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A Comprehensive Review of Natural Rubber Composites: Properties, Compounding Aspects, and Renewable Practices with Natural Fibre Reinforcement

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Abstract
This review provides a comprehensive overview of natural rubber (NR) composites, focusing on their properties, compounding aspects, and renewable practices involving natural fibre reinforcement. The properties of NR are influenced by the compounding process, which incorporates ingredients such as elastomers, vulcanizing agents, accelerators, activators, and fillers like carbon black and silica. While effective in enhancing properties, these fillers lack biodegradability, prompting the exploration of sustainable alternatives. The potential of natural fibres as renewable reinforcements in NR composites is thoroughly covered in this review, highlighting both their advantages, such as improved sustainability, and the challenges they present, such as compatibility with the rubber matrix. Surface treatment methods, including alkali and silane treatments, are also discussed as solutions to improve fibre-matrix adhesion and mitigate these challenges. Additionally, the review highlights the potential of oil palm empty fruit bunch (EFB) fibres as a natural fibre reinforcement. The abundance of EFB fibres and their alignment with sustainable practices make them promising substitutes for conventional fillers, contributing to valuable knowledge and supporting the broader move towards renewable reinforcement to improve sustainability without compromising the key properties of rubber composites. © 2025 The Authors.

Author Keywords
acoustics; carbon black; fillers; natural fibres; Natural rubber composites; reinforcement; renewable; silica; sound absorption; surface treatment; vulcanization

Index Keywords
Compounding (chemical), Vulcanization; Composite properties, Compounding process, Empty fruit bunches, Fiber reinforcement (e), Natural rubber composites, Property, Renewables, Sound absorption, Vulcanisation, Vulcanizing agents; Rubber

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