An investigation into the performance of aligned discontinuous carbon fibre composites produced with the HiPerDiF 3G

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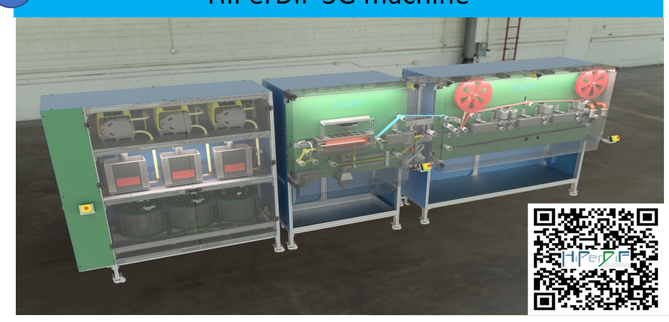
Introduction

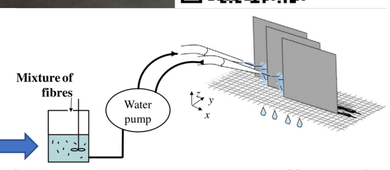
Discontinuous fibre composites generally exhibit lower tensile properties when compared with their continuous counterparts. However, If the fibres are well aligned and longer than critical length it is possible to maximise their mechanical properties while retaining the formability advantages short fibres already possess. This poster outlines how we have explored varying the HiPerDiF 3G machine parameters in order to produce laminates with improved performance.

Manufacturing & Testing

1 HiPerDiF 3G machine



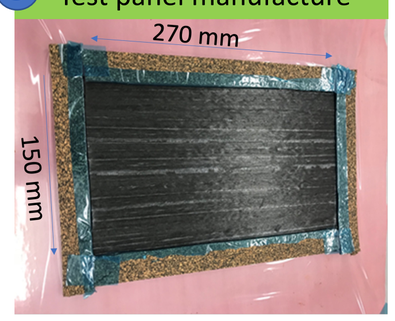
Key parameters:
- Belt speed
- Fibre concentration
- Fibre Length (longer fibres = improved stiffness)



2 Impregnated roll

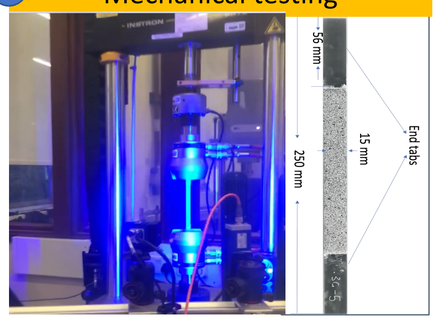
- CYCOM® resin, 36gsm
- Tenax® HT short fibres
- 30mm width, 50m length

3 Test panel manufacture



- Hand layup $[C]_8$ unidirectional
- Autoclave cure @ 180°C

4 Mechanical testing

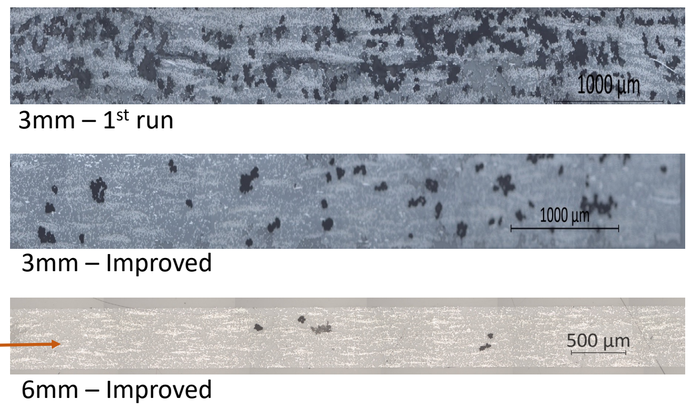


- ASTM D3039/3039M
- Strain measured by Digital Image Correlation

Results

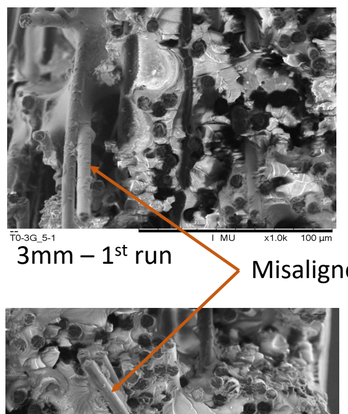
Run	Input (key parameters)			Output	
	Fibre Length (mm)	Fibre concentration (% w/v)	Belt speed	Areal weight of tape (gsm)	V_f - TGA (%)
1st run	3	6	Low	36	39 ± 1
Improved settings	3	4	Med	21	24 ± 1
Improved settings	6	4	Med	21	24 ± 1

Cross section images



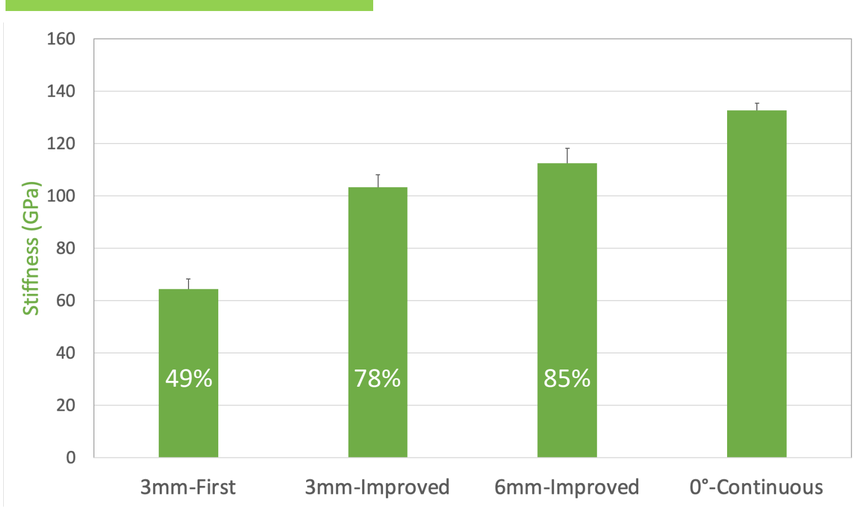
Less voided regions
Fibres look more aligned

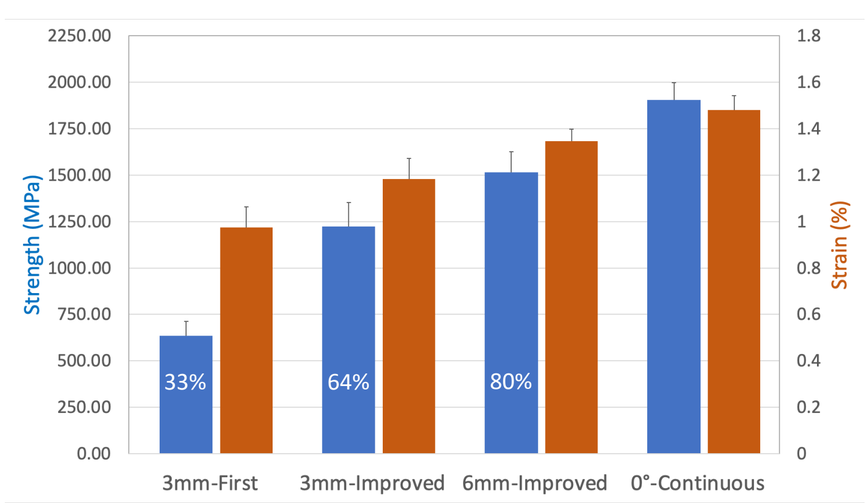
Images of fracture surfaces



Fibres oriented perpendicular to fracture surface
More fibre breakage observed

Tensile test results





- Mechanical properties of HiPerDiF 3G compared against UD continuous samples of similar constituent materials.
- Results normalised to 55% V_f, highest achievable using the HiPerDiF technology [1]

Conclusions

- Reducing areal weight of tape produced a more consistent quality of material with higher alignment
- Laminate with 6mm fibres and improved settings achieved 85% in stiffness and 80% in strength when compared to continuous composites at 55% volume fraction (V_f)
- Next steps will be to quantify alignment using image analysis techniques

[1] H. Yu, K. D. Potter, M. R. Wisnom, A novel manufacturing method for aligned discontinuous fibre composites (High Performance-Discontinuous Fibre method), Composites Part A: Applied Science and Manufacturing 65 (2014) 175–185.doi:10.1016/j.compositesa.2014.06.005.-1.

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