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Sustainable Bio-Based Composites Reinforced with Natural Fibres for Structural Applications

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Statement: The global demand for sustainable and eco-friendly materials has led to increasing interest in bio-based composites reinforced with natural fibres. These materials offer environmental advantages and suitable mechanical properties, making them ideal for lightweight structural applications in automotive and construction sectors.

Methodology: In this study, a biodegradable polymer matrix, polylactic acid (PLA), was reinforced with varying weight percentages (10%, 20%, 30%) of treated flax fibres. The fibres were treated using an alkaline solution (5% NaOH) to improve fibre-matrix adhesion. The composites were fabricated using hot pressing followed by controlled cooling. Mechanical properties were evaluated through tensile, flexural, and impact testing. Thermal stability was assessed via TGA (Thermogravimetric Analysis), and the morphology of the fracture surfaces was examined using SEM.

Results: The incorporation of flax fibres enhanced the mechanical performance of the PLA matrix. At 30% fibre content, tensile strength improved by 32%, and flexural strength increased by 28% compared to pure PLA. Thermal analysis showed improved thermal degradation temperature by approximately 15°C. SEM imaging revealed strong fibre-matrix bonding, particularly in alkali-treated fibres, confirming effective adhesion.

Conclusion: Natural fibre-reinforced bio-composites show promising potential as sustainable alternatives to conventional synthetic composites. The optimized PLA-flax combination achieved a balance of mechanical performance and environmental friendliness, making it suitable for semi-structural applications. Future work will explore long-term durability and scalability for industrial applications.

Biography

Emily Dawson is a doctoral researcher in the Department of Materials Science at the University of Leeds, United Kingdom. Her research focuses on sustainable composite materials, with a particular emphasis on natural fibres and biodegradable polymers. Emily holds an MSc in Polymer Engineering from the University of Sheffield and has contributed to several international conferences on green materials. Her current research aims to bridge the gap between material sustainability and industrial feasibility in structural applications.

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