University of BRISTOL

Bristol Composites Institute

Forming of Aligned Discontinuous Fibre Thermoplastic Prepreg for Sustainable Composite Manufacturing

Burak Ogun Yavuz

Supervisors: Jonathan Belnoue, Marco Longana, Ian Hamerton

BCI PGR Symposium

UKRI Engineering and Physical Sciences Research Council

University of BRISTOL

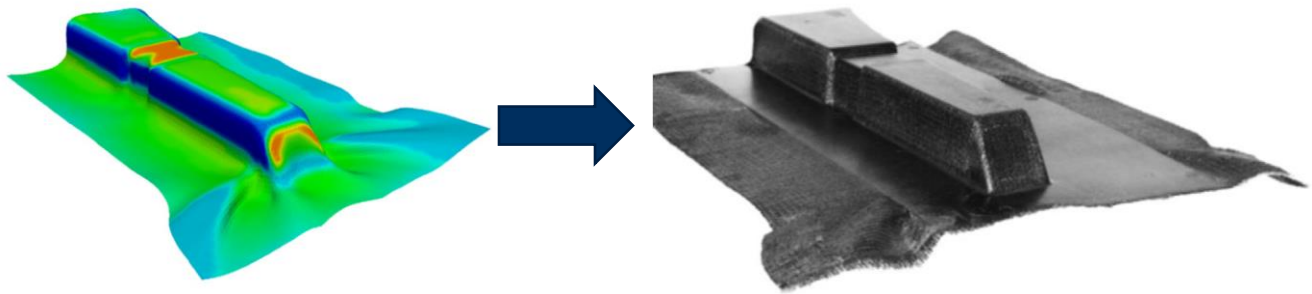
EPSRC Centre for Doctoral Training in Composites Science, Engineering and Manufacturing

SIMprocs

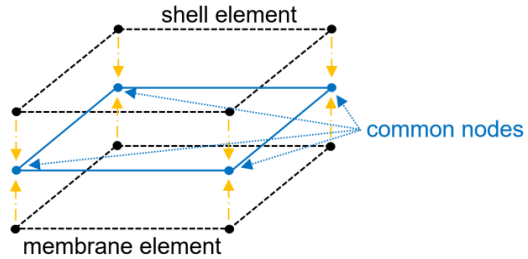
HiPerDiF

Forming of Thermoplastic Short Fibre Prepreg

- Problems
  - Sustainable solutions are needed
  - Thermoplastic composite manufacturing is very hard with standard methods
  - Forming of defect free composite parts depends on experience and trials
- Aim: Development of forming simulation tool for manufacturing of thermoplastic HiPerDiF tapes



Guzman-Maldonado, E., Hamila, N., Naouar, N., Moulin, G., & Boisse, P. (2016). Simulation of thermoplastic prepreg thermoforming based on a visco-hyperelastic model and a thermal homogenization. Materials & Design, 93, 431-442.

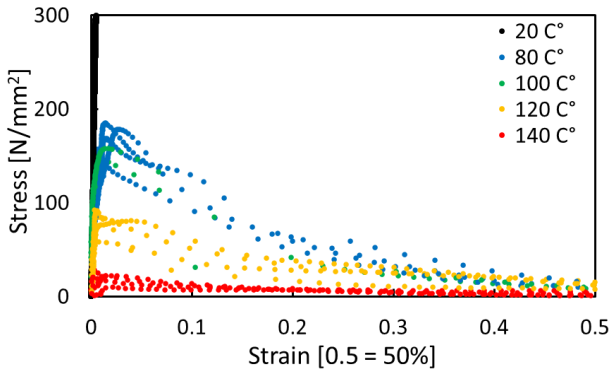


Element Type	E_1 [MPa]	E_2 [MPa]	G_{12} [MPa]
Membrane	?	?	?
Shell	?	?	?

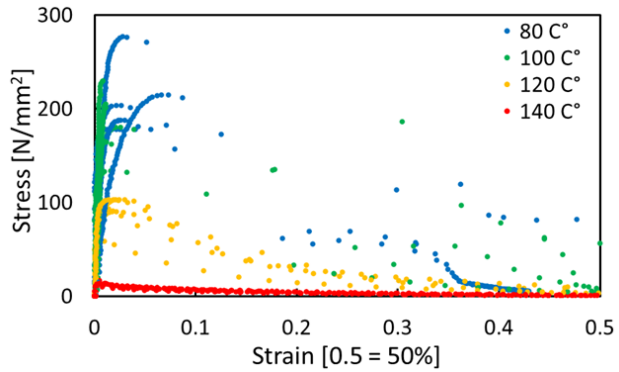
Thompson, A. J., Belnoue, J. P., & Hallett, S. R. (2020). Modelling defect formation in textiles during the double diaphragm forming process. Composites Part B: Engineering, 202, 108357. doi:10.1016/j.compositesb.2020.108357

Tensile Characterisation under Processing Condition

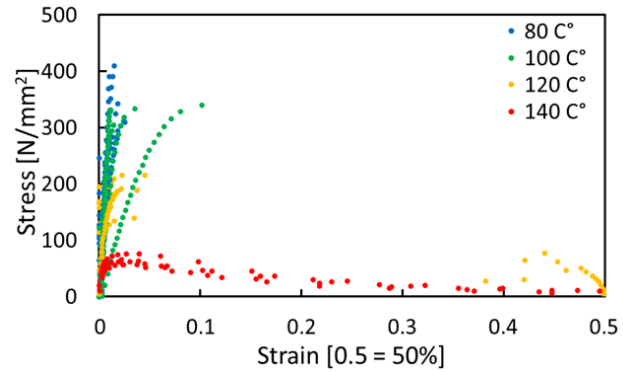
1mm/min



10mm/min

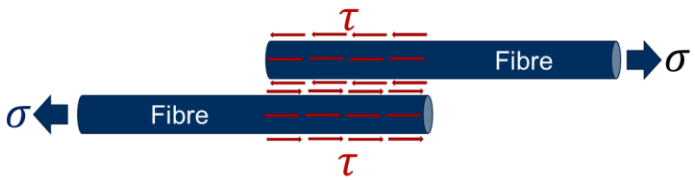


100mm/min



➢ Higher temperatures diminish the matrix properties, thereby reducing load-carrying capacity, whereas higher speeds enhance them

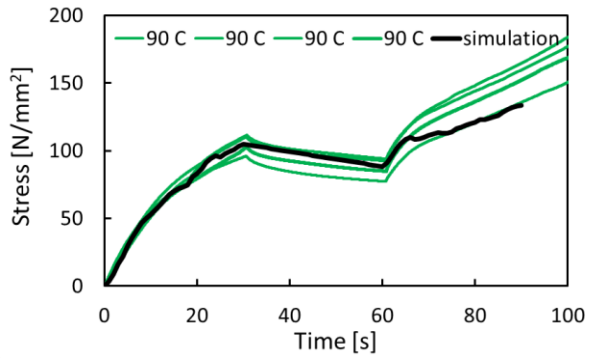
Model derivation, implementation and validation



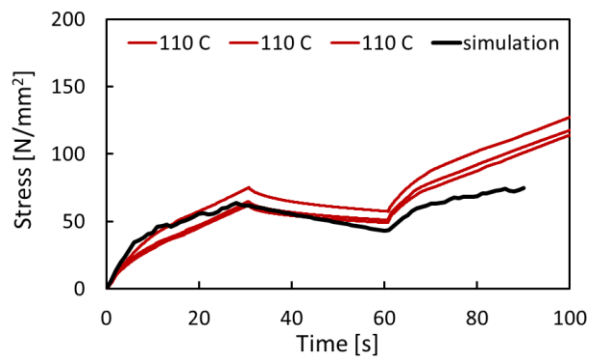
Micromechanical model

$$\dot{\sigma} = \left(2G(\dot{\varepsilon})\left(\frac{L-\delta}{D}[K-1]f\frac{\delta}{D}\right)\dot{\varepsilon} - \left(\frac{G(\dot{\varepsilon})}{\eta(\dot{\varepsilon})}\right)\sigma\right)$$

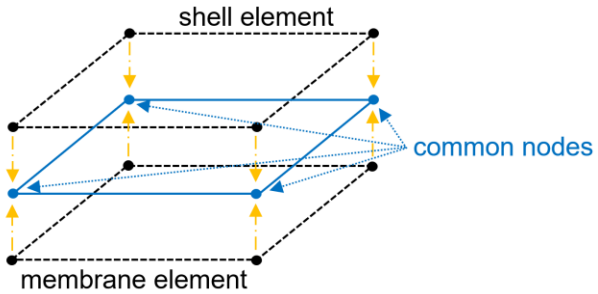
90 C° 1mm/min



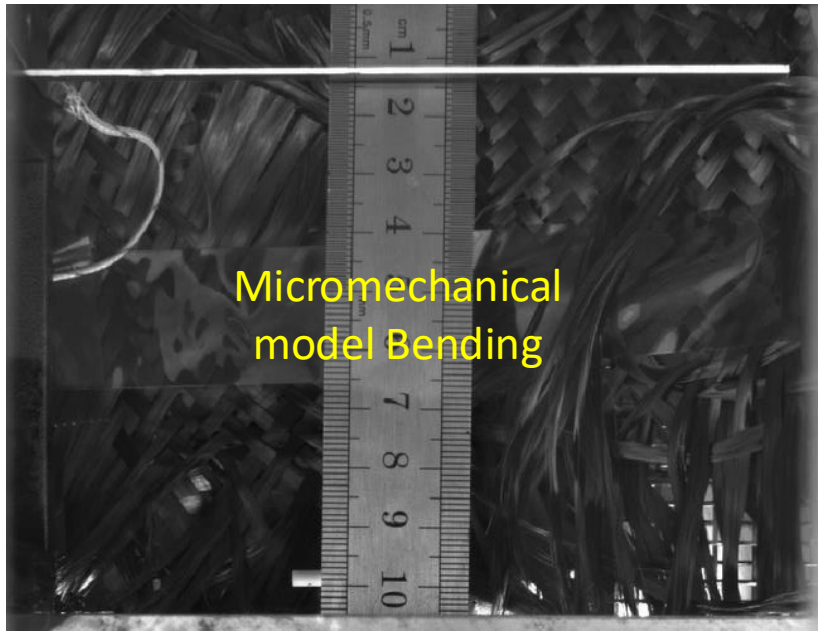
110 C° 1mm/min

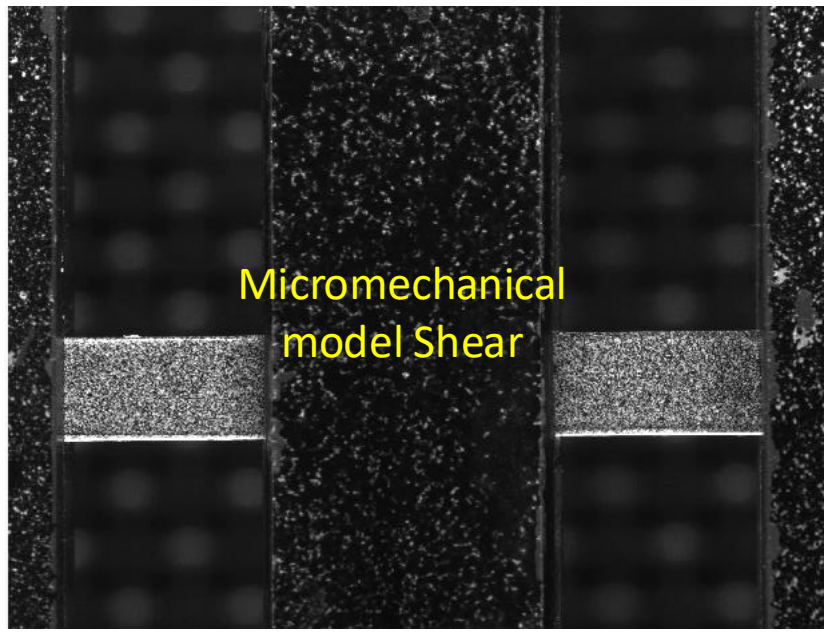


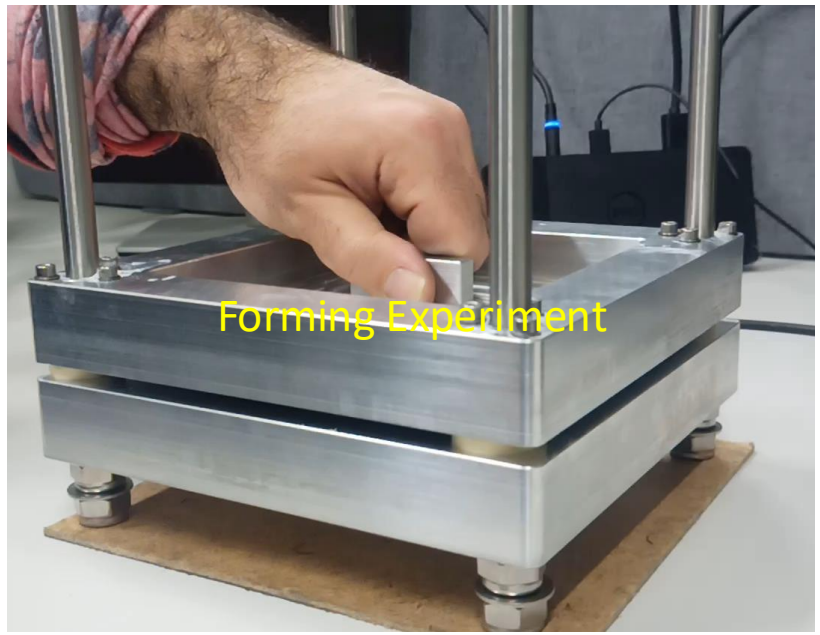
Process Simulation



Element Type	E_1 [MPa]	E_2 [MPa]	G_{12} [MPa]	Density [tonne/mm^3]
Membrane	Micromechanical model Tension	Modulus at each temp.	Micromechanical model Shear	7.13E-05
Shell	Micromechanical model Bending	1	0	7.13E-05







University of BRISTOL

Bristol Composites Institute

Thanks for listening!
Any questions?

ogun.yavuz@bristol.ac.uk

Acknowledgements

Supervisors: Jonathan Belnoue, Marco Longana, Ian Hamerton

Funded by the Republic of Türkiye Ministry of National Education

Supported by Physical Sciences Research Council (EPSRC) (grant no. EP/S021728/1) and Simulation of New Manufacturing Processes for Composite Structures (SIMPROCS) (grant no. EP/P027350/1)

UKRI Engineering and Physical Sciences Research Council

University of BRISTOL

EPSRC Centre for Doctoral Training in Composites Science, Engineering and Manufacturing

SIMprocs

HiPerDiF