Mechanical combined with chemical recycling for vacuum-infused acrylate-based composites reinforced by glass and basalt fabrics

Authors

Inès Meyer zu Reckendorf [a,b]
Didier Perrin [a]
Anne Bergeret [a]
Clément Lacoste [a]
Karynn Morand [b]

[a)] Polymers, Composites and Hybrids (PCH), IMT Mines Alès
[b)] SEGULA Technologies, 69200 Vénissieux, France

Partners

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Benjamin Gallard
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Patrick Ienny

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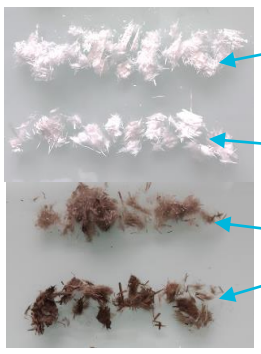
CONTEXT

- Development of semi-structural composites for the automotive industry based on fabrics by vacuum infusion.
- Study of the end of life of these composites by considering a mixed recycling combining mechanical grinding and dissolution.

GOALS

- Satisfy the requirements of the automotive sector in terms of durability and recyclability.
- Circular economy approach: aiming at end-of-life recycling.

DEFINITIONS



refG	Reference Glass fibers
G/S G	Ground Glass fibers (fraction >2mm)
G/S/D G	Ground, Sieved and Dissolved Glass fibers (fraction >2mm)
refB	Reference Basalt fibers
G B	Ground Basalt fibers
G/D B	Ground and Dissolved Basalt fibers

MATERIALS

First-generation composites to be recycled:

- Plain basalt fabrics (220 g/m²), Basaltex
- Plain glass fabrics (202 g/m²), M.C. Technics
- Elium ®150 resin, Arkema

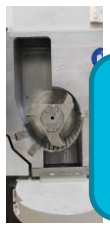
Vacuum infused thermoplastic composites (10 plies)

Second-generation composites:

- Polyamide 6 Akulon F223-D, DSM Engineering Materials.
- Reference short glass fibers (4.5 mm; OCV) and short basalt fibers (3.2 mm; Basaltex).
- Ground/dissolved first-generation composites

METHODOLOGY

Plain basalt/glass Elium®150 composites



Grinding: Grid of 8mm, 1500rpm

Dissolution in acetone ratio 1:20, 16h, 3min ultrasound

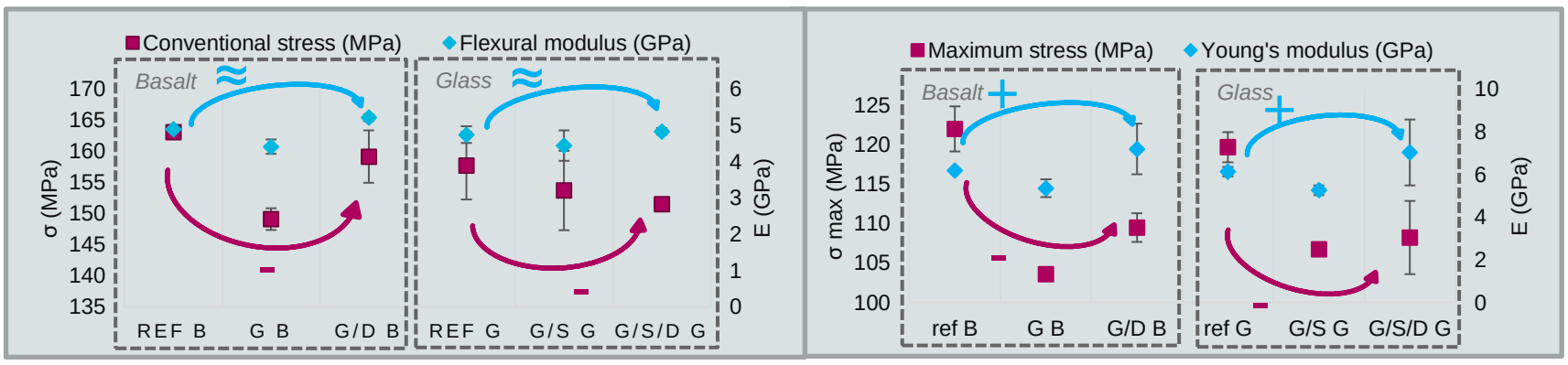
Injection/Extrusion

CHARACTERISATION OF PA6/SHORT FIBERS COMPOSITES

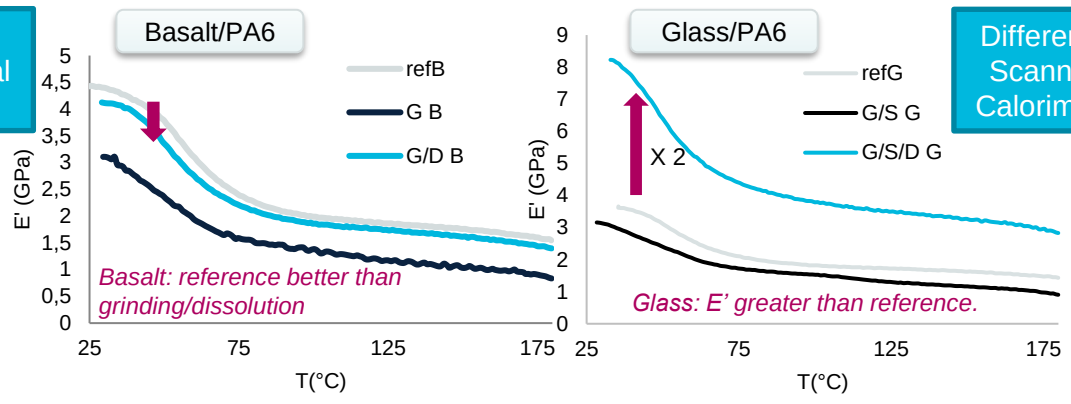
Flexural and tensile strengths

Flexural properties of G/D better than G except for glass. Comparable flexural moduli for reference and G/D basalt.

Grinding/dissolution samples have better tensile properties than grinding ones. Even better Young's modulus for G/D than reference in both cases of glass and basalt.



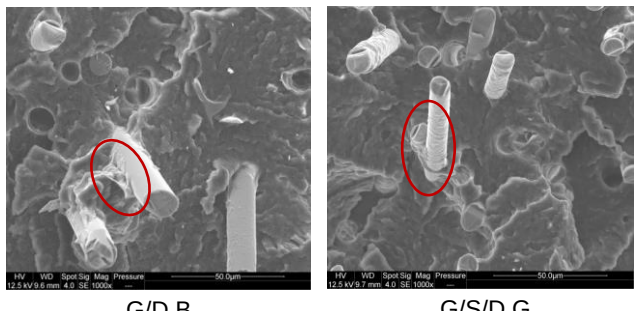
Dynamic Mechanical Analysis



Differential Scanning Calorimetry

	Wf (%)	Xc (%)
PA6	-	42.77 ± 12.25
refG	19.30 ± 0.49	22.76 ± 1.93
G/S G	13.13 ± 0.59	25.01 ± 2.24
G/S/D G	18.52 ± 0.32	26.42 ± 1.67
refB	18.34 ± 1.45	27.14 ± 1.50
GB	13.45 ± 1.45	25.00 ± 1.66
G/D B	19.50 ± 0.28	27.22 ± 0.91

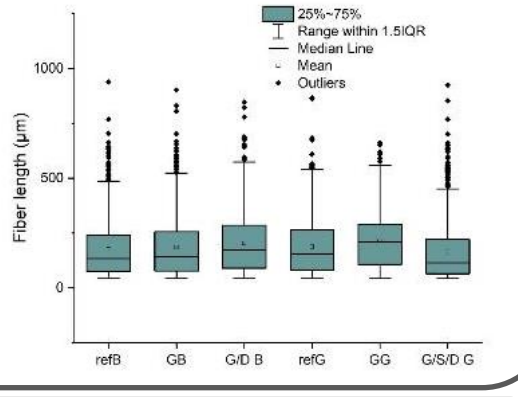
Scanning Electron Microscope



G/D B G/S/D G

- *Average fiber length of 200 µm.*
- *Incorporation of fibers in PA6 decreases Xc proportionally to the fiber content in the composite.*
- *Good fiber-matrix adhesion thanks to the presence of residual Elium®150 resin on the fiber surface but lower than reference => Increase of E' in DMA*

Fiber length measurement



CONCLUSION

Coupling grinding and dissolution could be considered as an efficient approach to recycle basalt/glass Elium©150 composites:

- *Dissolution increases the fiber content in the second-generation composite.*
- *The presence of residual resin improves fiber-matrix adhesion (mechanical adhesion, physico-chemical wetting adhesion).*
- *Tensile properties are increased (Young's modulus, E).*

=> Reincorporation of ground and dissolved basalt or glass fibers into PA6 thermoplastic matrix is an interesting way to valorize end-of-life plain thermoplastic composites.

Contact: ines.meyer-zu-reckendorf@mines-ales.fr