TWENTY-THIRD INTERNATIONAL CONFERENCE ON COMPOSITE MATERIALS (ICCM23)

INVESTIGATION OF THE EFFECT OF STAR-LIKE POLYMERS ON BASALT FIBRE BIO-COMPOSITES

Rochele Pinto[1], Vladimir Špaček[2] and Daiva Zeleniakienė[1]

[1]*Department of Mechanical Engineering, Kaunas University of Technology, Kaunas, Lithuania*

[2]*SYNPO, Pardubice, Czech Republic*

HUMAN SIDE OF TECHNOLOGY

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Outline

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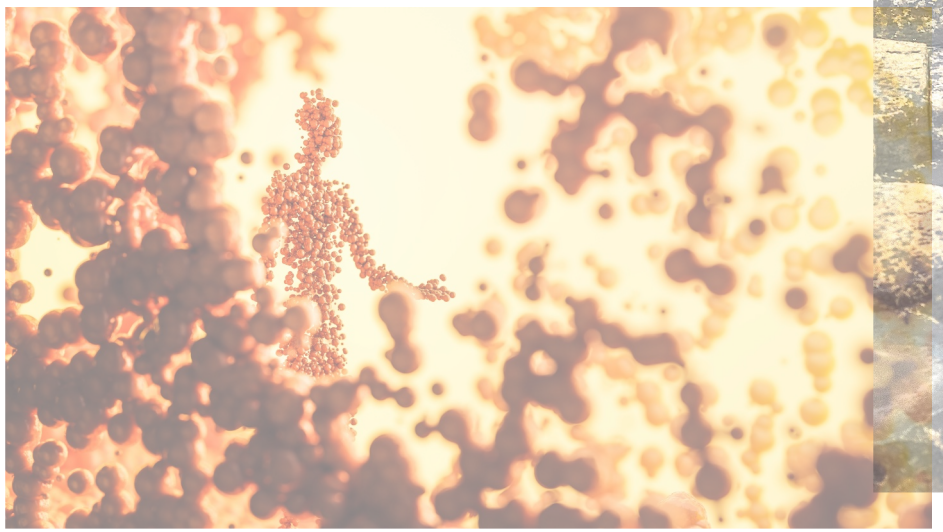
- Motivation and aim
- Research methodology
- Star-like polymer synthesis and characterisation
- Bio-based matrix characterisation
- Composite characterisation
- Comparative study
- Conclusions

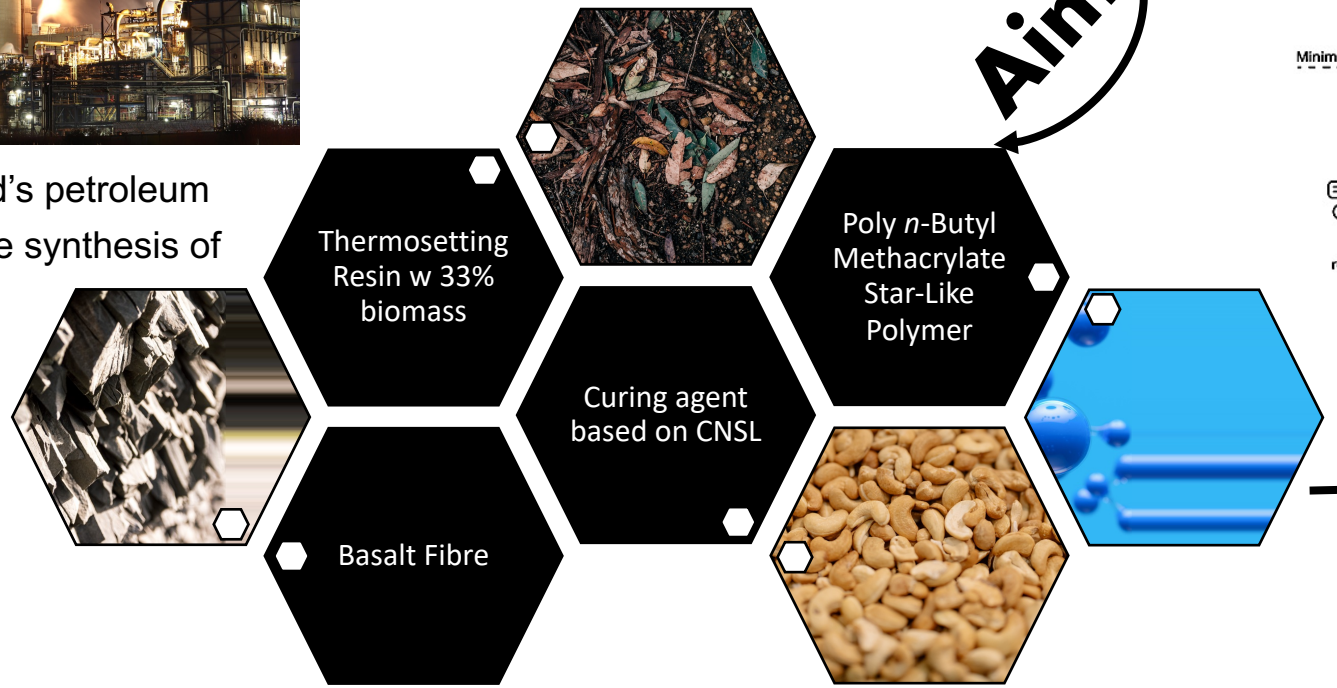


Research Motivation

About 6-8% of the world's petroleum production is used in the synthesis of monomers (Bozell, 2008)

Reducing dependability on petroleum based is the first step to a more sustainable future

Aim



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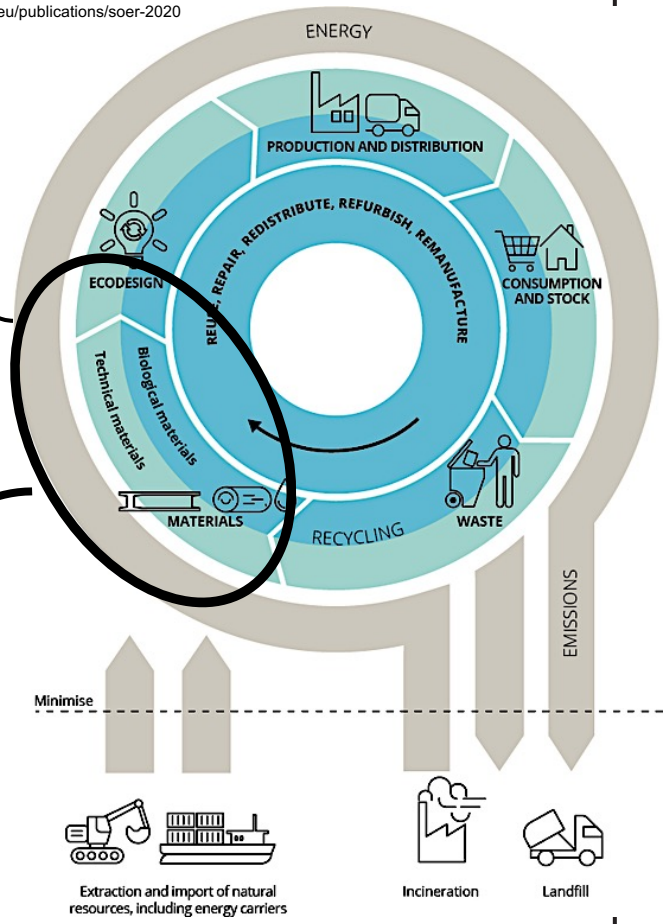

Poly (n-butyl methacrylate) star–like polymer

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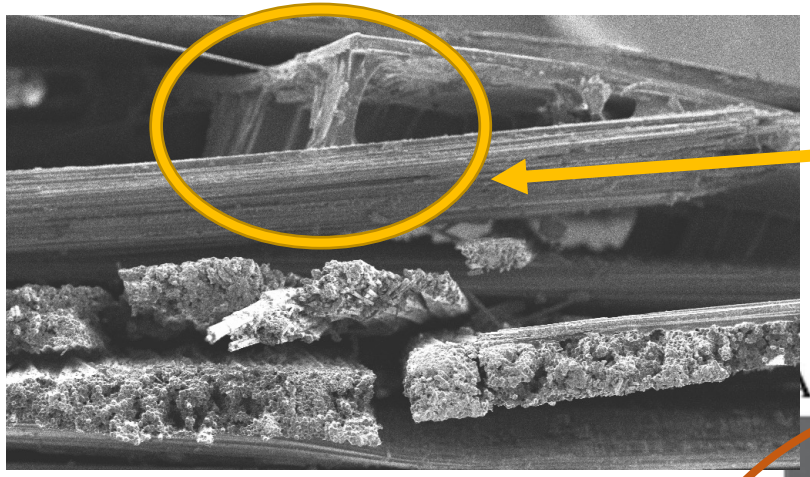
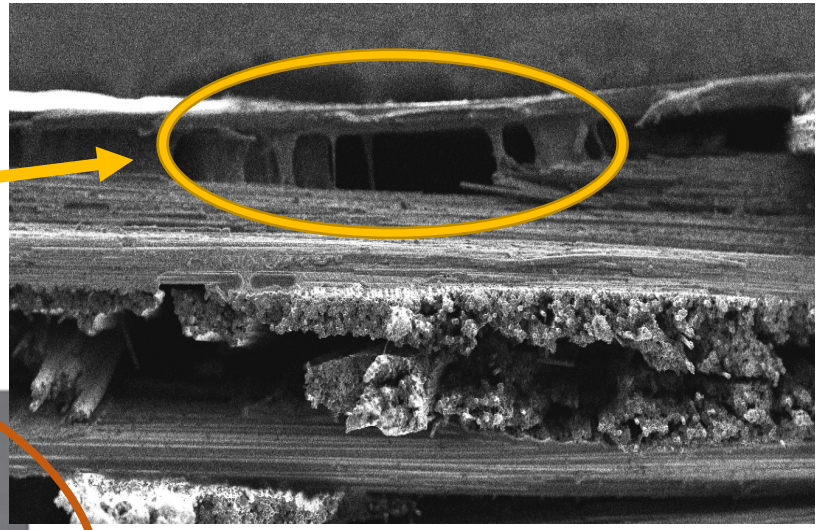
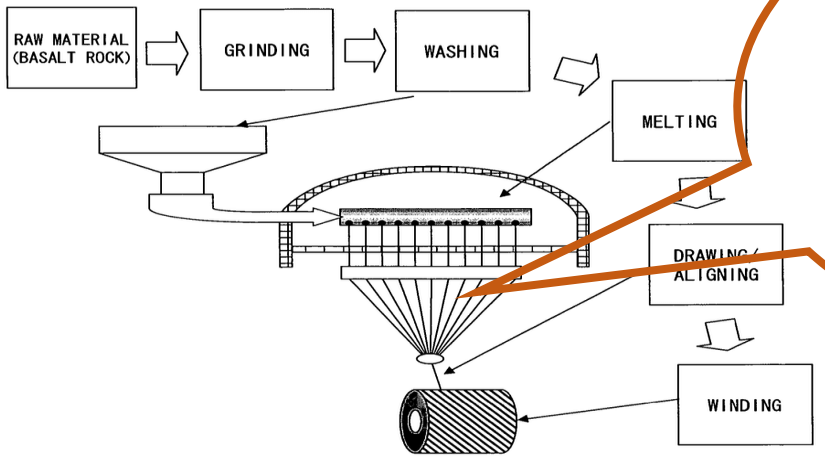


Star-like polymer in CFRP composites post-impact displayed high ductility





Bhat, Tanmay (2016)

https://doi.org/10.1515/JMBM-2017-0026

Smooth, cylindrical surface

Process Methodology

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Characterisation of bio-based matrix with star-like polymer	• Differential scanning calorimetry • Dynamical mechanical analysis • Tensile testing
Testing of basalt fibre reinforced star-like polymer composites	• Tensile testing • Low-velocity impact testing • Interlaminar shear strength testing
Post-fracture characterisation	• Scanning electron microscopy

Overview

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MATERIAL	SPECIFICATIONS	~BIO-CONTENT
Basalt fibre (BASALTEX N.V.)	Twill woven 2/2, 220g/m^2	100% igneous basalt rock (43-53% SiO_2 , 12-16% Al_2O_3 , 6-18% iron oxide, 10-20% alkaline earth metal, and 2-8% alkali)
Epoxy Resin **SR GreenPoxy 33** (Sicomin)	Density @20°C -1.159 g/cm^3 Viscosity @25°C - 1780 m.Pas Refractive index @25°C - 1.556	34-36% molecular structure coming from plant origin
Curing Agent **LITE 2002** (Cardolite)	Phenalkamine hardener, solvent free AHEW - 104 (g/eq.) Viscosity 25°C - 495 cps	>65% from CNSL (cashew nut shell liquid)
Poly (n-butyl methacrylate) Star-Like Polymer (GTP 490)	Mw – 60467, synthesized by group transfer polymerisation	-
		Total bio-based content* ~ 45%

Synthesis & characterisation of poly (n-butyl methacrylate) star–like polymer

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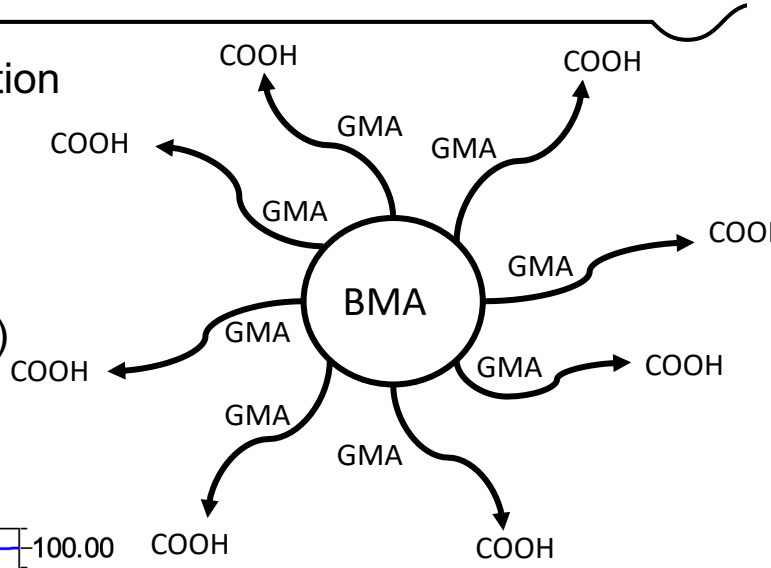
- Synthesized by group transfer polymerisation (GTP) using ‘arm–first’ method.
- Polydispersity of 1.44
- Proven results of ductile behaviour (sticky) within plies of laminates[1]



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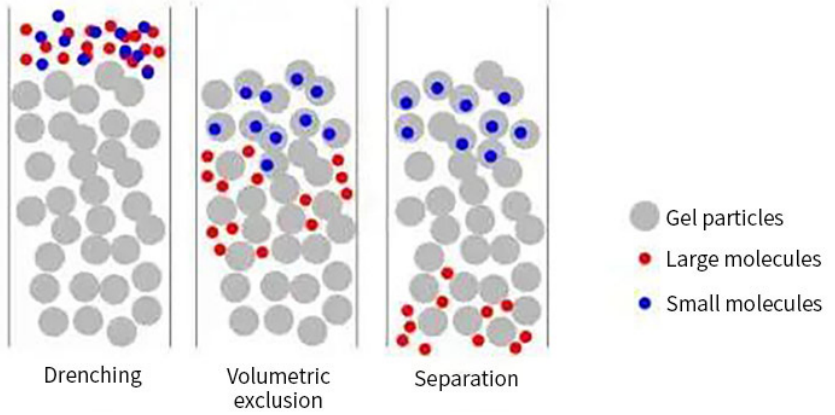

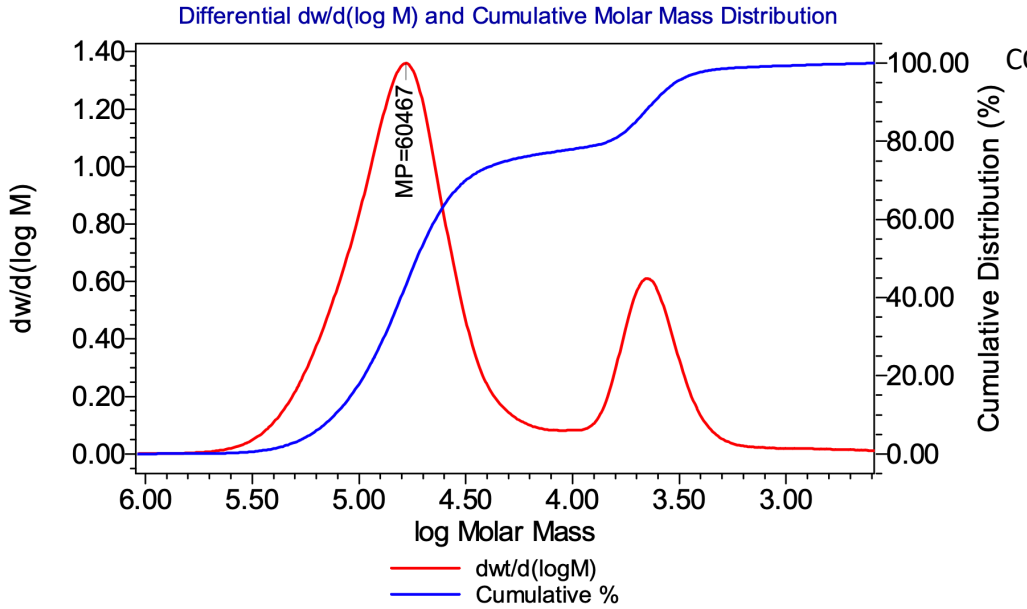

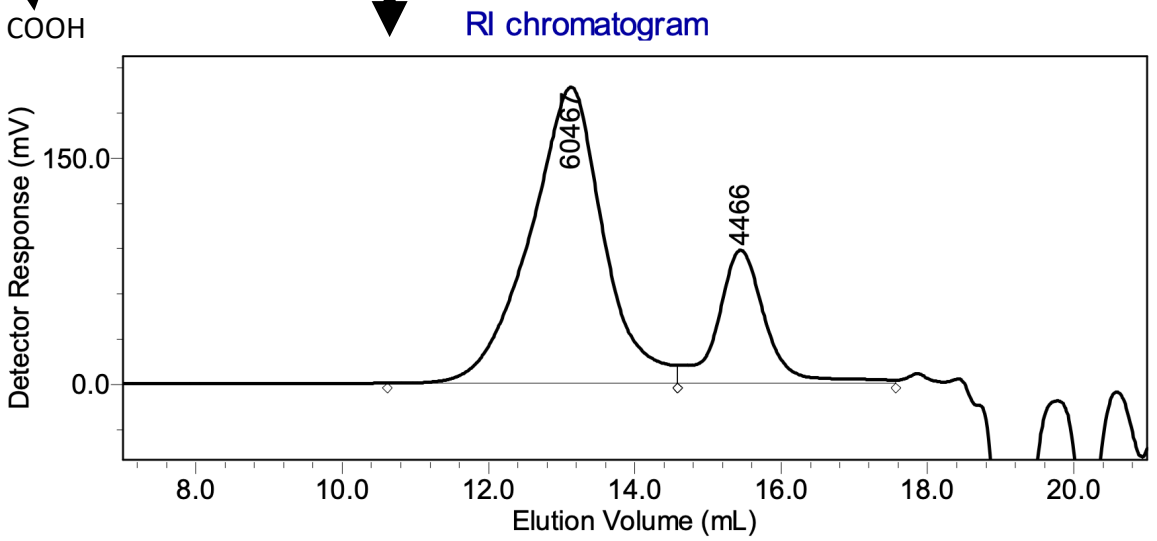

Characterisation of bio-based matrix

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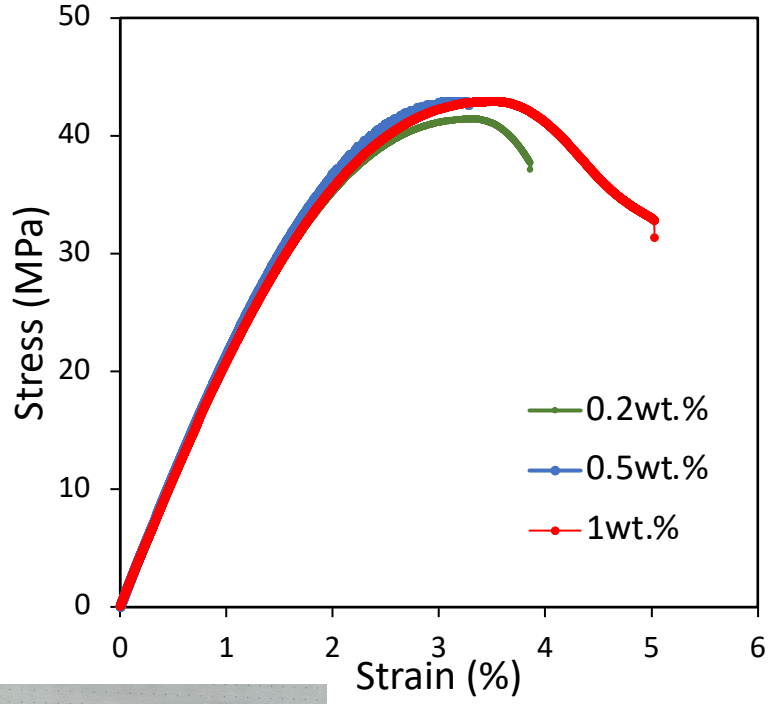
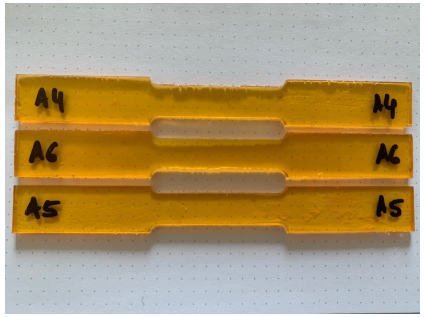
- **No significant change in Young's modulus was observed**
- **Stars visually looked more compatible with bio-matrix to conventional matrix**

	Maximum Stress (MPa)		Maximum Strain (%)		Young's Modulus (GPa)	
	Bio-Matrix	Conv_Matrix	Bio-Matrix	Conv_Matrix	Bio-Matrix	Conv_Matrix
Pure Epoxy	41.44	43.64	3.4	6.03	2.01	1.09
0.2 wt.%	42.54	66.95	3.4	8.44	2.19	1.23
0.5 wt.%	41.3	65.96	3.2	8.54	2.19	1.28
1.0 wt.%	42.0	71.04	2.9	9.9	2.25	1.45





0.2, 0.5, and 1 wt.% of star-like polymer

Low-velocity impact test

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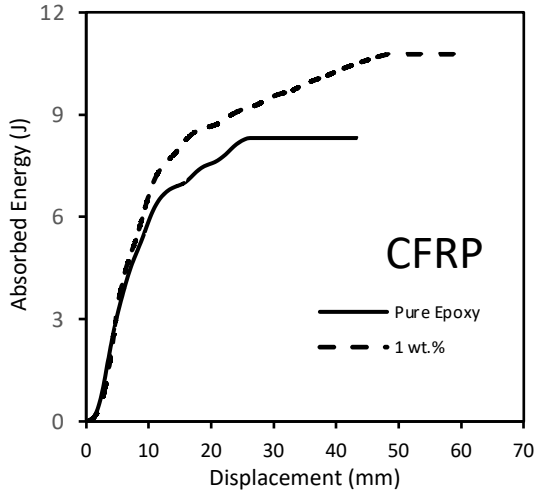
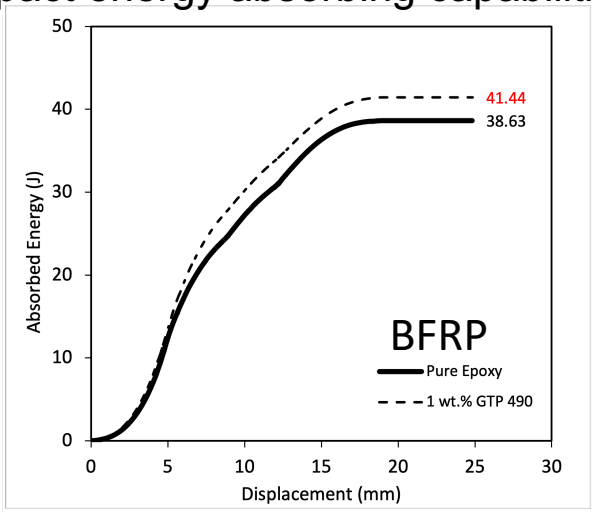
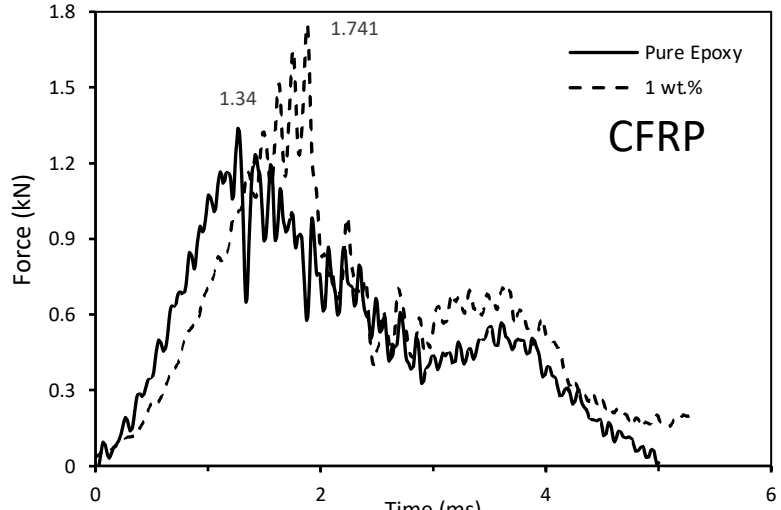
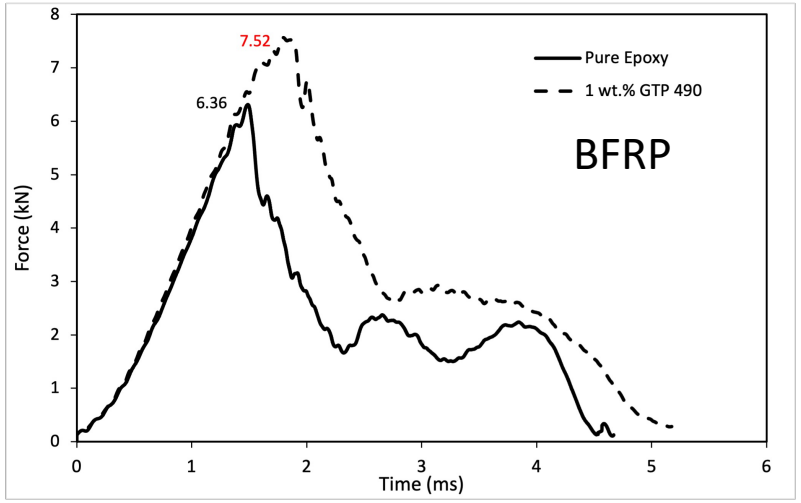
CFRP vs BFRP (conventional matrix) impact energy absorbing capabilities

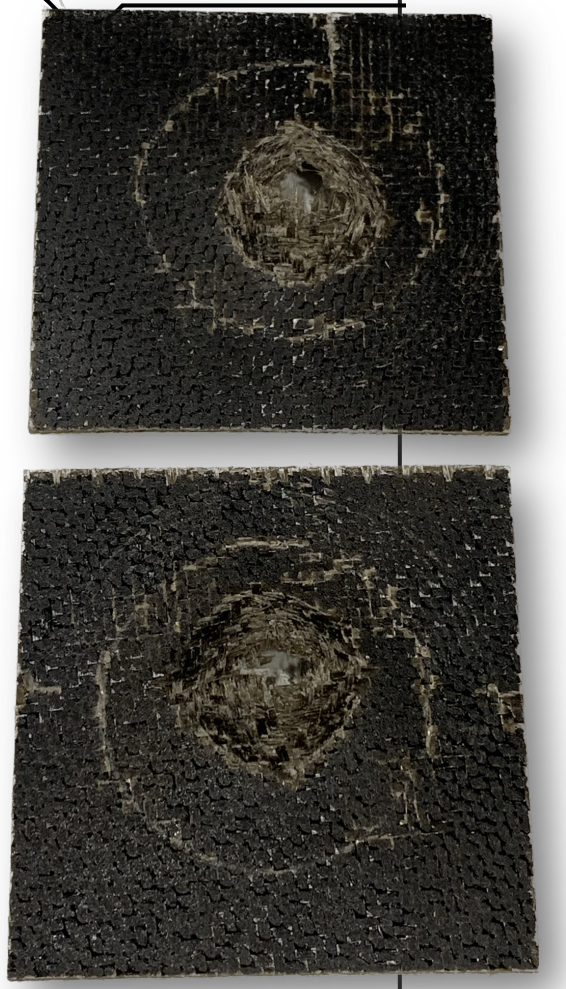




https://doi.org/10.1177/00219983211065206







Conclusions

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- Reducing dependability on petroleum derived materials, is the first big step towards sustainability.
- It is possible to have a high bio-content composite and not have a trade off with low mechanical performance.
- Addition of star-like polymers improves the interfacial adhesion between fibres and matrix, therefore higher load bearing capabilities and excellent impact resistance.
- The novel composite has good energy absorbing abilities making it a possible suitable substitute in the transport industry.
- Future scope of this work is to analyse the effect of a bio content >50% and it's effect on the mechanical performance.

Thank you for your attention

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Q&A