Materials Science Forum
ISSN: 1662-9752, Vol. 1111, pp 77-82
doi:10.4028/p-tw3uJj

Submitted: 2023-07-11
Accepted: 2023-08-04
Online: 2023-12-22

Tensile Properties Characterisation of Hybrid Luffa/GCW Fiber Reinforced Polymer Composite

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Keywords: Hybrid fiber composite, natural fiber composite, polymer composite, tensile, sustainable.

Abstract. Extensive research has been conducted on fiber reinforced polymer (FRP) composites, which have demonstrated superior mechanical properties compared to their individual components. In order to add on to current research trends, the use of ground coffee waste (GCW) and Luffa fibers reinforced polyethylene (PE) composites were fabricated to produce a hybrid natural FRP composite. Tensile testing of the composite indicates that the optimum fiber volume to be between 15% and 35%, as the tensile strength exhibited 9.32 MPa and 8.75 MPa, respectively. Similarly, the tensile modulus of the fabricated composite peaked at 25% with 238 MPa, then declined to 173 MPa at 35%. This indicates that the fibers effectively reinforce the polymer matrix, but once the composite reaches its optimal fiber volume, a decrease in both tensile strength and tensile modulus is observed. The reduction in tensile properties can be attributed to an uneven distribution of load-bearing capacity throughout the composite, as the fibers are no longer able to fully support the matrix once the optimal fiber volume is reached. The specific tensile strength and specific tensile modulus also shows that with the inclusion of Luffa fiber and GCW microfiber contributed to a lighter weight composite. In a nutshell, the hybrid composite fabricated using 25% fiber volume exhibited a tensile strength almost similar to its neat matrix counterpart, though has a noteworthy value in terms of its tensile modulus. The hybrid composite can be as strong in terms of tensile strength, but far more significant in its rigidity, in comparison to the neat polyethylene laminate. Therefore, it showed that the hybrid natural Luffa/GCW FRP has the potential in the engineering industry, such as lightweight furniture, household appliances, automotive parts, and other composite engineering applications.

Introduction

In the past two decades, much research has been done in regards with fiber reinforced polymer (FRP) composites. This comes to no shock as some FRP composites deliberately enhances material strength, stiffness, density, and economical value in the fields of construction, mechanical, automobile, aerospace, biomedical, and marine [1], where a conventional single pure polymer would not [2]. In fact, composite materials are highly sought after due to the versatility of their properties which enables them to be applied into various fields. Composite materials have superior properties than those of the individual components when used alone depending on the type of materials being combined [3]. Some composites may also have better resistance towards corrosion and chemicals. However, the requirement of improving these properties must be linearly improved against sustainability of sources [1]. The concept behind composite materials is the combination of two or more materials in creating a new engineered material [4]. It is a multiphase material that is artificially made, as opposed to one that occurs or forms naturally [5]. In general, composite materials are composed of two phases: matrix and reinforcement. This means in regards of FRP composites, it consists of natural or synthetic fibers acting as load-carrying reinforcements, providing strength and rigidity, embedded in polymer matrices that maintains the fibers position and orientation while protecting them against any possible damage [2]. These various individual materials in the composite work together to give the composite unique properties such as being lightweight while rigid [3].