/conversion applications. Since 2010 he has contributed toward projects on energy storage technologies spanning from micro-batteries to grid energy storage with a variety of chemistries at multiple UK academic institutions as well as stint at a spin out company. He is currently working in the area of all solid-state lithium-ion battery materials on a project entitled MoSESS which is aiming to develop solid-state batteries for high performance automotive applications.

Tanveer Pathan

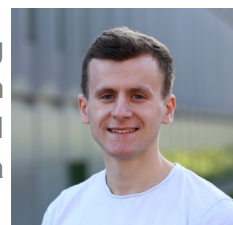


Tanveer is also one of the Research Fellows in the recently formed Energy Materials group headed by Prof. Emma Kendrick. His research interests are focused on the life-time and cycle life of lithium ion batteries. His research focusses on the initial formation of the batteries that subsequently determines the cycle life and overall performance of the battery. The research work is based on the use electrochemical methods to improve cycle life and capacity retention of existing and newly developed battery chemistries.

Tanveer obtained his undergraduate degree in Chemistry and attained his Masters with First Class distinction from Loughborough University. He has worked at Tata Steel UK where he worked in the Coated Products Department. He completed his PhD in Electrochemistry at the Electrochemical Innovation Lab in the Dept. of Chemical Engineering at UCL in 2017. After his PhD, he was at WMG, University of Warwick working on characterisation of lithium ion batteries until he moved to University of Birmingham in March 2019.

Kieran O'Regan (PhD student for Faraday Fast Start Project – Multi-scale modelling)

Kieran is currently working under the Faraday Institution on the Multi-Scale Modelling fast-start project. He is looking into the effect of lithium-ion electrode manufacturing on model parameters, specifically, the effect of calendaring on electrode microstructure and its influence on battery performance – the projects aim is to determine a structure-property relationship for electrodes.



The following Research Fellows and members of staff have also recently joined the School:

Zhonguan (Tom) Sun



Zhongyuan Sun received the B.Eng. degree from the Tianjin University of Technology and Education, Tianjin, China, in 2007, and the M.S. degree from Edinburgh Napier University, U.K., in 2009, and the Ph.D. degree in photonics from the Aston Institute of Photonic Technologies (AIPT), Aston University, U.K., in 2016. He was a post-doc Research Fellow in Aston University for 2 years since he was awarded a PhD. Now he joins the school of Metallurgy and Materials as post-doc research fellow under Professor Gerrard Fernando supervision. He has been investigating the design and fabrication of novel fiber grating devices and their applications in sensor devices and fiber laser systems. His current project is "Process Monitoring and Structural Integrity Assessment of Composites using Optical Fibre Sensors". Tom is based in office 2C04.

Amy Jade Newell

Amy is the newly appointed Characterisation Technician for Metallurgy and Materials and will be using instruments such as the Raman Microscope and the XRD, amongst many other things. Amy was previously a Microbiology Specialist for Muller and will look to transfer her knowledge & skills over towards a career guided more physics than biology! Amy is currently working towards an Open Degree in Science BSc (Honours). She is based in office 1C07 and can be contacted on 07879992303 or by email at A.J.Newell@bham.ac.uk.

Sam Cruchley

Many of you will know Sam who has worked in the School for a number of years. He has recently taken on the role of Deputy Head of Education and will support the Head of Education, Mark Ward. Sam has previously supported the nuclear programmes.

Also joining the School recently are **Dominika Gastall** and **Dave Burnett**. If you have any staffing news (new appointments, promotions, role changes etc.) that you would like to share in future editions please send details to [James Keatley](mailto:James.Keatley@bham.ac.uk).

An Introduction to...

Each edition of the newsletter will feature an introduction to a new or recently appointed Research Fellow within the School. In edition 1 of the newsletter we heard from Dr Lydia Pickering, and in this edition we hear from Early Stage Researcher Mohammad Qureshi who joined the School in late 2018. If you would like to feature in future editions please send details to [James Keatley](mailto:James.Keatley@bham.ac.uk).

Mohammad Qureshi

Mohammad Ali is from Pakistan and was born in Rawalpindi. He studied for his bachelor degree in Mechanical Engineering at the National University of Sciences and Technology (NUST) Pakistan, and Masters in Computational Engineering at the Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany. His masters thesis 'Simulation of Local Heating of the Fabric Reinforced Thermoplastic' was based on simulations of heat-transfer process of composite materials using infrared heat source. Mohammad is currently working as an Early Stage Researcher (ESR) for a Marie Curie ITN project DOC-3D-Printing. This research aims to model laser processing of additive manufacturing and post-treatment of bioceramics for orthopedic extremities. Apart from his work, in his free time he is interested in travel and photography.



Publications (January to March)

Since the 1st January 2019 there have been more than 40 different journal articles published or e-published ahead of print by colleagues from across the School (as authors or co-authors). These have been published in journals including *Acta Materialia*, *Corrosion Science*, *Nature*, *Scripta Materialia*, *Journal of Alloys and Compounds* and *Intermetallics*.

Featured Paper



New Ways to Stick Atoms Together.

Lisac, K., Topić, F., Arhangeliskis, M., Cepić, S., Julien, P. A., Nickels, C. W., Morris, A. J., Friščić, T. & Cinčić, D. (2019), 'Halogen-bonded cocrystallization with phosphorus, arsenic and antimony acceptors', *Nature Communications*, 10, 1-10

<https://doi.org/10.1038/s41467-018-07957-6>

Atoms stick together to make the world around us through a set of different atom-atom interactions called bonds. Without atomic bonding, the universe would be just be one large gas with nothing solid in it at all.

The text-book four types of atomic bonding are ionic (think table salt), covalent (silicon chips), metallic (steels, iron etc) and Van der Waals (how Geko's stick to the ceiling). However, there is a fifth kind of bonding, called a non-covalent directional interaction. It is responsible for water's unusual properties such as expanding on freezing (most liquids shrink) and having a high boiling point compared to other molecular liquids.

We care about this fifth-kind of bonding as it can stick molecules together into molecular crystals which have a wide variety of uses, for example, capturing carbon dioxide from the atmosphere, detecting trace impurities and toxins, sensing biomolecules and a vast collection of pharmaceuticals. It's similar to molecular Lego -- the more different ways we can stick bricks together, the more useful (and fun!) materials we can make.

The halogen elements such as fluorine, chlorine, bromine, and iodine can form these fifth-kind bonds. Up until now they were thought to only bond to small, compact atoms like nitrogen or oxygen, limiting the ways molecular crystals could be assembled. In this international collaboration between UK, Canada and Croatia we show that we can make molecular crystals by bonding the halogen iodine to the much heavier phosphorus, arsenic and antimony atoms, some 2, 5 and 8 times more massive than oxygen respectively.

Recent Publications

- Adjigble, M., Marturi, N., Ortenzi, V., Rajasekaran, V., Corke, P. & Stolkin, R. (2019), '[Model-free and learning-free grasping by Local Contact Moment matching](#)', *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*. Institute of Electrical and Electronics Engineers (IEEE), p. 2933-2940 8 p. (IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS); vol. 2018).
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Future Editions

Ideas, suggestions and contributions for future editions of the Metallurgy and Materials Research newsletter are invited from all members of staff and research students. Please contact [Hanshan Dong](#) and [James Keatley](#) with any suggestions or relevant items that you would like to submit. The newsletter will only be as good as the contributions that everyone makes, so please take the opportunity to share information and achievements related to your research activities with other colleagues across the School.

It is anticipated that future 2019 editions will be circulated in July, October and December; the frequency and content will be determined by feedback from colleagues.



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