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Evaluation of the UV-Stabilising Efficiency of Pyrolytic Recovered Carbon Black in Polypropylene Composites

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ABSTRACT

Pyrolysis is one of the sustainable pathways for managing end-of-life tyres (EOLTs), producing recovered carbon black (rCB) as a solid by-product. The rCB can be a promising alternative to fossil-fuel-derived commercial carbon black. However, the large-scale use of rCB is limited by variable quality and insufficient understanding of its structure–property relationships in non-rubber applications.

This study investigates the direct use of untreated rCB as a functional filler in polypropylene (PP) composites for outdoor applications. To better understand its suitability, the rCB was first thoroughly characterised for morphology, elemental composition, and surface properties. Thereon, PP–rCB composites of 1, 3, and 5 wt% rCB were prepared via melt compounding followed by compression moulding. To assess long-term durability under environmental conditions, the moulded composites were subjected to accelerated UV weathering. The mechanical properties of unexposed and weathered samples were systematically examined.

After 480h of UV exposure, the tensile strength of neat PP decreased by nearly 60%, and the sample became noticeably brittle. In contrast, the rCB-filled PP composites' reductions are limited to approximately 3–25% with prolonged UV exposure for composites containing 1–5 wt% rCB. In addition to tensile strength, the changes in Young's modulus and elongation at break were also evaluated. Neat PP showed a noticeable reduction in ductility and stiffness after UV exposure, whereas the PP–rCB composites exhibited comparatively smaller variations in these properties. These results suggest that the rCB particles effectively absorb incident UV radiation, thereby retarding oxidative processes and surface degradation in the PP matrix relative to neat PP. Importantly, this improvement was achieved without any surface modification or pre-treatment of rCB, making the approach both economically and environmentally beneficial.

KEY WORDS

Recovered carbon black, Polypropylene, Pyrolysis, End-of-life tyres, Accelerated UV weathering, Tensile properties.

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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