Journal of Polymers and the Environment
https://doi.org/10.1007/s10924-024-03359-6

ORIGINAL PAPER

Enhancing the Bio-epoxy Composites with Oil Palm Fibre as Reinforcement: Assessment of Mechanical, Physical and Thermal Properties

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Accepted: 7 July 2024

Abstract

In this work, short oil palm fibre-reinforced bio-epoxy matrix composites were fabricated using the hand-lay-up technique. The effects of oil palm fibre composites on mechanical, physical, and thermal behaviours were examined. This work aimed to identify the optimal fibre loading that enables the oil palm/bio-epoxy composite to have superior thermal and mechanical properties. Fibre loading varied from 30 to 60 wt%. A maximum Young's modulus of 5.76 GPa was obtained at 60 wt% while a maximum flexural modulus of 5.2 GPa and impact strength of 5.55 kJ/m^2 was obtained at 50 wt%. However, tensile and flexural strength were not much improved. Regarding the moisture absorption and thickness swelling, the composites followed a similar order: bio-epoxy matrix < 30 wt% < 40 wt% <50 wt% < 60 wt%. The fickian diffusion model was used to describe the thickness swelling behaviour. The major inference from the thermal characterization was that as the fibre loading was increased, there was a substantial improvement in thermal stability evident from the lower damping factor (0.21 at 60 wt.%), better dimensional stability and higher residue % (22.22% at 50 wt%) at elevated temperatures. Besides, scanning electron microscopy (SEM) was examined for tested samples to understand the fibre-to-matrix bonding phenomenon. Based on these results, the short oil palm fibre composites can be suggested for some potential applications such as automotive components (e.g., door trims, interior panels), aerospace (e.g., tray tables, overhead bins) and construction materials (e.g., cladding, roofing).

Keywords Oil palm · Biocomposite · Thermal properties · Mechanical properties · Fibre loading

Introduction

There has been a growing interest in developing sustainable and environmentally friendly composite materials as alternatives to synthetic fibre composites in recent years. In particular, natural fibre-reinforced composites have emerged as promising candidates, utilizing renewable and biodegradable natural fibres as reinforcement within a polymer matrix [1]. According to the market data, in 2021, the market size of natural fibres was valued at USD 7.46 Billion and is projected to reach USD 20.38 Billion by 2030, exhibiting a remarkable Compound Annual Growth Rate (CAGR) of 15.45% from 2023 to 2030 [2]. These composites find significant applications in reducing carbon footprints and also help to improve the sustainability of various products. For example, researchers used jute fibres and basalt fibre-reinforced epoxy composites in automotive applications to reduce the overall weight of vehicles while maintaining

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Published online: 18 July 2024