

Newsletter

September 2021

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The University of Manchester



Welcome to our autumn edition of the Hub Newsletter!

Hub Training and Networking Opportunities 1/2

The Hub recently became a member of the **Vitae Researcher Development Framework (RDF)**, which is designed to enhance and develop the necessary skills for individuals to pursue a career in academia. If you are a Hub PhD student or a member of the research team, then you are encouraged to enrol to further your professional development. More information on the RDF can be found at:



www.vitae.ac.uk/researchers-professional-development/about-the-vitae-researcher-development-framework

Other Training and Networking Opportunities

The Researchers Network

The RN is made up of students and researchers, focussing on professional development, knowledge exchange and networking through social engagement. As a reminder, The RN has recently launched a call for **Hub Researcher Awards**. The award aims to support small research projects (up to £5,000) and provide the very first steps to independence for Hub researchers. The projects must be focused on the manufacturing of fibre reinforced polymer composites. The award is open to researchers who are currently employed or study at any of the 15 Hub universities.



cimcomp.ac.uk/wp-content/uploads/2021/08/Hub_Researchers_Award_2021.pdf

Hub Training and Networking Opportunities 2/2

International Exchange Programme (IEP)

The Hub is pleased to relaunch the IEP, which offers students the opportunity to participate in an exchange to a partnering international institution. The exchange programme is intended to foster collaborations and expand knowledge, exposing students to the latest technologies championed by leading academic and research institutes. Funding is available to support visits of up to 3 months.

For more information on any of the above opportunities, please click on the following link:



cimcomp.ac.uk/hub-training/

If you would like to register your interest in any of the opportunities above, please contact:



joanne.eaves1@nottingham.ac.uk

Events and Outreach

Webinars

Our most recent webinar took place on Thursday 23rd September 2021. It was a free-to-attend virtual event based on Hub Work Stream 3, Multifunctional Structural Composites. Professor Emile Greenhalgh from Imperial College London presented research investigating the design and manufacturing issues associated with multifunctional composites. The presentation entitled '**Design and Manufacturing Issues for Multifunctional Structural Composites**' gave an overview of emerging technologies, with a particular focus on structural power composites: Structural composites imbued with the capacity to store/deliver electrical energy.

If you missed any of our webinars, you can watch the video recordings from our website on the research project page:



cimcomp.ac.uk/research/



[www.youtube.com/channel/UC7SilvzjuY6s9nmw0Gni2ag/
videosat](https://www.youtube.com/channel/UC7SilvzjuY6s9nmw0Gni2ag/videosat)

International Composites Summit (ICS)

The Hub recently attended the 2-day International Composites Summit on 8 - 9th September at the ILEC conference centre, Earls Court, London. This forum was the first face to face event since the start of the COVID-19 pandemic and we were pleased to see some familiar and new faces at the event. We look forward to attending more events in the next year and meeting up with our industrial and academic partners.

Hub Open Day

The Hub has released the programme for this year's Open Day. It will take place on Tuesday 19th October 2021 and will be hosted by Hub Spoke, the University of Edinburgh. The Open Day will be conducted as a virtual event and will be free to attend.

We are delighted to announce two keynote speakers, Dr Adrian Gill from Vestas Wind Systems, and Dr Isabelle Paris from Bombardier Aviation. The programme will cover a range of Hub projects and provide Hub partners with the opportunity to highlight research progress to date, and showcase project outputs. Current PhD students and researchers will present their high quality and diverse composites research through short elevator pitches in a Quick Fire session. The Open day will be supported by SAMPE UK and Ireland, who will host a Young Engineers and Student challenge, where participants will design and manufacture a composite bridge, which will be judged on the day.

To view the programme and register to attend the event please click on the following link:



cimcomp.ac.uk/hub-news/programme-launched-for-hub-open-day/

The event will be followed by The International Conference on Manufacture of Advanced Composites (ICMAC 21), which will be hosted by IOM3 on 20th – 21st October 2021.

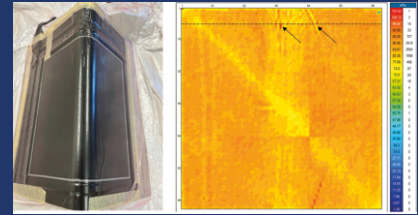
Research

2021 Q3 Publications

Hubert, P., Kratz, J. 2021.

Tool interface pressure during the forming of model composite corners

Composites Part A: Applied Science and Manufacturing.
<https://doi.org/10.1016/j.compositesa.2021.106639>



Example of full-field images for the 0,903s sample at 3.1 Hz loading frequency. (a) coordinate system, (b)-(d) GFRP and (e)-(g) CFRP results.

Noble, T., Davidson, J.R., Floreani, C., Bajpai, A., Moses, W., Dooher, T., McIlhagger, A., Archer, E., Ó Brádaigh, C.M., Robert, C. 2021.

Powder Epoxy for One-Shot Cure, Out-of-Autoclave Applications: Lap Shear Strength and Z-Pinning Study

Journal of Composites Science. 5, 225.
<https://doi.org/10.3390/jcs5090225>

Viisainen, J.V., Sutcliffe M.P.F.

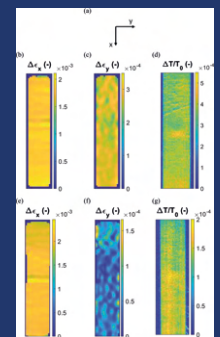
Characterising the variability in wrinkling during the preforming of non-crimp fabrics

Composites Part A: Applied Science and Manufacturing, Volume 149, 2021, 106536. <https://doi.org/10.1016/j.compositesa.2021.106536>.

Jiménez-Fortunato, I., Bull, D.J., Thomsen, O.T., Dulieu-Barton, J.M. 2021.
On the source of the thermoelastic response from orthotropic fibre reinforced composite laminates

Composites Part A: Applied Science and Manufacturing.
<https://doi.org/10.1016/j.compositesa.2021.106515>

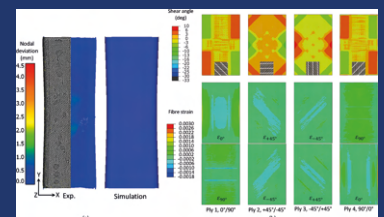
Wrinkles in sensors material in external corners: a) excess length causes wrinkles when vacuum bag is applied, b) pressure map with artefacts that were particularly strong along the dashed line, and c) oscillating pressure response along the line of interest.



Yu, F., Chen, S., Harper, L.T., Warrior, N.A. 2021.

Investigation into the effects of inter-ply sliding during double diaphragm forming for multi-layered biaxial non-crimp fabrics

Composites Part A: Applied Science and Manufacturing, 106611.
<https://doi.org/10.1016/j.compositesa.2021.106611>



(a) Surface scan and nodal deviation distance of the consolidated layup L5 [0°/90°, +45°/-45°]s. (b) Shear angle and fibre strains of individual plies within the layup predicted using the reduced inter-ply friction coefficients listed in Table 4.

A full list of publications can be found on our website:



cimcomp.ac.uk/publications/

Optimised Manufacturing of Structural Composites via Thermoelectric Vario-thermal Tooling (VarioTherm)

Principal investigator, Professor Ton Peijs, University of Warwick

In this study, the feasibility of using thermoelectric heating/cooling technology to manufacture a vario-thermal tooling system for the optimised processing of thermoplastic composite laminates was investigated. Particularly, the project investigated the heating/cooling performance of commodity thermoelectric (Peltier) modules in a tooling system context, delivered several prototype technology demonstrators and applied these prototype systems to process studies using commercially-available tape-based aligned fibre reinforced thermoplastic laminate materials.

The first prototype tooling system that was developed was built around a single Peltier module (with control system) and showed that peak heating and cooling rates of >3 °C/s were achievable at the tool surface, demonstrating the capability to execute a heat/cool cycle based on PA6-based TPCs in ~100s. The first full tooling system (2 x 2 Peltier array, single-sided tool) was used to process PP-GF60 laminates at 2mm thick, completing a full heat-dwell-cool cycle in <400 s. Measurements taking during these experiments showed a heating/cooling rate of ~1 °C/s was achievable at the laminate mid-plane, limited by thermal losses from the upper free surface inherent to the use of single-sided tooling. A two-sided system was then developed (each side comprising a 2 x 2 array) and applied to perform a modest parametric moulding study on 4 mm-thick PP and PP-GF60 samples. This study revealed that the cooling rate in the system could be sufficiently controlled and adapted to effect measurable changes in relative crystallinity within the PP as determined via DSC.

The three project deliverables set were achieved:

- D1: Prototype construction as a technology demonstrator, allowing a feasibility determination of the proposed technology to a selected application.
- D2: Detailed performance data of the system in the context of rapid processing of thermoplastic composites.
- D3: A review of the benefits, limitations of proposed zone heating technology as compared to existing tooling technology.

Feasibility Studies [2/2]

As a result of this Feasibility Study, WMG HVM-C has sponsored the manufacture of a larger tooling prototype for technology demonstration as part of WMG's National Polymer Processing Centre's TPCs sustainable lightweighting initiative (Peijs et al.). This is currently under manufacture at the industrial project partner's premises. Additionally, WMG and the industrial partner have submitted a proposal into the recent May 2021 I-UK Smart Manufacturing call (PIXELTHERM - Precise Next Generation Localised Intelligent-heat control in thermoplastic moulding, Peijs/Reynolds). The technology will also be further explored by WMG through the recently awarded £6m ENLIGHTEN (Enabling Integrated Lightweight Structures In High Volumes) programme led by the University of Twente; an industrially funded project with Van Wees B.V. (Netherlands) on recycling of manufacturing waste of thermoplastic UD tapes.

The full report can be found on the Hub website:



cimcomp.ac.uk/wp-content/uploads/2020/03/Final-report_Peijs-Variotherm.pdf

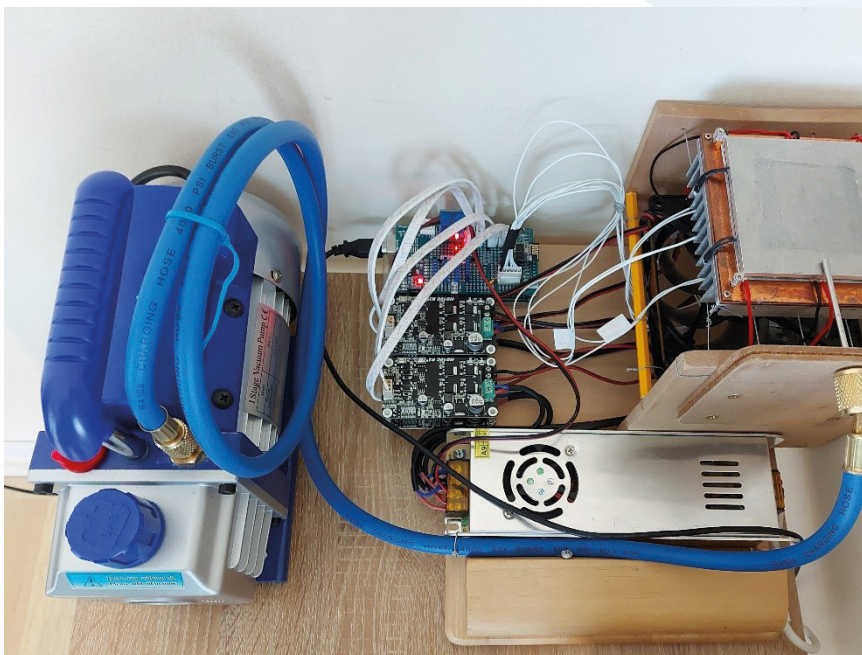


Figure 1: D1a tooling system.

Synergy Projects

Dr Colin Robert recently completed his synergy promotion project entitled '**Powder Epoxy for One-Shot Cure, Out-of-Autoclave Applications: Lap Shear Strength and Z-Pinning Study**'. The study came about through Colin's existing work and Ulster University's z-pinning through-thickness reinforcement technology developed with the Hub funded Feasibility Study '**Controlled Micro Integration of Through Thickness Polymeric Yarns**' (PI Edward Archer). This initial study is a promising proof of concept to demonstrate the advantages of the powder epoxy resin when combined with co-curing and pinned joining methods. The very specific processing properties of the powder epoxy system allowed to show the best of both thermoset (low viscosity, better co-curing mechanical properties) and thermoplastic (non-brittle pinning on complex structures, higher toughness), allowing co-curing and pinning all at once, leading to vastly superior mechanical properties when combined. Overall, the powder epoxy resin has a range of advantages, making it a suitable candidate for the co-curing of large composite structures. Future work will involve employing the co-curing and pinning bonding methods on more complex structures, for example on thick section composites such as tidal turbine blades. Automated applications, such as additive manufacturing, will also be considered. There will be the ability to locally change the polymeric properties to meet specific requirements, e.g. erosion protection.

Dr Adam Sobey, University of Southampton, instigated and organised a workshop between the Hub and the Data-centric Engineering community at the Alan Turing Institute. Like many industries, composite manufacturing is increasingly taking advantage of data and artificial intelligence (AI). However, to fully unleash the potential for digital manufacturing, it will require deeper relationships between manufacturing experts and data/AI experts. The workshop aimed to initiate conversations on what the problems are and to share ideas on how to tackle them and to form new partnerships with the aim of more regular interactions, ensuring that the manufacturing sector is ready for future challenges. The event consisted of talks to introduce the state of the art work in AI and in digital manufacturing and brought together experts from the Massachusetts Institute of Technology, the University of Cambridge, the University of Nottingham, and the Alan Turing Institute with representatives from each organisation delivering talks to an audience of approx. 100 attendees.

The Hub are pleased to announce the appointment of an Equality, Diversity and Inclusion Officer (EDI), **Dr Connie Qian**, University of Warwick. Connie commented: "I'm glad to see that more and more institutions have started taking EDI seriously during recent years. It's my honour to work with the Hub to continue improving and promoting our EDI policy."



Dr Jonathan Belnoue has been appointed to the position of Lecturer in Composites Process Simulation at the University of Bristol. Jonathan was awarded a D.Phil in Engineering Science from the University of Oxford in 2011. Jonathan joined the University of Bristol as a Research Associate and was promoted to Senior Research Associate in 2014 and Research Fellow in 2017. During the last 8 years, his research has focused on the development of

extremely efficient, physics-based numerical models for the simulation of the manufacturing process of real-size composite structures. Some of his current research interest include the use of numerical models to help mitigate manufacturing-induced defect in composites, the use of simulations to support the development of new manufacturing processes and the creation of composite manufacture digital twins.

Jonathan's position is half funded by the National Composite Centre (NCC) where he will spend some time doing research with the aim to strengthen the links between Bristol Composites Institute and the NCC. Following his longstanding involvement with the Hub, Jonathan was a researcher on the Core project: Defgen in the CIMComp grant and has worked on 2 Feasibility Studies and is a Co-I on the Core Project; Fibre-steered Forming Technology. Jonathan is looking forward to further collaborations with the Hub.

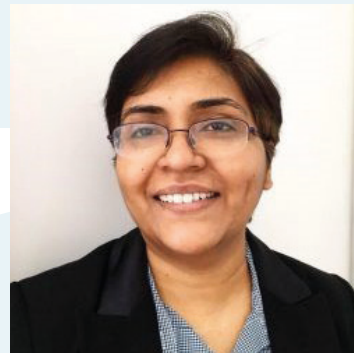
Staff News [2/2]

The Hub would like to congratulate Hub Spoke Representative, Dr Dipa Roy, University of Edinburgh, for her outstanding academic achievement in being ranked as one of the 'Top 50 Females' in Engineering in the UK and receiving a prestigious WE50 award.

More details can be found on this link:



www.wes.org.uk/WE50-2021



Dr Chrysoula Aza has recently joined the University of Bath as a Research Associate on the Core Project Design Simulation Tools and Process Improvements for NCF Forming, where she will be working on understanding the ply mechanics of non-crimp fabrics (NCFs) and the effect of tool geometry on forming behaviour. Chrysoula has a BSc and MSc in Structural Engineering from the Democritus University of Thrace. Her MSc research work on multifunctional cementitious nanocomposites sparked her interest in advanced composite materials. Chrysoula obtained a PhD in Advanced Composites from the Bristol Composites Institute at the University of Bristol, with her PhD focusing on the structural analysis of assemblies of nonlinear composite structures with helical architectures. Chrysoula has also worked for iCOMAT, a spin-out company from the University of Bristol that develops automated composite material deposition machines with defect-free fibre steering capabilities.

The Hub would like to congratulate EngD student; **Preetum Mistry** on receiving an EPSRC Doctoral prize Fellowship at the University of Nottingham. His 12-month fellowship is focussed on 'Tubular composite shafts under high cycle bending fatigue' with a focus on the railway axle and will be mentored by Professor Andrew Long. Preetum commented: "I was delighted and honoured to receive this fellowship funded by the EPSRC. I believe this EPSRC Doctoral Prize Fellowship will allow me to progress as an independent researcher and will provide an excellent opportunity for growth. I am passionate about the subject on which I have been working and I am inspired by the potential ways to collaborate with other groups. I also intend to use my fellowship platform to inspire younger students and engage with a wider audience through science communication".



Recruitment

Business and Research Development Manager

The University of Nottingham is looking to appoint a Research and Business Development Manager. The closing date for applications is Friday 8 October. Further information and details on how to apply for the position can be found here:



nottingham.ac.uk/jobs/currentvacancies/ref/ENG366321

Other News

Continuous Improvement

The Hub are continuously looking to improve their processes and would like to hear about what works well and where improvements could be made. The Hub have recently launched an Anonymous Feedback feature on the website where technical or operational matters can be reported for review. Each submission will be anonymous and confidential. If you have any feedback to provide please go to:

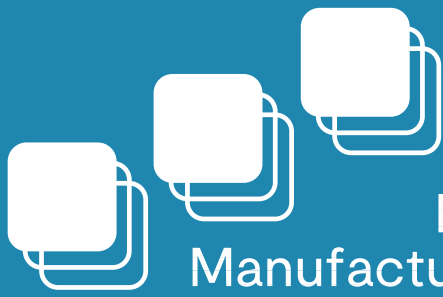


cimcomp.ac.uk/anonymous-feedback/

IDC Showcase 2021

The Industrial Doctorate Centre in Composites Manufacture will be holding a Showcase event on Tuesday 26th October in Bristol. The Showcase will be a special cohort building and feedback event for the IDC Research Engineers. The IDC Alumni, academic and industrial supervisors have been invited to take part, along with some VIP guests. It is a wonderful opportunity for the cohort to come together in person to provide an insight into their diverse research activity in composites manufacture through a series of oral and poster presentations, followed by a celebratory dinner.

The IDC has been running since 2013 and has recently recruited its final student. Therefore, the Showcase will mark this milestone and celebrate the achievements of the IDC Research Engineers, as well as the support from our industrial collaborators and academic partners and supervisors. The Showcase will be a stepping-stone in life returning to normal for the Research Engineers and their supporters. We are looking forward to a lively exchange of ideas and views to stimulate new interactions and on-going collaboration.



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

 joanne.eaves1@nottingham.ac.uk