



All-Cellulose Composite

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Executive Summary

This research proposes a novel approach to new-generation natural fibre textile and composite development. There is a rising interest in using agricultural waste fibres as more sustainable replacements for virgin fibres. These fibres will only provide the positive impacts they promise if they can function as realistic alternatives to existing materials, and if one set of negative environmental impacts is not exchanged for another. Ananas Anam provided the yarns made from the agricultural waste of pineapple agriculture. UK luxury interior textiles brand salt. created woven base fabrics using Piñayarn made from Anam-PALF and Tencel fibres. Fabrics were enhanced through textile-finishing processes designed by the University of the Arts London team with expertise in circular and sustainable design. University of Leeds applied their patented method to create controlled rigidity in mono-composite, cellulosic-based materials, without modifying the chemistry of the textile. The collaborative academic and industry team convene expertise in woven textile design, UK textiles manufacturing, circular design, material innovation, biomaterials, waste natural fibres for textiles production and sustainable composites.

The aim is to broaden the application of textiles made of waste natural fibres by adding new functionality and a range of design-led finishes for specific end-uses. Potential applications include structured materials for the luxury hospitality sector, automotive, footwear and accessories.

Introduction

Materials made from agricultural waste derived fibres are promised as a viable alternative to virgin fibres but must

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match up in terms of performance, particularly, when applied in high performance technical sectors. Use of harsh chemicals and petroleum-based additives used to achieve commercial performance standards compromise the sustainable credentials of these materials.

This project sought to create a range of design-led all-cellulose composites made from pineapple-leaf fibres without additives that would restrict end of life solutions. Through an R&D process of material development the impact of woven stitch structures and composite process parameters on material flexibility and strength was understood to produce repeatable results with commercial appeal. Woven material and composites underwent physical tests for pilling, tensile strength and elongation using industry applied standards.

A Cradle-to-Gate LCA using 'SimaPro' software provided insight into environmental impact and opportunities for improvement through scaling. Insights from clients in luxury hospitality, automotive, footwear and accessories sectors helped to steer material development to produce materials that performed both in terms of aesthetic and performance.

Methodology

This collaborative project spanned across academic and industry utilising an interdisciplinary methodology. A process of design-driven material R&D and industry liaison was used to create a range of repeatable mono-composite materials. Quantitative testing methods were used to provide insights related to material performance and environmental impacts. This triangulated approach bridging design-driven materials R&D with quantitative testing and industry insight



enhanced the commercial viability of materials produced.

Woven textile development at Ogam Jacquard Weavers followed a design-driven material R&D approach exploring the effect of stitch structure and yarn count. June Swindell of salt, liaised between industry clients and Richard Evans, manager at Ogam, to produce a variety of woven samples with controlled fabric densities. Composite processing of the fabric at University of Leeds followed a similar approach recording processing parameters to create repeatable effects. Physical testing of the materials at Ananas Anam provided data related to fabric strength, elongation and abrasion resistance. Quantitative data fed into the LCA and provided insight into the environmental impacts of material manufacture.

Main findings

Thirty-seven different fabrics exploring various structures including twill, herringbone, double cloth and honeycomb were produced across three warp phases. More than 100 composite samples were created offering a range of flexibilities from lightweight to dense 3D structures. A full dataset testing elongation, pilling and strength revealed varied and controllable effects.

Key insights:

- Material flexibility and appearance can be tailored towards specific application requirements.
- Composite processing significantly improved abrasion resistance enhancing material applicability in technical demanding sectors such as automotive, footwear and accessories.
- Material flexibility is significantly reduced by composite processing.
- The woven material can be dyed and printed responding to the requirements of different commercial applications and the colour remains after composite processing.
- Environmental impact of processing has scope to be reduced.

Conclusions and recommendations

This project has shown that mono-composite processing of woven Piñayarn fabrics can produce controlled repeatable effects to produce materials of varying flexibility and aesthetic that appeal to different markets including technical demanding sectors. The collaborative outcomes of the work build towards the growing interest in use of agricultural waste derived fibres and demonstrate that performance can be enhanced without the use of harsh chemicals or petroleum-based additives that limit end of life solutions.

Further investment to take this work further should:

- Test end of life scenarios after composite processing.
- Explore bio replacement for fire retardance and water repellence.
- Reduce environmental impact hotspots identified by Cradle-to-Gate LCA.
- Light testing and degradation for commercial interior applications.
- Seek client partnerships to take the work towards a commercial application.
- Explore impact of colour further.

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For further information: please visit [All-Cellulose Composite](#).