**Influence of Thermoforming Parameters on The Mechanical and Aesthetic Behaviour of Flax Polypropylene Laminates**

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# **Abstract**

Bio-composites - especially plant fibre reinforced plastics - are rapidly being seen as credible alternatives to more traditional synthetic composites; due to reductions in environmental footprint and cost [1]. Flax fibre has emerged as a capable contender to glass for the reinforcement of polypropylene (PP) matrices for automotive applications [2]. However, it is arguable that flax/PP bio-composites still require greater volumes of physio-mechanical characterisation, to better understand and develop their potential for structural applications. This work aims to resolve some of those data availability concerns; and identify the optimum fabrication parameters for a flax/PP laminate, to maximise tensile performance whilst improve aesthetic appearance without the need of special handling/treatment. Laminates were produced from a commercially available plain-woven fabric sewn from untwisted/untreated flax/PP tows using a hot press, with three control parameters of temperature, dwell, and applied pressure; Table 1 summarising the combinations employed. The flax/PP fabric and subsequent fabricated laminates were stored in typical environmental conditions; and all tests followed ASTM procedures. Results showed that changes in temperature & dwell time significantly impacted on the mechanical/aesthetic performance, in terms of wettability; colour; surface roughness, and; mechanical behaviour - see the example in Figure 1. In contrast changes in the applied pressure had only a minor effect on the mechanical/aesthetic performance; though employing higher pressures will improve the laminate consolidation and hence performance. The work shows that flax/PP bio-composites for automotive use can have extensively tailored mechanical and aesthetic characteristics when using thermoforming, and mapping acceptability criteria by these parameters is now being explored. As despite tensile and aesthetic properties being primarily chosen to act as simple indications on the degree of flax/PP degradation [3-4], outputs suggest they can be co-employed as useful future design criteria.

# **References**

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2. Baley C. Composites: Part A 33 (7) 939-948, 2002
3. Gourier C. *et al.* Composites Part A 64, 159-166, 2014
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| **Table 1:** Thermoforming parameters used for the Flax/PP laminates. |
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| Dwell (sec) | Pressure (MPa) | Temperature (oC) |
| 20 | 3.7 | 175 |
| 40 | 3.7 | 175 | 185 | 200 |
| 160 | 3.7 | 175 |
| 640 | 4.7 | 3.7 | 2.7 | 175 |
| 1280 | 3.7 | 175 |

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| **Figure 1:** High temperature and dwell time effects on the flax/PP composite. |