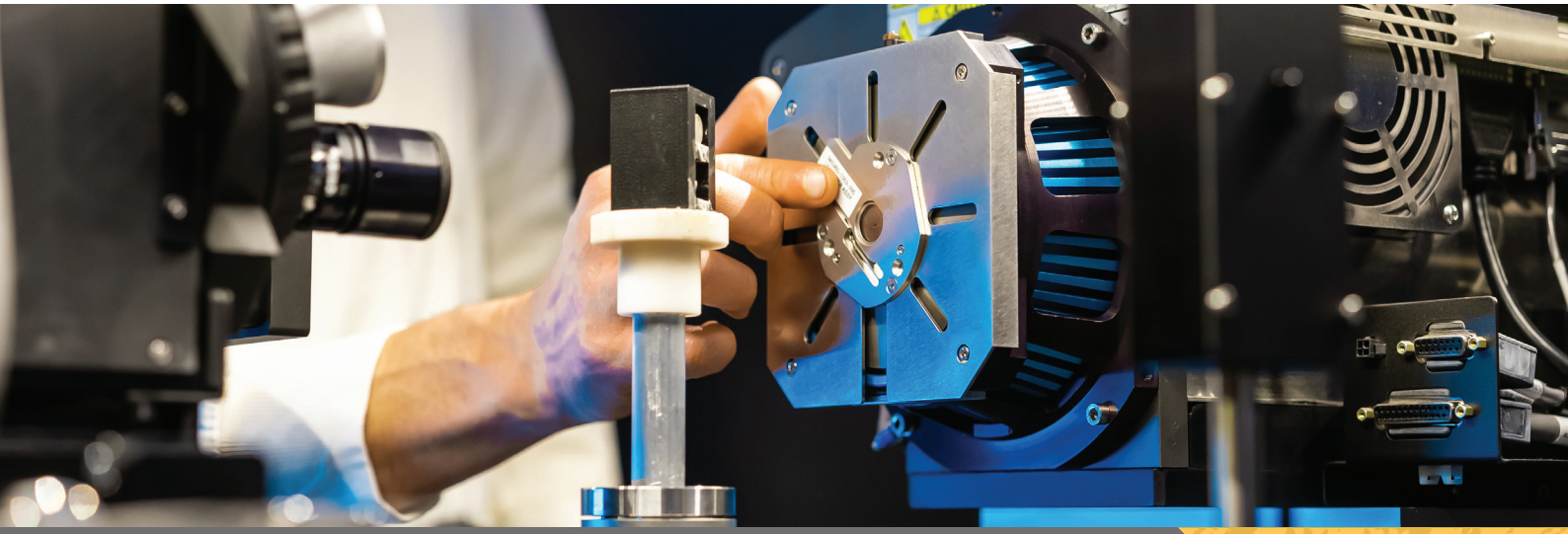
UNIVERSITY OF CAMBRIDGE

ADVANCED MATERIALS RESEARCH & INNOVATION

Measurement of In-Situ Inter-Ply Contact Area

Inter-ply friction is a critical deformation mechanism in the preforming of composite fabrics such as carbon fibre. Previous work had shown that frictional behaviour is highly dependent on the applied normal load. A Royce Cambridge grant allowed University of Nottingham researchers to use the Royce 3D X-Ray Computer Tomography suite to characterise the deformation of multi-ply fabric stacks under vacuum pressure.



3D Computer Tomography (CT) Microscope

The Royce Cambridge CT Microscope is a ZEISS Versa 510 used for non-destructive, in-situ characterisation and observation of the composition, deformation and damage development of a broad range of materials. The system is rarely limited. Samples can be as small as tens of microns to several inches. The stage can handle up to 15kg, custom stages can be developed.

Our CT microscope can view deeply buried microstructures that may be unobservable with 2D surface imaging. It can also be used for investigating samples with features on length scales from 50 microns down to 1 micron.

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THE CHALLENGE

When the relationship between inter-ply friction and contact area is established, there will be a better understanding of how non-crimp fabrics deform. This would improve semi-automated manufacturing processes, such as double diaphragm forming (DDF). DDF is a semi-automated method of producing dry composite preforms. This project aimed to establish the relationship between changes in inter-ply contact area and previously measured coefficients of friction with normal load.

RESULTS

Using machine learning techniques, due to the high quality data gathered on the 3D CT Microscope, it was possible to automate the identification, segmentation, and classification of the two fibre bundle directions. From this, key parameters such as fibre volume fraction, fibre bundle aspect ratio and inter-ply contact area could be determined to establish the relationship between inter-ply friction and compaction behaviours.

The results from the project will inform the design of the manufacture of future composites, improving the formability of high-rate, high specific strength composite components. This will be beneficial for understanding the carbon fibre forming process to better understand where defects can occur. This may result in lower cost and faster development of high-rate composite components, ultimately contributing to net-zero manufacturing and material technologies.

"Establishing the relationship between inter-ply friction and contact area is important to improve understanding of how non-crimp fabrics deform; this could then improve semi-automated manufacturing processes."

Visit **royce.ac.uk/impact** to read more impact case studies from the Henry Royce Institute

Contact royce@maxwell.cam.ac.uk to use Royce Cambridge equipment

"The Royce Cambridge external funding grant funded both; six full days access to, and the construction of the custom compression rig, in their entirety. The support provided by the highly skilled technicians and researchers at both the Maxwell Centre and Department of Engineering at the University of Cambridge was invaluable, enabling the production of high-quality data and the planned scanning schedule being exceeded."

Guy Lawrence
PhD Student, University of Nottingham

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