Recycling of Polypropylene in PPE Face Masks for Manufacturing of FlaxPP Eco-composites

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Aim of the project

Providing an innovative solution to the issue of discarded plastic face masks by recycling the primary plastic, polypropylene to manufacture an eco-composite by reinforcing it with natural flax fibers. The project aims to implement UN SDGs by bringing together the three pillars of sustainability through an engineering perspective.
The mechanical properties of the FlaxPP material were analysed using software simulations and mathematical calculations. Physical manufacturing of the FlaxPP material is underway to test mechanical properties, specifically the favourable vibration damping properties due to Flax's hollow, composite-like structure.

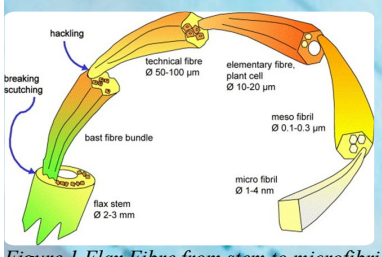

Figure 1 Flax Fibre from stem to microfibril (Bos et al., 2006)

Methodology

Manufacturing:

1. Flax/PP. Using flax fibres and face masks.
2. Flax/vPP. Using flax fibres and virgin polypropylene sheets that are the raw material for manufacturing the face masks. (Benchmark)
3. Glass/PP. Using the more widely utilised glass fibres and polypropylene as a matrix.(Benchmark)

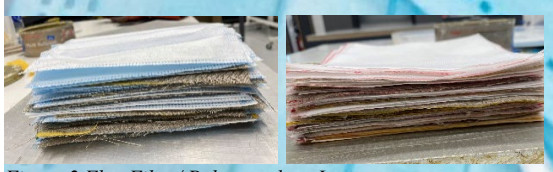

Figure 2 Flax Fibre/ Polypropylene Layups

Figure 3 2x2 Twill Flax Fibre Cloth made by Eco-Technilin

Compression Molding:

- 5 mm thickness/10 fibre layers
- 190 º C Temperature/ 20 bar pressure
- 8 minutes (Hachem et al., 2021)
- 40% flax fibre weight fraction
- 33 masks for 5 mm thickness
- 61 virgin PP layers for 5 mm thickness

Vibration & Tensile Testing

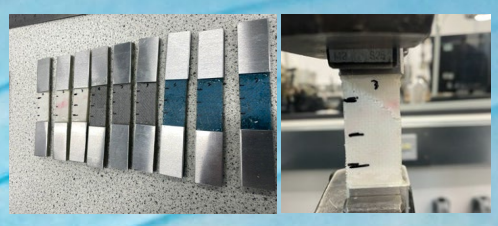

Figure 4 Tensile testing of 3 samples per each of the 3 materials

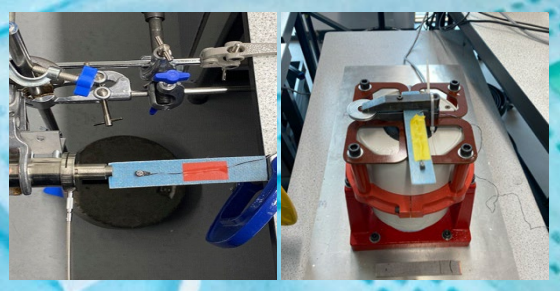

Figure 5 Vibration Damping tests using Impulse Hammer, Shaker and Accelerometer

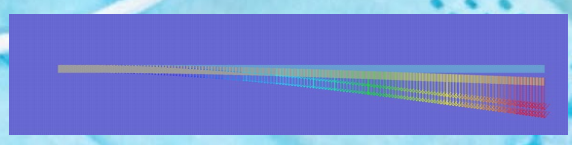

Figure 6 Modal Analysis capture using FEA software simulations

Results

Table 1:Vibration Damping Testing Results

	Damping Ratio (ζ)	ω / Hz (Natural Frequency)
Flax/PP	0.03004	118.2
Flax/vPP	0.02614	117.5
Glass/PP	0.01930	84.8

Table 2: Tensile Testing Results

	Stiffness (δ) / MPa	Strength (σ) / MPa
Flax/PP	25.1	59.2
Flax/vPP	30.1	78.7
Glass/PP	64.2	107.0

Future Work

- SEM Analysis to examine morphology and fibre matrix interface adhesion
- Explore fibre treatments processes and coupling agents to improve mechanical properties
- Temperature and moisture analysis

References:
Hachem, Z. E., Célino, A., Challita, G., Branchu, S., Duigou, A. L., & Fréour, S. (2021). Dimensional variation and evolution of mechanical properties of wet aged composites reinforced with flax fibers. Journal of Composite Materials, 55(8), 1131–1148.
Bos, H.L., Van Den Oever, M.J.A. and Peters, O.C.J.J., (2002). Tensile and compressive properties of flax fibres for natural fibre reinforced composites. Journal of Materials Science, 37(8), pp.1683-1692.

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