Circular Use of rPP with Natural and Basalt Fibres: From Carpet Waste to Automotive Applications

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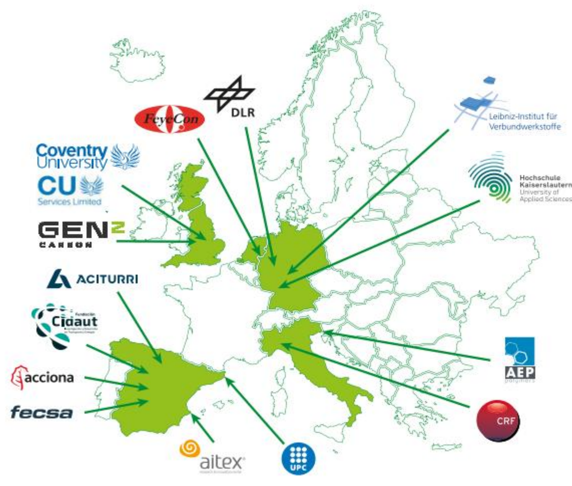
Introduction

This study investigates hybrid composites combining natural fibres (flax, hemp) and basalt fibres (BF) with polypropylene (PP) and recycled PP (rPP and rPP-carpet). Incorporating rPP maintains or enhances mechanical performance, while increasing recycled content. The results highlight the potential of these composites for automotive applications, balancing sustainability and performance.

Project Description

r-LightBioCom is an EU-funded project developing sustainable, recyclable, high-performance lightweight bio-composites. The consortium includes 15 partners from research, academia, and industry across five European countries.



Materials and Methods

Manufacturing of semi-finished products by carding and needling, as well as composites by compression moulding

Challenges:

- Achieving homogeneous fibre distribution in nonwovens
- Processing brittle basalt fibres (≈ 10 cm) without excessive breakage
- Minimising fibre loss during carding and needling
- Handling non-heat-stabilised rPP-carpet with the risk of material flow out of the mould during compression moulding

Reinforcing Fibres and Polymer Matrices

Basalt

Flax

Hemp

PP (virgin)

rPP (heat-stabilised)

rPP-carpet

Nonwoven Manufacturing Processes: Carding and Needling

Carding

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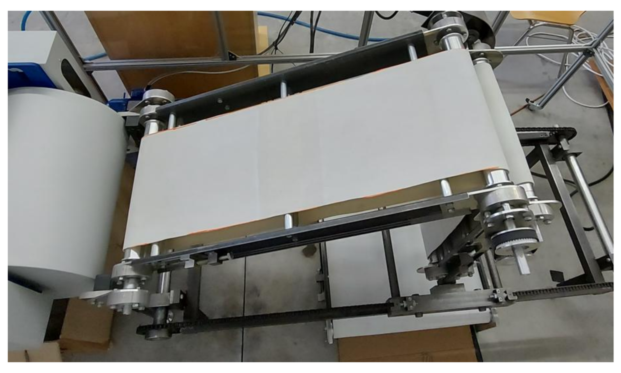

Cross-laying

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Needle punching

Composite Manufacturing: Compression Moulding

Hot pressing

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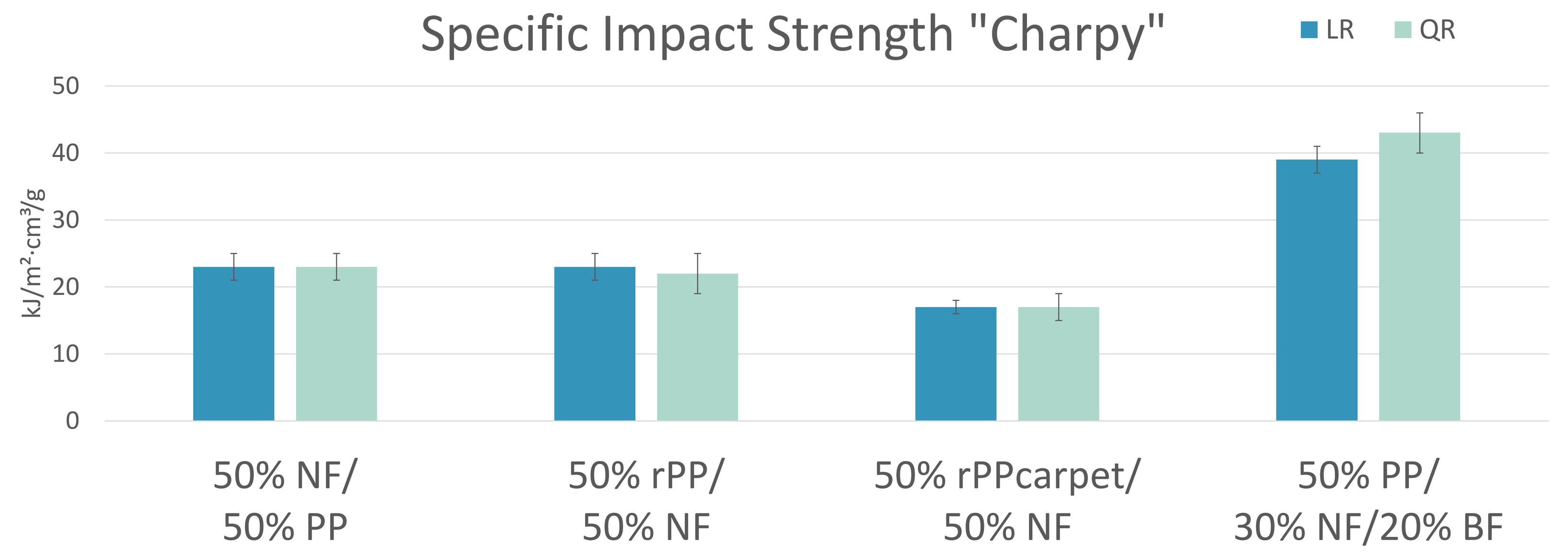
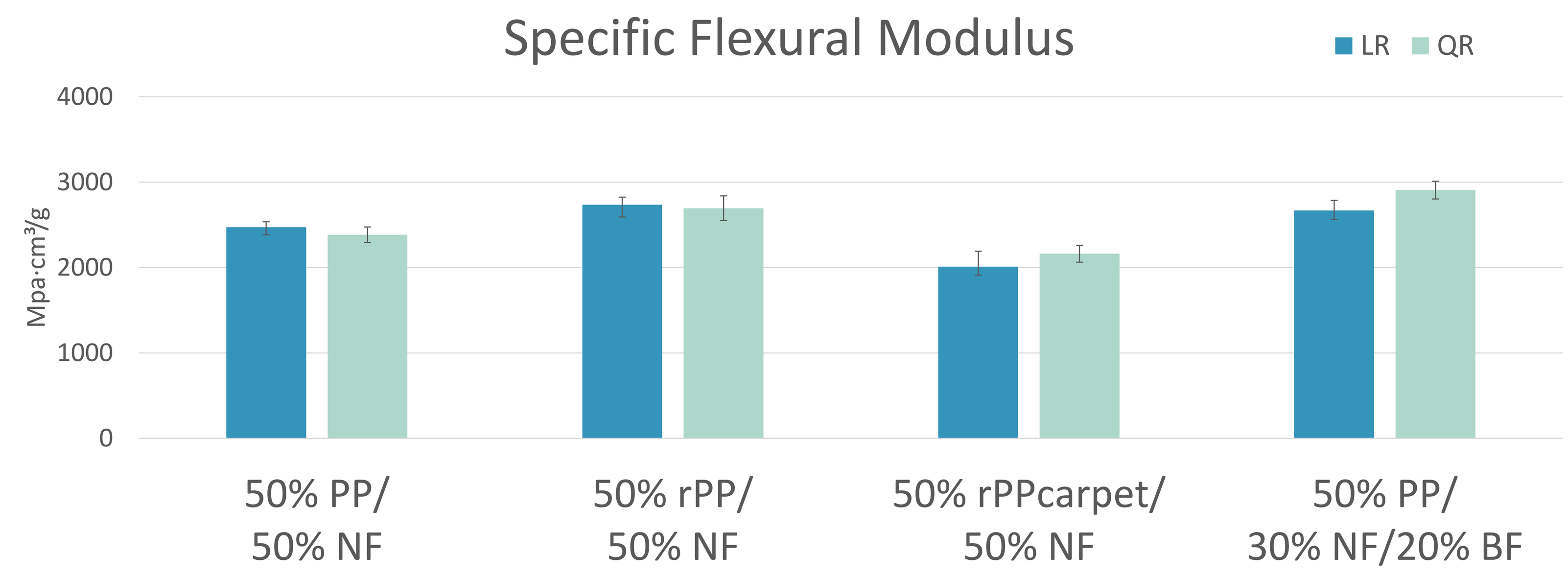
Nonwoven → Composite

Mechanical Characterisation of Composite

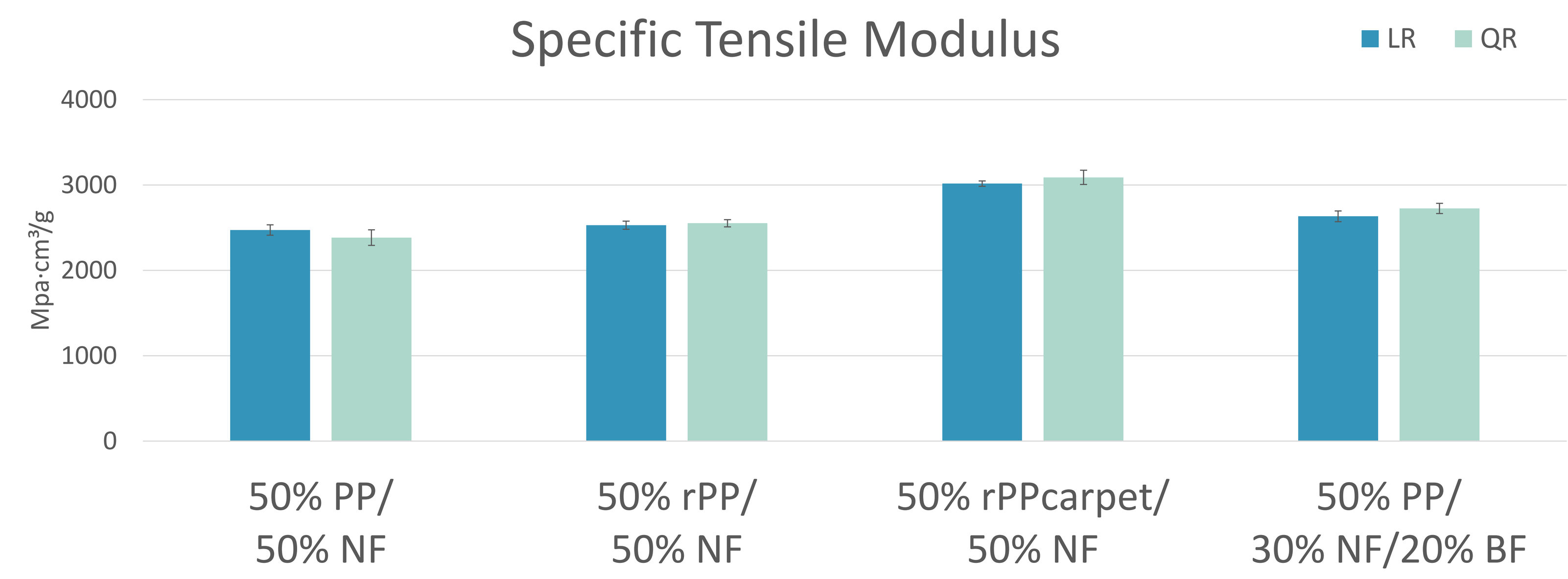
Comparison of PP/rPP Matrices and BF Composites



- ➢ rPP composites show similar impact strength than virgin PP
- ➢ rPP carpet leads to a decrease of the impact strength properties
- ➢ Addition of basalt increase significantly the specific impact strength



- ➢ rPP composites achieve comparable stiffness to virgin PP
- ➢ rPP-carpet sample shows 15% lower flexural modulus than virgin PP
- ➢ Basalt fibre addition achieves specific flexural modulus close to rPP



- ➢ rPP-carpet composites observed the highest specific tensile modulus
- ➢ Specific tensile modulus of basalt fibre composite is comparable to virgin PP

*LR – Longitudinal direction; QR – Transverse direction

Summary and Conclusion

- Incorporating of **rPP-carpet** and **rPP** into natural fiber composites allows for a successful replacement of conventional **PP** (virgin) without compromising mechanical performance
- The addition of **basalt fibres** leads to a significant improvement in the specific impact strength of the composites
- Composites with **rPP-carpet** achieve a high specific tensile modulus and balanced stiffness, highlighting the potential of recycled materials in high-performance, sustainable composites
- The results demonstrate the feasibility of developing sustainable, partially bio-based and high-performance composites for automotive and construction applications

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