

Newsletter

June 2023

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UNIVERSITY OF
BATH



University of
BRISTOL



Brunel
University
London



UNIVERSITY OF
CAMBRIDGE



THE UNIVERSITY
of **EDINBURGH**



University
of **Glasgow**



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Of
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Southampton



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WARWICK
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**Engineering and
Physical Sciences
Research Council**

Welcome to the Summer edition of the 2023 Hub newsletter

Hub Research [1/2]

2022/2023 Annual Report

The 2022-2023 Hub Annual Report has recently been published. Please click on the link below to learn more about our latest research and activities:



[Annual Report 2023](#)

UK Composites Research Challenge Landscape Report – Composites Sustainability

The Hub is a key player in funding fundamental composites manufacturing research in the UK, and through information gained from a series of workshops has published a report which identifies and validates the current composite manufacturing challenges associated with end-of-life disposal, carbon emissions during the production phase, and circularity. For further information on this activity and to view the report please click here:



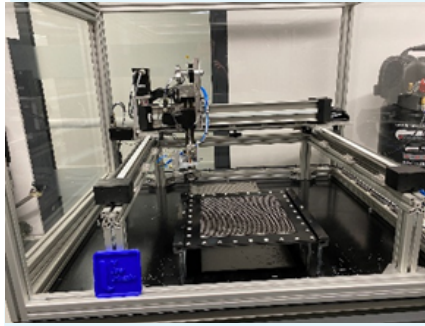
[Composites Sustainability Report](#)

Controlled Micro Integration of Through Thickness composite Yarns

Following on from a successful Feasibility Study 'Controlled Micro Integration of Through Thickness composite Yarns' <https://cimcomp.ac.uk/research/controlled-micro-integration-of-through-thickness-polymeric-yarns/> with CIMComp in 2019 led by Dr Edward Archer, the team at Ulster University Advanced Future Materials & Manufacturing group have now developed a fully automatic system for placing through thickness micro yarns in the 'z' direction. This machine was developed in collaboration with PAC Group in Belfast who are an industrial partner in the Hub.

Hub Outreach (1/2)

The computer-controlled system uses a blunted hypodermic needle which is inserted through the dry fabric preform allowing a room temperature polymer coated carbon, glass or Kevlar filament to be inserted through the needle. The needle is then withdrawn leaving the filament in place before the filament is cut with approximately 5mm protruding from each side of the preform.



This process is repeated for the remainder of the preform to give the required pin density. With the new computer-controlled system the pin density can be varied and tailored. The dry pinned preforms are then pressed in a heated tool to bend the filaments over and press them into the preform. Thermoset epoxy resin is infused through the tool using the RTM method and cured to form the composite. The current preforms and composites are being tested for marine applications as part of the UKRI Strength in Places Belfast Maritime Consortium project led by Artemis technologies.

Hub Outreach [1/3]

Hub Open Day 2023

The Hub Open Day will take place on 6 September 2023 at the Marshall Arena in Milton Keynes, held in parallel with the International Composites Summit. We are pleased to have a number of Hub academics, researchers and students presenting on their projects, as well as a poster competition and QuickFire session.

We will also have presentations from the National Composites Centre (NCC) and keynote speakers, Professor Ian Lane from Vertical Aerospace Group and Dr Emer McAleavy from Artemis Technologies. The event will be followed by a dinner at the DoubleTree Hilton Hotel.



[Click here to register and find out more about the event.](#)

Composites Laboratory Tour - Advanced Manufacturing Building, University of Nottingham

It was our pleasure to host 40 Indonesian final-year undergraduate students at the University of Nottingham's Advanced Manufacturing Building, and introduce them to some of the world-class manufacturing equipment in the Composites Laboratory. The students are studying with the University of Nottingham for a semester on a programme directly funded by the Indonesian Ministry of Education. The programme is part of a broader strategic engagement between the University and Indonesia. Our PhD students and researchers were on hand to discuss their research, and answer questions.



Indonesian undergraduate students taking a tour of the Composites Laboratory at the University of Nottingham.

Hub Outreach (2/3)

JEC World 2023

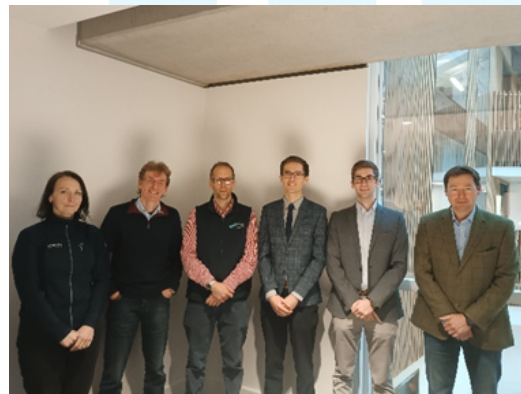


Hub Business Development Managers, James Whyman and Simon Quinn, attended JEC World 2023 in Paris, France, on 25 to 27 April. The event brought together the international composites community and showcased the latest advancements and innovations in composites materials, their manufacturing technologies, and their applications in industry. A wide range of exhibits, workshops, and conferences featured at the show, covering topics such as automation, materials, and design. One of the key themes of the event was sustainability and with the increasing demand for environmentally friendly products, the composites industry is poised to play a significant role in shaping the future

of manufacturing. The Hub stand attracted a number of visitors and several new business relationships were formed.

SAMPE 2023

The annual SAMPE student seminar was held on 7th March 2023 at the Northern Ireland Advanced Composites and Engineering (NIACE) Centre in Belfast. There was a record number of entries this year, with 16 students taking part from 11 UK and Ireland universities. Participants were asked to present a 15-minute overview of their thesis to a panel of judges, which included Dr Emer McAleavy from Artemis Technologies and Alastair Ryder from Surface Generation.



From left to right: Dr Emer McAleavy, Artemis Technologies, Andrew Mills, Cranfield University, Dr Lee Harper, University of Nottingham, Adam Whitehouse, Imperial College London, Thomas Maierhofer, University of Bath and Alasdair Ryder, Surface Generation.

Hub Outreach [3/3]

The standard of the presentations was exceptionally high, and two winners were selected to represent the SAMPE UK/Ireland chapter at the European competition in Madrid in October 2023.

Thomas Maierhofer from the University of Bath - A Route to Certification of Bonded Thermoset Composite Structures via Resistance Welding.

Adam Whitehouse from Imperial College London - A Novel Profiling Concept Leading to a Significant Increase in the Mechanical Performance of Metal to Composite Adhesive Joints.

To keep up to date with our events visit:



<https://cimcomp.ac.uk/hub-news>

Hub Staff News [1/3]

The Hub would like to welcome the following members:

Dr Anatoly Koptelov is a Research Associate in the Bristol Composites Institute (BCI), University of Bristol. After receiving his Master's degree in Aerospace Engineering in Bauman Moscow State Technical University, Moscow, Anatoly continued his studies as a PhD student at the BCI.



His dissertation on "Autonomous and objective characterisation of composite precursors in manufacturing" focused on the application of modern machine learning techniques for challenging composite modelling problems. In particular, he worked on the development of a real-time experimental analysis framework for autonomous testing of composites.

Currently, he is working on the application of modern AI and Deep learning techniques for predicting woven architectures of 3D textiles, experimental characterisation of prepreg materials, and exploration of overmolding effects in stiffened panels during manufacturing.



Josh Evans is a Project Engineer working at the WMG in the Automotive Composites Research Centre. He joined the Hub in 2023 and is working on the Warwick and Nottingham Synergy project: "Zero-waste manufacturing of highly optimised composites with hybrid architectures". Josh is focusing on developing industry-applicable processes to reclaim and reuse

waste prepreg material.

Josh studied Mechanical Engineering at the University of Bath where he developed an interest in composite materials. He gained experience working with composites during an industrial experience year with Williams Grand Prix Engineering and through designing and building a human powered submarine during his final two years at Bath.

After graduating, Josh spent five years working on bespoke automation machinery for the medical device and pharmaceutical industries, consolidating his theory and skills through industry experience. However due to the nature of the products manufactured by these machines, use of composite materials is explicitly banned to maintain patient safety. Josh therefore decided to look for opportunities to work again with composite materials and has settled into a new career path at the WMG ACRC.

Hub Staff News [2/3]

Dr Hasina Begum is a Project Engineer at the University of Warwick – WMG's Automotive Composite Research Centre (ACRC). Hasina is currently involved in research and process engineering of high-volume manufacture thermosetting carbon fibre composites in automotives and working on the Hub Synergy project "Zero-waste manufacturing of highly optimised composites with hybrid architectures". Collaborative companies include Jaguar Land Rover, Aston Martin and Ford. Hasina Begum started a new role on 1st April as a Research Fellow in the sustainability of plastics and polymers.



Hasina's previous role looked at defects in buried pipes using fibre optics and distributed acoustic sensing. Hasina completed her PhD at the University of Sheffield from the department of Mechanical Engineering where she looked at silica aerogels and their uses in vibro-acoustics for building and pipe insulation. During her PhD, Hasina completed over 6 months of her research abroad and worked alongside international establishments in Italy and Switzerland. Through this, she has successfully published 6 journal papers, contributing to her field of research in Science and Engineering. Her research interests lie in polymers, materials science, composites, porous materials, and acoustics.



Jesús Molinar Díaz obtained his Biomedical Engineering degree at the Universidad Autónoma de Ciudad Juárez (UACJ, Mexico) in 2016 and his PhD in Materials Engineering and Materials Design as a member of the Advanced Materials Research Group based at the University of Nottingham in 2023, where he contributed to the development of highly-porous magnetic glass-ceramic & ceramic microspheres for healthcare applications. His research is focused on the interrelationship between process, structure, functional properties of bulk, micro- and nanostructured materials, their analyses using a range of characterisation techniques. Furthermore, Jesús's research is strongly oriented to process optimisation in order to generate high-quality and cost-effective products. He is currently working as a Research Fellow in Composites Manufacturing in the Composites Research Group at the University of Nottingham.

Hub Staff News [3/3]

Dr Georgios Xypolias is a Research Fellow in composites manufacturing at the University of Nottingham. The main focus of his current project is the development of high performance CFRP composites from recycled carbon fibre. His aim is to contribute to the circularity of composites by creating a recycled product which can compete with virgin FRPs. Georgios has previously successfully completed a PhD at the University of Strathclyde in Glasgow. His PhD was centred around the environmental ageing of glass fibre/vinyl ester FRPs designed for large infrastructure applications, such as wind turbine blades. During his PhD, he achieved a thorough understanding of the effect of in-service environmental conditions on composite structures life. Moreover, he extensively studied the micromechanical behaviour and the role of the fibre/matrix interface in the performance of GFRP composites, and in turn developed invaluable expertise in micromechanical single fibre testing. He also investigated in-depth the chemistry and cure kinetics of complex vinyl ester resins and produced a correlation between their curing behaviour from an interfacial, microscale to a bulk composite matrix, macroscale. Lastly, he has previously participated in the DACOMAT consortium, funded by the EU-H2020 programme and has authored/co-authored a number of peer-reviewed publications.



Dr Usman Shafique joined the Hub as a PhD student in 2017 under the supervision of Dr Tom Turner at the University of Nottingham. Usman successfully completed his PhD and has progressed his career to the role of a Research Fellow working alongside Professor Chris Dodds on a project for Rio Tinto at the University of Nottingham. The project aims to advance an innovative new technology to deliver low-carbon steel. The process uses sustainable biomass in place of coking coal, as a reductant and microwave energy to convert iron ore to metallic iron in the steelmaking process, providing a potentially cost-effective option to cut industry carbon emissions.

"I had the opportunity to work on the Core project 'Automated Dry Fibre Placement', <https://cimcomp.ac.uk/research/technologies-framework-for-automated-dry-fibre-placement/> funded by the Future Composites Manufacturing Research Hub. The skills I acquired during my PhD have provided me with the confidence to excel in my current job and have been instrumental in my professional growth. I am deeply grateful to my supervisors and the Composites Research Group for their unwavering support throughout my academic journey".

Hub Equality, Diversity and Inclusion (EDI) [1/3]

The Hub has recently created a dedicated EDI page on the website, to read more about it please click here:



<https://cimcomp.ac.uk/equality-diversity-and-inclusion-committee/>

In this edition, we welcome an EDI experience provided by **Dr Monali Dahale**, Project Engineer, The National Composites Centre.

“I studied my first degree in fibres and textile processing at the Institute of Chemical Technology in Mumbai, India. I moved to the UK in 2017 when I joined Ulster as a student and a PhD candidate, as well as a Marie Curie early career researcher. During this time, I worked on an EU Horizon 2020 Iconic Project to improve the crashworthiness of composite transportation structures. It was a very interesting experience because usually PhD candidates work on small projects with few researchers, but the Marie Curie fellowship gave me an opportunity to work closely with researchers from many other universities and industries across the world, such as German Aerospace Centre, University of Limerick, University of Patras and Fiat in Italy where I also spend one month for a secondment. I feel very fortunate to have received input and feedback from all these external collaborators.



In 2020, I left Ulster University to take on a research contract at the University of Huddersfield. I didn't have much flexibility when choosing my job after my PhD due to my visa status: I had to find another contract in the UK when I finished my Marie Curie project, otherwise I would have to leave the country and not return for a whole year. During my time at Huddersfield, I worked on a project in collaboration with a company called Camira Fabrics Ltd, on developing sustainable material solution for fire retardant wool fabrics.

Hub Equality, Diversity and Inclusion (EDI) [2/3]

I rejoined Ulster University in 2021 for a post doc position working on a project led by Artemis Technologies to develop hydrofoil-based ferries. My role in this project was to develop near-net-shaped 3D woven preforms for hydrofoil applications and to improve the performance of 3D woven composites for maritime applications by architectural modifications, damage tolerance, impact resistance of 3D woven composites structures for hydrofoils.

I joined the EPSRC Future Composites Manufacturing Hub after receiving a Hub Researcher Network Award in 2022, which was jointly applied with the University of Nottingham. The project is on manufacturing and modelling of variable thickness in near net-shaped 3D woven composites for complex aerospace structures. This project is very important for my personal development because unlike other projects where I only work on pre-defined tasks, I can take a lead on this project and manage the progress and the finance. There aren't many funds and awards available for PhD students and postdocs to work independently so I really appreciate the opportunity.

My father is the most influencing role model for me. He's an engineer himself and I grew up seeing him make and break things which inspired me very much to pursue a career in engineering. I also want to acknowledge Dr Lisa McIntyre at Heriot-Watt University who offered me research internship opportunities in her group during the second year of my bachelor's degree. I travelled from India to take this internship and it was a very challenging experience for me, but the way she treated me and moulded me made me want to do research. My supervisors and mentors at Ulster University, Prof Prof Alistair McIlhagger, Dr Edward Archer and Professor Eileen Harkins Jones have all provided me great support and inspiration through my study and my career and have helped me to grow into an independent researcher. A special mention to Roy Brelsford at Ulster University for always inspiring me.

The first challenge I encountered after moving to the UK was to figure out how to communicate with project partners effectively, and also the cultural shock. But people have been very friendly and welcoming, which has helped me a lot. It can also sometimes feel daunting to be a woman in a heavily male-dominated society, but I have taught myself to be confident about my abilities and be very determined, and fortunately I have been treated very well by my colleagues, so that I never feel discriminated.

Hub Equality, Diversity and Inclusion (EDI) [3/3]

I think it's very important to promote females in engineering and ensure equal career progression opportunities because the number of male academics is still much higher compared to female academics. Gender equality is not the only issue, and other characteristics such as race should also be considered. Everyone should be treated the same regardless of their background. I'm very keen to join Ulster University's EDI committee and become an EDI ambassador. I'd love to promote STEM subjects as a career choice to young female engineers, and school girls in Northern Ireland and India, and I want to encourage them not to feel daunted by a male dominated industry. Just keep working hard and do the best you can without worrying about the outcomes if you are really passionate about your subject."

EDI Training Session with Inclusionnering

24 Hub members attended an online training session on 'The Agile Inclusion Paradox: Lessons for inclusive, innovative teams', organised by the EDI Committee and delivered by Jo Stansfield of Inclusionnering. The session uncovered the research background of inclusion in technical teams, and shared findings from Jo Stansfield's original research that examines why our existing ways of working may not build inclusion and equality. Actions you can take with your team were explored to consciously develop greater inclusion, unlocking potential and elevating the performance of the entire team.

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



cimcomp.ac.uk/people/connie-qian/

International Exchange Programme

Dr Andrea Codolini is a Research Associate at the University of Cambridge and in September 2022 he visited the University of British Columbia (UBC), Canada. At the Vancouver campus Andrea gave an update on the latest Hub activities and discussed his recent discoveries in using machine learning to design aerospace structures using dry fabrics. At the Okanagan campus, Andrea conducted mechanical characterization tests using the biaxial-shear testing fixture in Fig.1, developed by the Composites Research Network group.

From the UBC partnership, experimental data was collected to further understand the defect formation in complex loading conditions that are observed during unidirectional non-crimp fabric (UD NCF) forming. Novel post-processing methods to extract normalised load and local strains for the unbalanced material are currently being compiled for future publication.

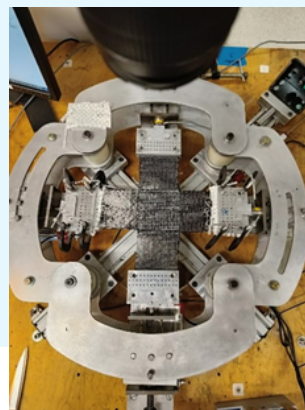


Figure 1. The biaxial-shear testing fixture.

Hub Innovation Fellow **Dr Yang Chen**, University of Bath has recently completed his exchange to the Centre for Composites Materials (CCM) at the University of Delaware, USA, under the supervision of Prof. Suresh Advani and Dr. Pavel Simacek.



Prof. Advani and Dr. Simacek are experts in composites manufacturing, with particular interests in liquid composites moulding and related numerical modelling. They have developed an advanced software (named as LIMS) for resin flow simulations. During his visit, Yang was trained on the LIMS software, and was provided two licenses for a duration of 1 year. The aim of the visit was to develop a numerical framework for analysing the variability of textile permeability, using radial injection experiments, and empowered by physics-informed neural networks.

Hub Training [1/2]



"I personally found this visit very useful and eye-opening not just for my research, but also for my experience and knowledge in a different culture. I was sitting in a shared office with PhD students and postdocs, from whom I received a warm welcome, interesting information on the lab and the university. At the end of the visit, I was invited to give a seminar to the lab, which gave me the opportunity to present my research and advertise the CIMComp Hub and the University and the city of Bath. The collaboration initiated during this visit will continue, with the current focus being the development of a PINN model for the radial injection problem. After that, we will incorporate the PINN model to solve inverse problems identifying the textile permeability, for which, interactions are expected with the Nottingham team (Dr Mikhail Matveev, Dr Andreas Endruweit, and Prof Michael Tretyakov)."

Yang is currently working on a Hub Innovation Fellowship 'Permeability variability of textile fabrics for liquid moulding' which is due to finish in December 2023.



cimcomp.ac.uk/research/permeability-variability-of-textile-fabrics-for-liquid-moulding-2

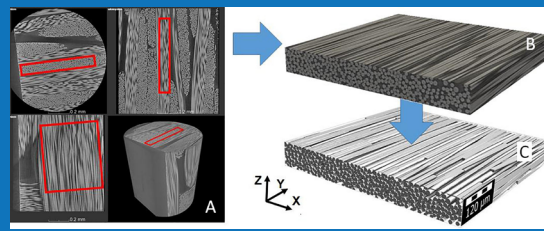
If students and researchers have suggestions for specific training opportunities which the Hub can support, please get in touch:



EN-INFO-CIMCOMP@exmail.nottingham.ac.uk

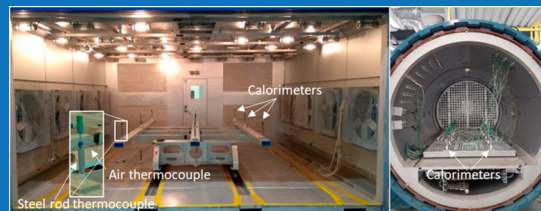
Publications [1/2]

Syerko, E., Schmidt, T., May, D., Binetruy, C., Advani, S.G., Lomov, S., Silva, L., Abaimov, S., Aissa, N., Akhatov, I., Ali, M., Asiaban, N., Broggi, G., Bruchon, J., Caglar, B., Dignonet, H., Dittmann, J., Drapier, S., Du Roscoat, S.R., Endruweit, A., Guilloux, A., Kandinskii, R., Leygue, A., Mahato, B., Martinez, P., Matveev, M., Michaud, V., Middendorf, P., Moulin, N., Orgéas, L., Park, C.H., Rief, S., Rouhi, M., Schladitz, K., Sergeichev, I., Shakoor, M., Shishkina, O., Swolfs, Y., Tahani, M., Umer, R., Vanclooster, K., Vorobyev, R. Benchmark exercise on image-based permeability determination of engineering textiles: microscale predictions. *Composites Part A: Applied Science and Manufacturing*, 2023; 167: 107397. <https://doi.org/10.1016/j.compositesa.2022.107397>



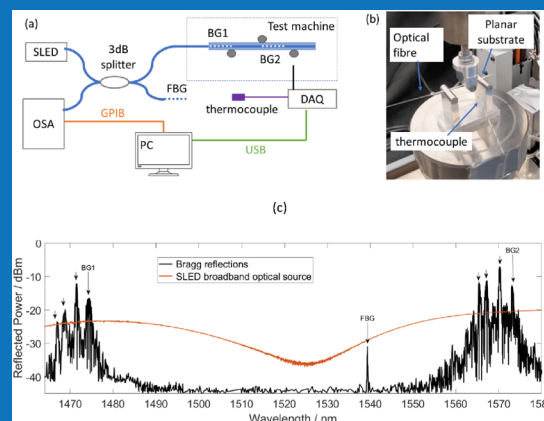
3D X-ray microscope scan from a section of the cut-out (A), extracted gray-scale non-segmented MSV (B), and segmented MSV for calculation (C).

2. Fisher, A., A. Levy, and J. Kratz. (2022) Effects of heat transfer coefficient variations on composite curing, *Journal of Composite Materials*. <https://doi.org/10.1177/00219983221145506>



Images of two of the studied vessels, oven 5 (left) and autoclave 1 (right).

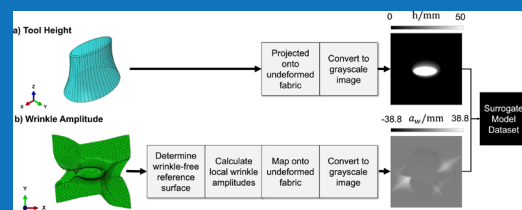
3. Holmes, C., Godfrey, M., Mennea, P.L., Zahertar, S., Dulieu-Barton, J.M. (2022) Flexible Photonics in low Stiffness doped Silica for use in Fibre Reinforced Polymer Composite Materials. *Opt Mater (Amst)*, vol. 134, p. 113133. <https://www.sciencedirect.com/science/article/pii/S0925346722011703?via%3Dihub>



The fatigue test set-up showing (a) schematic of the experimental set-up and (b) a photograph of the loaded flexible FHD under 3-point bending (c) spectral signature of Bragg gratings, showing fundamental and higher order modes of BG1 and BG2 and broadband optical source (Fresnel reflection from single arm of the 3 dB splitter).

Publications [2/2]

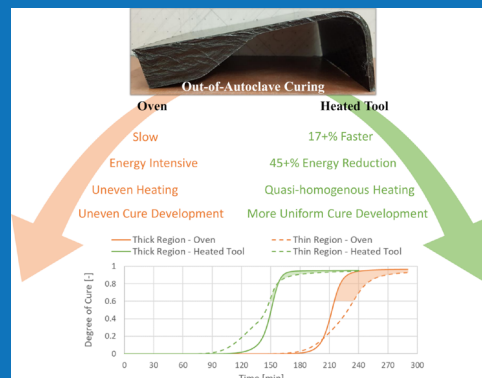
4. Viisainen, J.V., Yu, F., Codolini, A., Chen, S., Harper, L.T., Sutcliffe, M.P.F. (2023) Rapidly predicting the effect of tool geometry on the wrinkling of biaxial NCFs during composites manufacturing using a deep learning surrogate model, *Composites Part B: Engineering*, Vol 253 (2023), 110536. <https://doi.org/10.1016/j.compositesb.2023.110536>



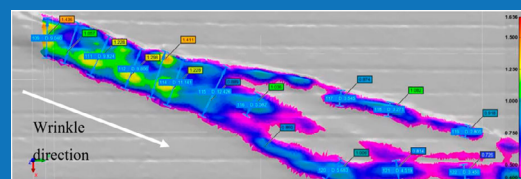
Processing of finite element data into grayscale images that are used to train the deep learning model: (a) tool height data and (b) wrinkle amplitude data.

5. Maes, V.K, Radhakrishnan, A., Lombetti, D., Kratz, J. (2023) Zonally Heated Tooling for Moulding Complex and Highly tapered Composite Parts, *Frontiers in Materials*, Vol 10. <https://www.frontiersin.org/articles/10.3389/fmats.2023.1126932>

Curing of composite parts using ovens rely on slow cure cycles to manage exotherms and thermal lag, especially for thicker or geometrically complex parts. An alternative is heated tooling, which improves the energy efficiency and has the ability to tailor the temperature profile in different regions. In our study, the zonal heated tool approach showed a reduction in cure time of 17.5% and an approximate 45% reduction in energy consumption while achieving a more even cure development throughout the part.



6. Jimenez Martin, C., Maes, V.K., McMahon, T., Kratz, J. (2023) Influence of NCF architecture on the morphology of forming induced wrinkling, *Frontiers in Materials*, Vol 10. <https://doi.org/10.3389/fmats.2023.1126933>



Example of sampling points for wrinkle width and height shown along wrinkle length with colour map showing out-of-plane heights.

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

 joanne.eaves1@nottingham.ac.uk