

Newsletter

October 2022

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Welcome to the autumn edition of the Hub Newsletter!

Hub Research [1/2]

Feasibility Study, **ADvanced Dynamic REpair Solutions for Sustainable Composites (ADDRESS)** led by Principal Investigator, Dr Dmitry Ivanov from the University of Bristol, finished at the end of July 2022. The ambition of this work is to develop design for repair strategy by means of manufacturing multi-matrix continuously-reinforced composites (MMCRC). The concept, pursued in this Feasibility Study, enables composite structures combining domains of Covalent Adaptive Networks (CANs) and conventional established resins. CAN's can change their topology without decreasing their connectivity and hence present a great potential for repair. On the other hand, CAN's are far less processable and present manufacturing challenges: high viscosity, short processing window, demanding consolidation requirements.

Designing repair with MMCRC right at the manufacturing stage allows bringing new and existent resin in an integral material assembly. Instead of relying on the adhesive bonding of repair patches the novel manufacturing concept creates fibre bridged interphases ensuring better structural integrity and reliability of repair. Such concept circumvents both the manufacturability challenges and lack of confidence associated with conventional forms of repair. Moreover, it has been shown that MMCRC structures do not demand excessive processing requirements for repair and can be dealt with tools available in-field. Inductive coil with new architecture has been designed specifically for the non-planar shape and aim at localised targeted and uniform heating.

The project demonstrated successful manufacturing of CAN-epoxy MMCRC for corner geometries and subsequent mechanical testing to generate controlled level of matrix damage. It has been shown that with relatively low processing requirements, which can be available in-field, the repair fully restores the mechanical performance of the MMCRC. Resultant approach offers sustainable solution to improve the life of complex composite structures, thus contributing to the priority Hub themes of "Reycling/Reuse". This brings closer the creation of circular economy and more efficient recovery of materials.

Feasibility Study, **Rewinding Tape Laying: can Direct End-of-Life Recovery of Continuous Tapes be a Step-change in the Sustainability of Thermoplastic Composites? (REWIND)**, led by Principal Investigator, Dr Davide De Focatiis from the University of Nottingham, finished at the end of June 2022. This project explored the feasibility of recovering continuous thermoplastic prepreg from simulated end-of-life parts by a controlled thermal peeling process in such a way as to make the peeled plies re-useable in new parts with minimal post-processing. The fundamental challenges in this project lay in achieving effective separation of laminates with minimal disruption/damage of the fibres.

Despite thermoplastic composites being touted as recyclable materials, the actual means of doing so remains relatively poorly realised. The most recent comprehensive review on continuous fibre thermoplastic composites recycling identified only shredding, pyrolysis, and solvent removal as existing recycling methods. With high value continuous fibre thermoplastics all these methods result in either a downgrading of fibres, a waste of matrix material, or environmental issues and limitations with solvent solubility.

The Feasibility Study was able to successfully demonstrate that peeling of thermoplastic composites can be achieved with minimal force at temperatures close to the melting point of the matrix. It was also discovered that some composite materials also lend themselves to cold peel. The peeled tapes had higher surface roughness than the virgin materials, but the recovered materials were successfully remoulded into new components. The stiffness of the components made with peeled tapes is almost identical to that of components made with virgin tapes, and the strength is still under investigation. The opportunity for impact is considerable, but there remains research to be done with respect to peeling a more realistic component and doing so in a more automated fashion. Digital twinning and automation will also need to be considered in a future study in this area.

Hub Outreach Activities [1/6]

International Composites Summit (ICS) – 21-22nd September 2022 – ILEC Conference Centre, London

Following the success of exhibiting at the first International Composites Summit (ICS) in 2021 the Hub returned this year. ICS is the only exhibition focused solely on the global composites market, bringing together leading industry professionals to address the worldwide opportunities within the composites sector. There were sector-based themes in the conference sessions, covering the challenges faced in addition to those centred on the contribution composites will make in addressing climate change targets, through presentations on Race to Zero, Sustainability and Hydrogen. The Hub enjoyed talking to members of the composite's community, both visitors to ICS and the other exhibitors, about the innovative work on composites manufacturing being conducted within our research network.



The Hub team exhibiting at ICS, from left to right, Business Development Manager James Whyman, University of Nottingham, Administrator Joanne Eaves, University of Nottingham and Business Engagement Manager, Simon Quinn, University of Bristol.

Hub Open Day – 13 September 2022 – The University of Sheffield, Advanced Manufacturing Research Centre (AMRC)

The Hub was delighted with the attendance of over 130 delegates at its recent Open day, held at the AMRC, Knowledge Transfer Centre, Sheffield. The programme opened with an AMRC and Composite Centre overview from Head of Innovation, Anthony Stevenson, followed by a high-level overview of the Hub from Professor Nick Warrior, Hub Director.



Hub Outreach Activities [2/6]

Dr Stu Morris, Engineering Director at Pentaxia, led the first keynote presentation with a fascinating presentation on his background and connection with the composites sector. The second keynote speaker Josh Sherwood, Composites Research Engineer from GKN Aerospace, presented an informative, high-level overview of the ASCEND project, a cross-sector composite Technology and Supply-Chain development programme, joining the Aerospace and Automotive supply chains. We also heard some interesting presentations on our current Hub projects and were pleased to hear of developments on the Technology Pull Through Programme presented by Matt Scott from the National Composites Centre (NCC). Prior to lunch, delegates were invited on an impressive tour of the AMRC facilities at the 'Factory of the Future Laboratory'.

This year's Young Engineers and Student (YES) competition, hosted by The Society for the Advancement of Material and Process Engineering (SAMPE UK & Ireland) invited students to participate in a 'Design and Make' competition to manufacture a composite crash structure that could protect an egg during a crash landing. The aim of the competition was to produce a structure that could be dropped from the highest height, whilst avoiding any damage to the content (in this case, an egg). Congratulations to the winning team from the University of Edinburgh Composites Group. It was a fantastic opportunity for students to put their composites design and manufacturing experience into action and represent their institution.



Tim Wybrow SAMPE committee board member presenting the SAMPE competition prizes to the winning team 'The University of Edinburgh Composites Group', the team members were: Muhammad Waqas, Arun Kumar Alapati, Murat Celik and Thomas Noble.

Hub Outreach Activities (3/6)

Students and Researchers from all Hub spokes were invited to present a poster on their current research. Congratulations to the following people on their placed posters:

1st Place

Dr Shuai Chen, University of Nottingham, "Prediction of Double Diaphragm Forming Defects for Large-Scale Composite Components".

2nd Place

Dr Oriol Gavaldà Diaz, University of Nottingham, "Reprocessability and Repairability of Vitrimer Epoxy Carbon Fibre Reinforced Polymers (vCFRPs)".

Joint 3rd Place

Joe Soltan, Industrial Doctoral Centre, University of Bristol, "Modular Infusion: Novel Approaches to Segregation and Control of Flow Fronts Within Liquid Resin Moulding".

Joint 3rd Place

Will Darby, Industrial Doctoral Centre, University of Bristol, "Overmoulding of Butt Jointed Aerostructures (OBStruct)".

Joint 3rd Place – George Street, University of Nottingham, "Modelling Non-Isothermal Thermoforming Behaviour of CF/PA6 Composite Laminates".

The open day closed with an evening reception for all delegates at The Crowne Plaza Royal Victoria Hotel, Sheffield.

The International Conference on Manufacturing of Advanced Composites (ICMAC 2022) - 14 September 2022 - AMRC

Following the Open day, the Hub supported The International Conference on Manufacturing of Advanced Composites (ICMAC 2022) on 14 September 2022 which was also held at the AMRC, University of Sheffield.

Hub Outreach Activities [4/6]

Farnborough International Airshow 18th - 19th July 2022

Hub Business Development Manager James Whyman represented the Hub at the Farnborough International Airshow.



The main themes prominently displayed within the 100,000sqm space and 1,500 exhibitors were those very much at the forefront of the latest domestic and international funding initiatives:



Sustainability: This was quite possibly the dominant, overarching theme of the event. The impacts of climate change promote a clear need for action to safeguard the planet's future. World leaders and industry heads came together to collaborate on the future of the aerospace industry and Net Zero through the Aerospace Global Forum.

Defence: Radical novel approaches to the defence industry were on display, bringing together world-leading defence companies and strategic decision-makers behind military delegations.



Space: The appropriately cold 'Space Zone' housing both deep space exploration and commercial space technologies was one of the highlights of the whole event. Representatives from ESA and other international space agencies were present, alongside delegates from the booming UK space industry, including Space Forge, Space Scotland, and Spaceport Cornwall.

Hub Outreach Activities [5/6]

James commented *"My first air show was an event I was looking forward to, not only due to the ripe business development prospects it would provide but also to see the latest innovations the world can offer. From Rolls Royce's colossal 140 TurboFan, which will be ready for use with sustainable aviation fuel from day one, to Vertical Aerospace's lifesize model of their sleek and stealthy eVTOL future flight aircraft, the VX4."*

Industrial Doctorate Centre (IDC) in Composites Manufacture at ECCM20 – 28 July 2022, Lausanne Switzerland

To mark the achievements of the IDC, two special sessions were organised at the ECCM by Professor Janice Barton. The ECCM brings together participants from academia and industry who share an interest in Composite Materials. The event is the main European forum for knowledge exchange on recent accomplishments and future trends in Composite materials. The conference theme was "Composites meet Sustainability" highlighting sustainability, which is a prominent topic in the IDC research projects. The sessions featured 12 papers, presented by the IDC EngD students, on a wide range of processes covering braiding, tape and fibre placement, modular infusion, overmoulding, application sustainable and novel materials; development of modelling procedures; and performance investigations. Professor Ivana Partridge kicked-off the event with her invited keynote lecture on 'Toughening Approaches in Composites'. The sessions were well attended, with many lively discussions and interactions. The presentations clearly demonstrated the success of the projects, and that commercially sensitive material can be presented in a useful generic way for all to benefit. Congratulations to the students in making the event an enormous success thanks to their hard work and efforts.



Delegates attending the ECCM conference.



IDC students with Ivana Partridge and Janice Barton.

Hub Outreach Activities [6/6]

UK National Manufacturing Day - 7 July 2022 - Advanced Manufacturing Building (AMB), University of Nottingham

The Hub participated in the National Manufacturing Day in July this year. The Composites Lab and other labs within the AMB opened their doors to the public and local schools, who were treated to short presentations and demonstrations delivered by the University's Engineering researchers and PhDs. The day was an enormous success with over 150 visitors attending. Thank you to everyone who gave up their time to help with the event.



A live demonstration of prepreg compression moulding from Dr Andrew Parsons



A discussion about sheet moulding compounds led by PhD student Daniel Wilson

Upcoming Events

Advanced Engineering Show (AES), 2-3 November 2022, NEC, Birmingham

The Hub will have a stand at the AES located in Hall 3A, stand number Q134, so please stop by for a chat if you are attending the event.



[Click here to find out more.](#)

Upcoming Events



[Click here to keep up to date with our events.](#)

The Hub would like to wish **Professor Andy Long** all the best with his new role as Northumbria University's fifth Vice-Chancellor and Chief Executive.



Professor Long left his role of Provost and Deputy Vice-Chancellor at the University of Nottingham in August. He was the founding Director of the Future Composites Manufacturing Research Hub and Principal Investigator on the Hub's Core Project 'New Manufacturing Techniques for Optimised Fibre Architectures'.

Professor Long studied for his PhD in Mechanical Engineering at the University of Nottingham, where he continued to work for 32 years. He is recognised internationally as a leading researcher for polymer composite materials with applications in the aerospace, automotive and renewable energy sectors. He has published extensively and received numerous awards for his research.



The Hub would like to welcome **Dr Dominic Palubiski** as a Research Associate at the University of Bristol. Dominic has recently completed the Hub Feasibility Study 'Advanced Dynamic Repair Solutions for Sustainable Composites (ADDRESS)' and is now working on the Hub funded project 'Modular Infusion and

Modular Forming for De-Risking Manufacturing and Sustainable use of Structures'. Both projects investigate the use of Covalent Adaptive Networks (CANs) as matrix for composite materials. The ADDRESS project aimed to investigate composite repair by allowing interlaminar failure to be healed back while maintaining fibre integrity. His current project is utilizing CANs ability to 'soften' (above a certain temperature) without sacrificing structural integrity to reduce the complexity of component deployment. This is envisioned through the manufacturing of simpler, planar, panels, and their reshaping into complex geometries in-situ using the vitrimer matrix inserts as hinges. Dominic obtained a master's in chemistry in 2016, and his Ph.D. at the Bristol Composites Institute in 2021 researching diamond manufacture and nanocomposite design.

The Hub would like to welcome the recent appointment of **Dr Xun Wu** as Hub Platform fellow working on thermoplastic overmoulding activities at the University of Bristol. Xun is also a Research Associate at the Bristol Composites Institute.



Prior to this appointment, Xun was a core member of Rolls-Royce University Technology Centre at University of Bristol, dedicated to using hybrid concepts to improve the energy absorption capability of composite materials, raising the possibility of producing more efficient structural components for the low carbon future. Xun obtained her PhD degree in advanced composites also at the University of Bristol, focusing on design and manufacture high performance ductile carbon fibre composites. Her research interests lie primarily in the processing of advanced composite materials, the design and prediction of the behaviour of novel hybrid composite systems and characterisation the behaviour under different loading conditions. Furthermore, Xun enjoys playing an active role in many activities that seek to promote STEM and women in engineering, such as being an invited speaker at the “Soap Box” science festival.

The Hub would like to congratulate **Dr Dipa Roy**, University of Edinburgh on her recent promotion to Reader at the University of Edinburgh, School of Engineering.

The Hub would like to congratulate **Dr Adam Sobey**, University of Southampton on his recent promotion to Professor of Data-Centric Engineering at The University of Southampton.

The Hub is pleased to announce the recent successful viva for **William Moses**, Ulster University. William commented:

"My Thesis is about a method of through-thickness reinforcement that sits between Z-pinning and tufting, see below the papers published covering the results of the process:

<https://www.sciencedirect.com/science/article/pii/S0263822322007619?via%3Dihub>

<https://www.tandfonline.com/doi/full/10.1080/14658011.2022.2108981>

<https://www.tandfonline.com/doi/full/10.1080/14658011.2022.2108981>

In terms of the viva I was concerned going in, as I am sure many folks still doing their PhD's are, that the lack of experimental results due to COVID might be an issue. However my experience was that the Viva team were very understanding on this point, and I am thankful to Professor Michaud for taking the time and energy to review my thesis and travel to speak in person."

Congratulations to William and thank you to **Véronique Michaud**, Associate Professor and Head of The Laboratory for Processing of Advanced Composites, and Hub Advisory Board member, for her continued support.

Lightweight Carbon fibre Railway Axles Feature in the Ministerial Visit to Support the Great British Railways National Headquarters Competition

Derby City Council's bid to make Derby the home of the Great British Railways National Headquarters has progressed to the final round. Of the 36 original bids there are 5 other cities still in the competition: Birmingham, York, Doncaster, Newcastle, and Crewe. The Minister of State for Transport, Wendy Morton, and her team visited the historic Derby Roundhouse on 10th August 2022 as part of the competition process. Dr Mike Johnson represented the University of Nottingham as part of the East Midlands Rail Cluster for Innovation & Decarbonisation. He spoke to the Minister about the lightweight carbon fibre railway axle being developed within the Hub as part of a Shift2Rail project, NEXTGEAR. MP Morton was delighted to hear that the anticipated 65% mass reduction of the axle will play a significant role in minimising track impact damage, thereby reducing maintenance costs and passenger travel interruptions.



Dr Mike Johnson looks on as Wendy Morton discusses innovative research within the East Midlands Rail Cluster.



MP Morton sets her sights on the lightweight railway axle.

IDC Extension

The funding for the current IDC provided by EPSRC ends in March 2023. As the new Director of the IDC, Professor Janice Barton has developed a new programme that will enable the IDC programme to continue with industrial support for EngD studentships. The first of the new studentships are being sponsored by NCC who have undertaken to support for the programme the next three years in the first instance.

The advertisement for the first cohort of NCC students is now available.



[Click here.](#)

The scheme is open to all companies who are interested in sponsoring a student. The students spend 75% of their time embedded in the company contributing to industrially based research. Please contact Janice if you are interested for further details:



janice.barton@bristol.ac.uk

This edition's EDI story was kindly provided by Dr Dipa Roy, Reader, University of Edinburgh

"I completed my PhD from the Indian Association for Cultivation of Science (IACS), Jadavpur University, India, back in 2002. After 3 years' postdoc, I became a lecturer in the Department of Polymer Science and Technology Department at the University of Calcutta, India, in 2005. In October 2011, I took an unpaid leave from my University at Calcutta and joined the Irish Centre of Composites Research (IComp), University of Limerick, Ireland, as a research fellow. I travelled to Ireland with my daughter, and this was only possible with the support of my family. My plan was to stay in Ireland for 12 months, and then go back to India to my previous job. However, my daughter really liked the friendly atmosphere of the school in Ireland, and that led to changing our mind and we decided to stay back in Ireland. My husband was offered a job in Ireland and moved there in 2013.



My family is always my first priority and then comes my professional commitments and my passion for research and teaching. While I did enjoy my work at IComp, but my daughter was the driving force that made me stay. During my time at IComp, my work mainly involved industrial research. I learnt a lot at IComp and had the opportunity to work with great colleagues. Although I liked the research and the collaboration with industries, but I did miss teaching and the freedom of being an independent academic. In 2017, I started an academic position at the University of Edinburgh.

Hub Equality, Diversity & Inclusion (2/2)

I'm not an ambitious person. I never set myself goals of becoming something. I do research not because I want to achieve anything, but because I love research, and my hard work and passion keep me going – these two are the key things to academic roles. There are several people who have inspired me during my journey, but I would like to name two persons who inspired me the most. One was my PhD supervisor Dr B. K. Sarkar in India and the second person is Dr Terry McGrail, Director of the IComp. I have learned so much from them and I will always remember and respect them as mentors in my academic career. I am also very much thankful to my present colleagues at the University of Edinburgh who are wonderful people and great support.

I feel very fortunate that throughout my career I have never faced discrimination for being a woman or for being a foreigner coming from a different continent. However, I must also admit that I try to forget or ignore unpleasant things that come my way and I am not very mindful in remembering such things unless that impacts me hard. If there was anything really upsetting, I would have remembered that. However, I know discrimination is a big concern and I have seen my female colleagues facing such problems. I think the key to an effective EDI strategy is that people remain conscious about the issues and believe in the idea, so that it automatically comes into practice. It will not be very effective if it is just a rule for people to follow. There needs to be a mechanism to make people understand why EDI is so important, and if people understand, they are more likely to believe and practise that.

My advice to other female researchers and academics is that do not undermine yourself. I have done that unknowingly in my career and now I realise that was a mistake. I have seen many female researchers including myself speak less about their achievements. I have heard in leadership trainings and workshops this issue has been brought up again and again. It is a proven thing now that many female academics are not good in beating their own drums, with some exceptions. I want to make other female researchers and academics aware of this – be assertive, confident about yourself and sing your own praises whenever needed.”

If you are interested in joining the Equality, Diversity and Inclusion committee please contact the EDI Champion, Dr Connie Qian



<https://cimcomp.ac.uk/people/connie-qian>

Hub Training

Hub Industrial partner [Pentaxia](#) delivered a bespoke training course to the University of Nottingham's PhD students and Researchers on 8th – 12th August. The training programme was an intensive five day 'hands on' course, covering: Mould Design, CNC Programming, WI creation / Kit templating & nesting, Laminating and Inspection.



University of Nottingham Hub students and researchers at the August 2022 training course at Pentaxia.

A PhD student who attended the course commented, *"It was an excellent training experience, the expertise and experience of the trainer and the fact that the training was hands-on, made the programme really interesting. The most useful element I gained from the training was learning how laminating is done, and seeing how the composite components are actually manufactured in the real world. I would highly recommend the training to other students and researchers."*

The Hub are now extending the opportunity to all Hub students and researchers and the course will take place 7th – 11th November at Pentaxia, Derby.

If you haven't already registered your interest and wish to do so, please contact Joanne Eaves by [clicking here](#). Places are limited, however if there is a high level of interest then the Hub will repeat the training course in early 2023.

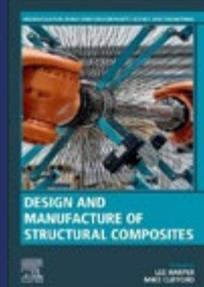
If students and researchers have suggestions for specific training opportunities which the Hub can support please get in touch: [click here](#) for more information.

Publications

2022 Q3 Publications

Dr Lee Harper and Dr Mike Clifford, University of Nottingham will be releasing the following textbook '**Design and Manufacture of Structural Composites**' on 10th December 2022.

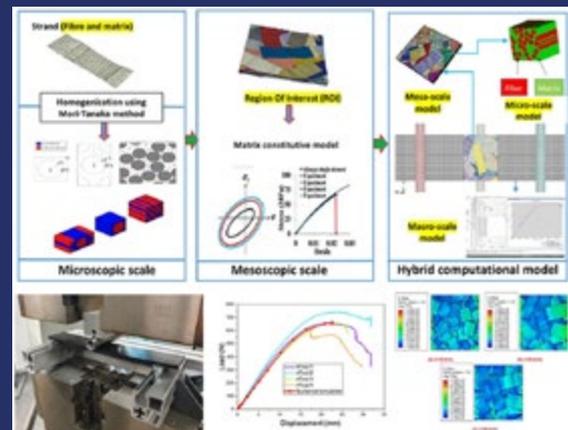
<https://www.elsevier.com/books/design-and-manufacture-of-structural-composites/harper/978-0-12-819160-6>



Nachtane, M., Meraghni, F., Chatzigeorgiou, G., Harper, L.T., Pelascini, F. 2022.

'Multiscale viscoplastic modeling of recycled glass fiber-reinforced thermoplastic composites: Experimental and numerical investigations', Composites Part B: Engineering, vol 242, 110087.

<https://www.sciencedirect.com/science/article/abs/pii/S1359836822004632?via%3Dihub>



Endruweit, A., Matveev, M., Tretyakov, M.V. (2022) '**Controlling resin flow in Liquid Composite Moulding processes through localized irradiation with ultraviolet light**', Polymer Composites.

<https://onlinelibrary.wiley.com/doi/10.1002/pc.27001>

Vacuum infusion experiments with UV irradiation; reinforcement covered with a mask (strip along flow direction, with rhombic inclusion); (A) mask removed before impregnation was complete; (B) mask removed after complete impregnation.





If you would like to contribute to our quarterly newsletters,
please contact Joanne Eaves:

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2022