Defect and Diffusion Forum
ISSN: 1662-9507, Vol. 432, pp 63-68
doi:10.4028/p-Jrgi9s

Submitted: 2023-11-27
Accepted: 2023-12-22
Online: 2024-03-25

Mechanical Properties of Luffa Fiber Reinforced Recycled Polymer Composite

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Keywords: Recycled polymer, Luffa, polymer composite, mechanical, impact test, natural fiber.

Abstract. Environmental issues over the eventual fate of post-consumer polymers can be dealt with in two separate ways which is recycling or using biodegradable polymers. However, it is evident that recycling polymers from post-consumer polymers can decrease the mechanical properties over time. Hence, to strengthen the recycled polymers, integrating fibers, such as luffa, into the High-Density Polyethylene (HDPE) matrix, was carried out to produce a fiber reinforced recycled polymer (FRrP) composite. The tensile testing of the FRrP composite shows that the 10% fiber volume fraction (FVF) composite exhibits a higher tensile strength of 3.9% than the neat recycled HDPE (RHDPE). In terms of Young's Modulus, the 5% FVF of FRrP is shown to have a higher value than the neat RHDPE by 54%. The low density of luffa fibers also contributes to the composites lightweight character. The impact testing shows that the FRrP enhances the impact properties when compared to the neat RHDPE. The peak load, perforation energy, and the total energy absorbed by the FRrP indicate an increasing trend when luffa, of up to 15% FVF, is added as the reinforcement. Thus, the addition of luffa as reinforcement in RHDPE shows significant potential as a high-performance, sustainable, and environmentally friendly material, such as automotive parts and protective gear.

Introduction

With the rise of polymer production, ensuring a sustainable supply of raw materials has become more critical than ever. To address the environmental impact of post-consumer polymers, two measures can be taken which are recycling and the use of biodegradable polymers. Recycling of polymers refers to activities that aim to recover materials and energy from post-consumer polymers. This process can involve mechanical recycling, energy recovery, or chemical recycling, among other methods. Polymers, also known as plastics, is defined as large molecules made by bonding (chemical linking) a series of blocks [1]. A molecule called polymer has long winded repeating monomer units [2]. Nowadays, High-Density Polyethylene (HDPE), which is one of the primary types of polymers, is currently the most widely utilized polymer in commercial and industrial products. HDPE is a highly versatile plastic material that finds application in various products like detergent bottles, plastic bottles, pipes, and cutting boards. It has impacted daily life as their use is rising, and their annual production is predicted to surpass 300 million tons. Yet, excessive, and unsupervised plastics consumption and manufacturing leads to wastage that may result in losses for certain businesses and environmental pollution. The major downside of plastics is the process of decaying them. Practical solutions must be sought for the issues brought on by expanding the use of plastics as it is difficult to stop plastic use. Hence, techniques for recycling and methodologies to assess these recyclable plastics must be developed. In order to minimize the effect of pollution on the environment, efforts were made to recycle the post-consumer plastic. It is well known that recycled materials have varied mechanical properties from their original materials. The objective of this study is to investigate the tensile and impact properties of the fabricated luffa fiber reinforced RHDPE composite and to evaluate the suitability of luffa plant as reinforcing material based on its tensile and impact properties.

Luffa acutangula / Luffa cylindrica. Luffa, one of the *Cucurbitaceae* species [3], is very popular amongst researchers, as its fibrous network can be easily obtained and is very affordable. Potential for