Industrial Processing of Biocomposites: Opportunities and Challenges

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The Challenge

Biocomposites have environmental benefits, but industry need to see performance and processing data.

110,000 tonnes of FRPs produced in the UK in 2019

But only 6% were reused.

Barriers to uptake in bio-composites:

1. Mechanical and Environmental Performance Data
2. Material Processing not well understood
3. Perceived high cost
NCC Work
Experience in flax end applications as an independent manufacturer
Sustainable Overmoulding
UK First for Injection Overmoulding of Bio-based Composites

- Processibility assessment of injection overmoulding an automotive demonstrator component
- Address industry concern on processibility and performance
- Assess sustainability credentials
Conventional Composites
Non-bio-derived materials which retain value in the economy through **repair**, **reuse**, and **recycling**

Bio-Composites
If designed correctly, both fibre and polymer will **biodegrade and regenerate** nature at end of life

Glass Fibre /Polypropylene

Flax Fibre/PLA
Manufacturing Capability
We have demonstrated manufacture is viable using the overmoulding process

Targets for automotive viability are to manufacture a part...

- Processing temperatures and pressures were similar for both materials
- Flax/PLA benefitted from longer cooling time
- Tool hygiene was important for high quality parts
In-house Verification
Testing has shown that the right application and design are key when using sustainable materials

**Tensile and flexural** properties of Flax Fibre/PLA are $< \frac{1}{3}$ of GF/PP

Lower mechanical performance means clever design is needed to boost properties for use in structural applications

Following humidity and temperature tests:
- **Tensile strength** of flax composite reduced by ~ 5% whereas GF composite this reduced by ~10%
- Flax Fibre/PLA **stiffness reduced** by ~50% post conditioning

Reduced environmental performance limits applications in automotive
Life Cycle Assessment (LCA)

Found improved fibre impact however better-quality data is required

NCC’s Screening LCA

- Glass/PP Total GWP: 4.78 kgCO2 eq
  - PP Polymer: 1.38
  - Glass Fibres: 1.86
  - Organosheet Production: 0.51
  - Overmoulding: 1.03

Flax/PLA Total GWP: 5.58 kgCO2 eq

- PLA Polymer: 3.61
- Flax Fibres: 0.45
- Organosheet Production: 0.48
- Overmoulding: 1.04
Life Cycle Assessment (LCA)

Benefits of natural fibres in GWP must be balanced with other impacts

Acidification Potential (AP)

- Flax long fibre
- E-glass
- PLA
- PP

Eutrophication Potential (EP)

- Flax long fibre
- E-glass
- PLA
- PP

Freshwater Aquatic Ecotoxicity Pot. (FAETP inf.)

- Flax long fibre
- E-glass
- PLA
- PP
We need more connection across the supply chain

**Growers**
Determine crop type and quantity and have high impact on environmental impact
Need to know end applications and demand

**Formatters**
Determine the process and parts fibres can be used in
UK supply chain gap in fibre separation

**Material Suppliers**
Accessibility of fibres to industry
Need to know properties and variability

**End Users**
Communicate to growers:
- Demand
- Required crop
Need to know properties, variability, and processing information
Headline Take Aways

Natural fibre composites offer the opportunity for composite materials to come from, and re-enter natural systems in the UK and we have shown they can make parts in high-rate processes. We still need to:

- Develop circular polymers
- Apply these materials to an in-service part
- Understand and model how material properties vary and apply to technical documentation
- Link up the UK supply chain to communicate demand and get quality, UK LCA data
Thank you for your time
Please come and discuss your challenges and opportunities

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