LIGHTWEIGHT SUSTAINABLE CARBON-FLAX HYBRID COMPOSITES WITH POLYBENZOXAZINE VITRIMER

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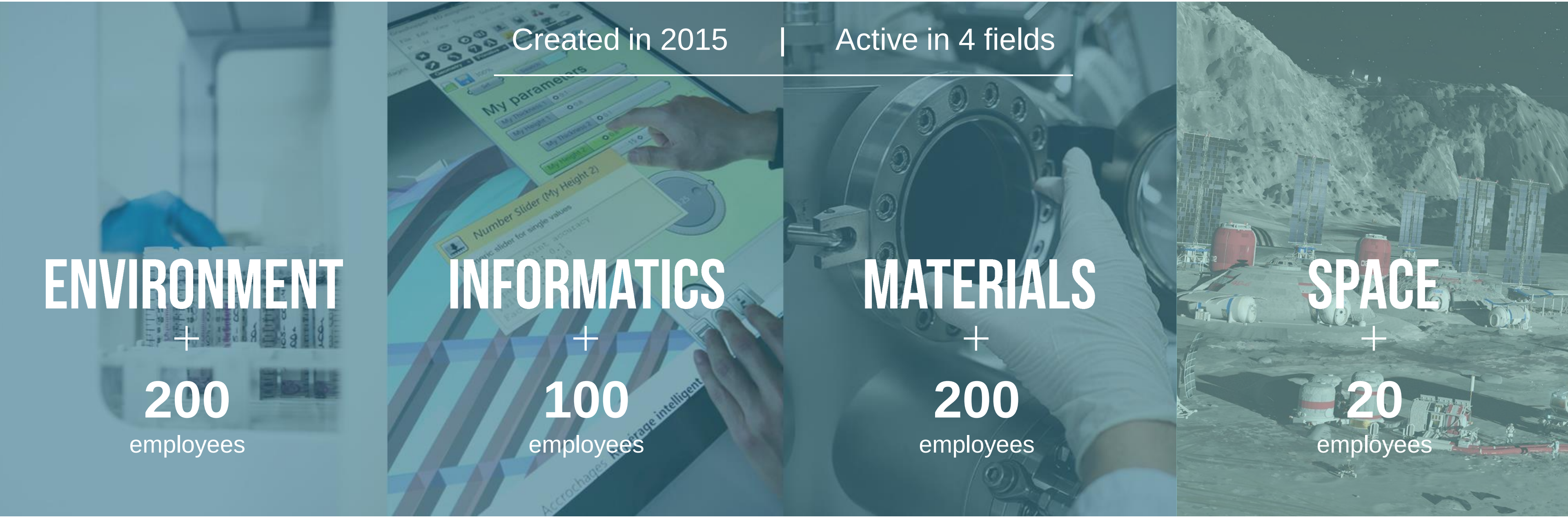

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LIST MATERIALS

Sensors & actuators

Photocatalysis & energy harvesters

Fibres/matrices adhesion

Functional coatings

Smart nanocomposites

Structures & multifunctional composites

Bio-based polymers & composites

Advanced manufacturing

Sustainable Composites

- **Design & structure**
- **Advanced materials**
- **Manufacturing**

In partnership with
Gradel, Anisoprint, Kleos

SUSTAINABLE POLYMER COMPOSITES (SUSPOCO) PROJECT

9 Ph.D studies on vitrimer composites from catalyst to hybrid natural fibres vitrimer composites

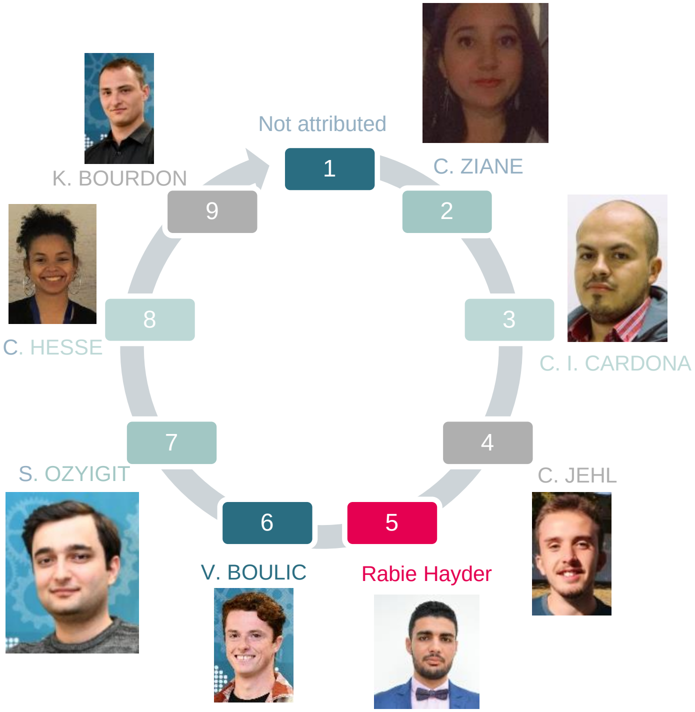
1: Designing vitrimers via advanced modeling and characterization

2: Novel polymeric catalysts for high performance vitrimers

3: Engineering the composition, structure & surfaces of renewable fibers

4: Directing vitrimer reactivity and structure for reliable thermal reshaping

5: Vitrimer composites: Design for repair



6: Vitrimer healing & mechanical recycling: multiscale and in-situ analyses

7: Programmed debonding / disassembly of fiber composites

8: Chemical recycling and fiber recovery in vitrimer composites

9: Multi-tier recycling of vitrimer / hybrid fibre composites

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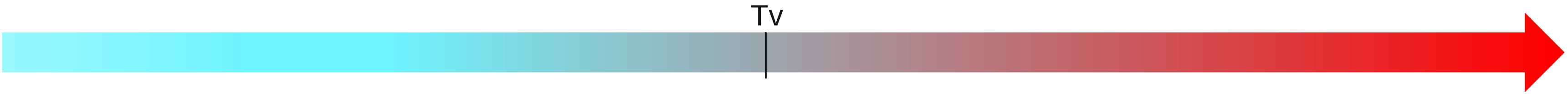
VITRIMERS AND THEIR INTEREST

A vitrimer is a polymer network that contains dynamic covalent bonds

Tv: Temperature above which bond exchange occurs



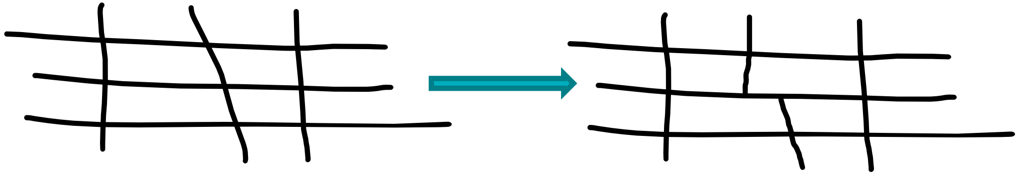
Permanent crosslinking:

- No loss in mechanical properties
- Possibility to chemically recycle the material thanks to specific reaction with dynamic bond

Creep and stress relaxation allows:

- Damage repairs/ material healing
- Permanent material reshape
- Mechanical recycling

Stress relaxation through dynamic bonds



HYBRID MATERIAL

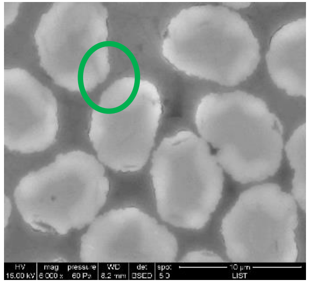
Process & study

Process:

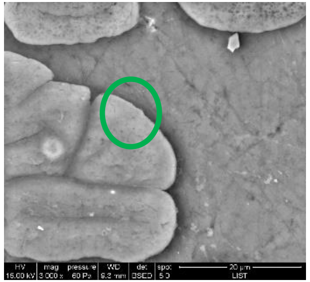
- Drying of the resin @55 °C under 0.5 mbar vacuum overnight
- Drying of flax @110 °C at atmospheric pressure overnight
- Vacuum assisted compression moulding (100 mbar vacuum pressure)
- Curing: 10 min @80 °C + 1h @170 °C + 30 min @190 °C

Name	Lay up	Fibre content weight	Flax content weight
Carbon	10 plies of carbon	62%	0%
Flax	3 plies of flax	47%	100%
2C2f2C	2 plies carbon – 2 plies flax – 2 plies carbon	47%	19.3%
1C1f2C1f1C	1 ply carbon – 1 ply flax – 2 plies carbon – 1 ply flax – 1 ply carbon	49%	19.3%
1f4C1f	1 ply flax- 4 plies carbon – 1 ply flax	47%	19.4%
3C1f3C	3 plies carbon – 1 ply flax – 3 plies carbon	50%	9.3%

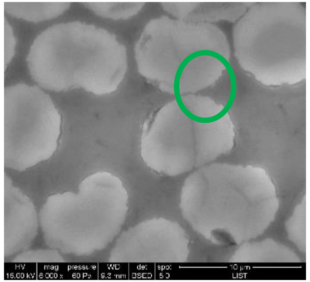
µ-CT AND SEM



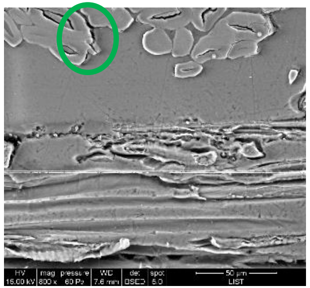
Fibre/ matrix interface in Carbon material



Fibre/ matrix interface in Flax material

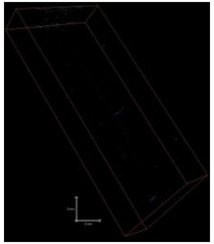


Carbon fibre/ matrix interface in 1f-material

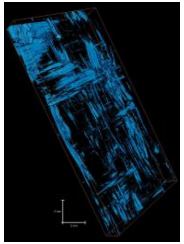


Flax fibre/ matrix interface in hybrid 1 material

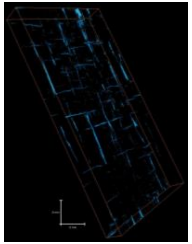
	Carbon	Flax	1f-4C-1f	2C-2f-2C	1C-1f-2C-1f-1C	3C-1f-3C
Porosity	<0.01%	1.5%	0.1%	1.0%	0.6%	0.1%



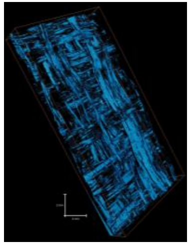
Carbon



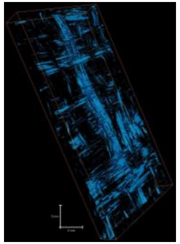
Flax



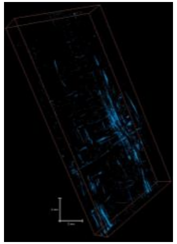
1f-4C-1f



2C-2f-2C



1C-1f-2C-1F-1C



3C-1f-3C

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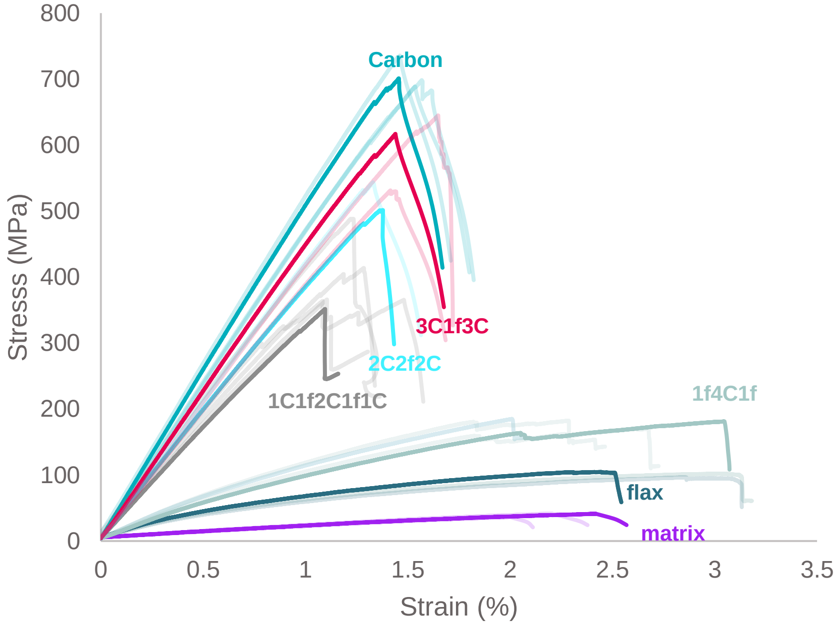
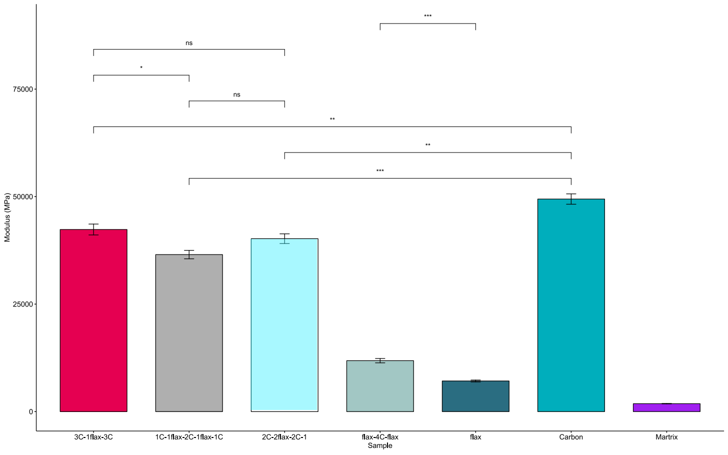
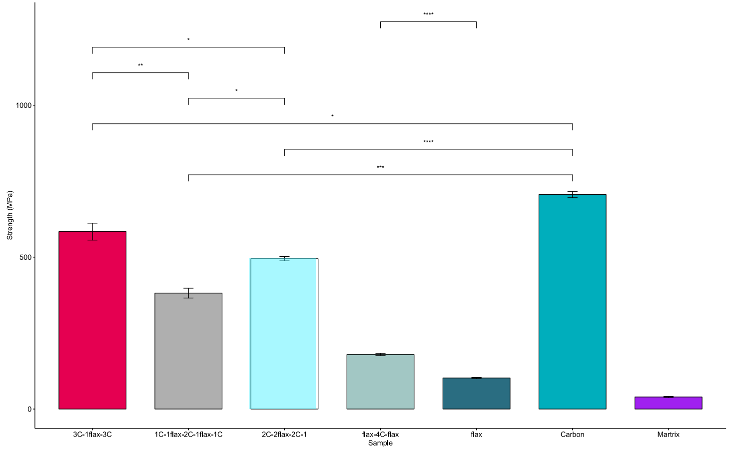
3 POINTS BENDING

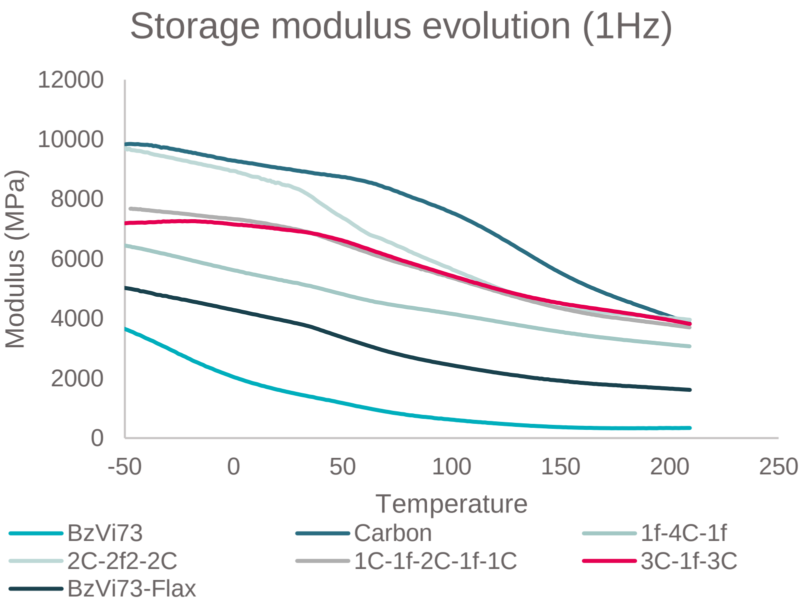
Comparison of hybrids material σ/ε curve

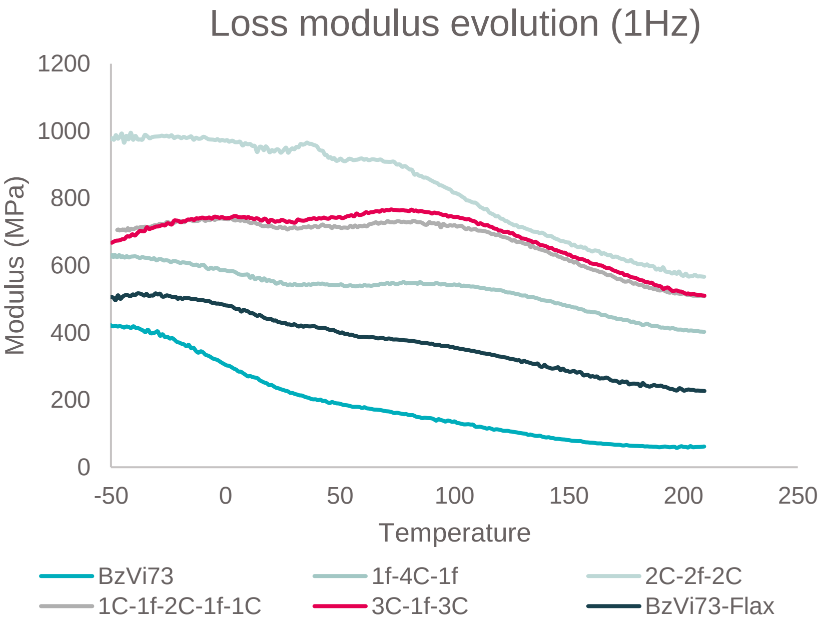






DMA





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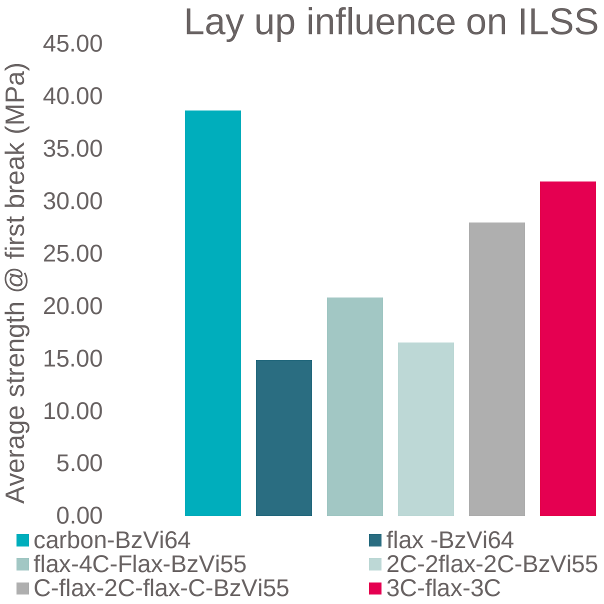
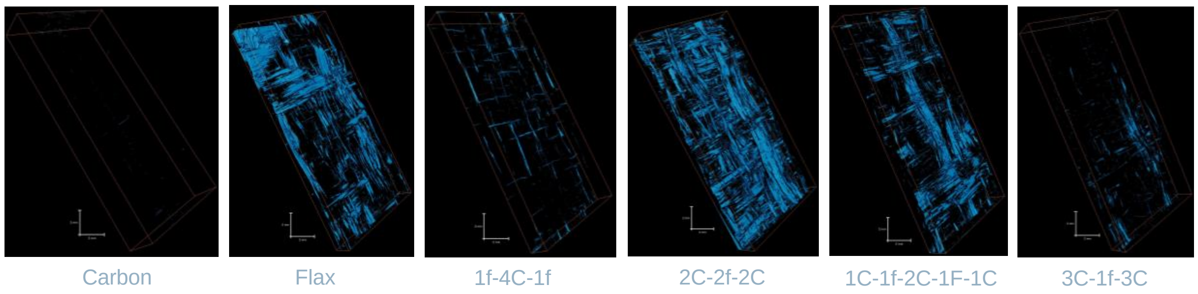
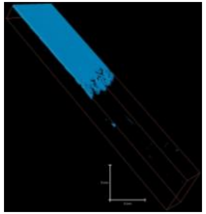
INTERLAMINAR SHEAR STRENGTH



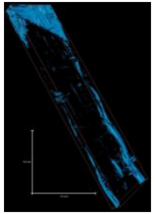


HEALING OF COMPOSITE SAMPLE

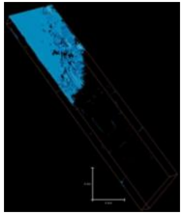
μ-CT



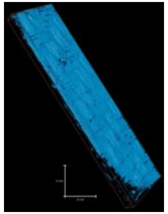
Carbon
4% of porosity



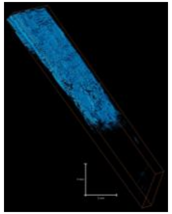
Flax
2.4% of porosity



1f-4C-1f
4.8% of porosity



2C-2f-2C
13.2% of porosity



1C-1f-2C-1F-1C
12.4% of porosity

Healing process

Temperature : 170°C

Pressure : 10 bars

Time : 1 min

μ-CT

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thank you

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