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Sustainable Alternatives: Evaluating Recovered Carbon Black as a Filler in Polypropylene Composites

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ABSTRACT

Pyrolysis is an eco-friendly solution for managing end-of-life tyres (EOLTs), but developing large-scale pyrolysis facilities remains limited. A major challenge in EOLT pyrolysis is the low market value of recovered carbon black (rCB), a key byproduct. The production of commercial carbon black (CB) depletes fossil fuels and increases CO_2 emissions. With global demand for CB rising and market prices fluctuating, rCB emerges as a cost-effective and viable alternative. Using rCB instead of CB reduces fossil fuel depletion and mitigates greenhouse gas emissions, supporting the circular economy and aligning with global decarbonisation efforts. Furthermore, using rCB addresses the environmental risks associated with EOLT landfilling, such as fire hazards and health concerns, while valorising the rCB market.

Polypropylene (PP) is one of the most used polymers in aerospace, automotive, packaging, construction, etc, due to its low cost, recyclability, and ease of processing. However, its UV light and temperature sensitivity affect its mechanical performance over time. Fillers, such as rCB, are added to enhance the performance and longevity of PP products by mitigating these sensitivities. This study focuses on using rCB as a filler to improve the mechanical properties of PP composites. By varying rCB loading from 0-5 wt%, the research aims to demonstrate its potential as a reinforcement material, improving PP's durability and strength. Advanced techniques were used to assess the physicochemical properties of rCB, including surface morphology, functional groups, ash content, and compositional and degradation properties.

The findings demonstrate that rCB exhibits properties comparable to conventional fillers, reinforcing its potential as a sustainable reinforcement in PP composites for industrial applications. These results will pave the way for rCB to have positive economic value and promote the use of sustainable fillers in the polymer industry.

KEYWORDS

Pyrolysis, End-of-life tyres, Recovered carbon black, Polypropylene composites, Polymers, Sustainable fillers.

BIOGRAPHY

Dharanija Banala is a PhD candidate in Chemical Engineering at RMIT University, Melbourne. She specialises in developing sustainable polymer composites using recovered carbon black derived from end-of-life tyre pyrolysis. Dharanija has wide-ranging experience in journal management and process manufacturing. Her research interests include waste management, sustainable materials, circular economy applications, advanced material recovery, and industrial-scale optimisation.

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