Accepted Manuscript

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PII: S1359-835X(18)30260-4
DOI: https://doi.org/10.1016/j.compositesa.2018.06.032
Reference: JCOMA 5093

To appear in: *Composites: Part A*

Received Date: 24 March 2018
Revised Date: 6 June 2018
Accepted Date: 28 June 2018

Please cite this article as: Lawrence Sy, B., Fawaz, Z., Bougherara, H., Damage EVOLUTION in UNIDIRECTIONAL AND CROSS-PLY flax/epoxy laminates SUBJECTED TO LOW VELOCITY IMPACT LOADING, *Composites: Part A* (2018), doi: https://doi.org/10.1016/j.compositesa.2018.06.032

DAMAGE EVOLUTION IN UNIDIRECTIONAL AND CROSS-PLY FLAX/EPOXY LAMINATES SUBJECTED TO LOW VELOCITY IMPACT LOADING

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Keywords: *A. Biocomposite; A. Natural Fibers; B. Impact Behaviour; D. Optical Microscopy*

ABSTRACT

With the resurgence of natural fibers as a viable alternative to synthetic fibers, there is a need to study their mechanical behaviour under different modes of loading. In this research, flax/epoxy composite laminates were manufactured and tested under low velocity impact loading to study the damage development on the laminates and assess their capability for low velocity impact applications. The laminates were tested using a pendulum-type impact apparatus. Two composite laminate configurations were tested: a symmetric unidirectional flax/epoxy laminate with stacking sequence $[0]_{8S}$ and a symmetric cross-ply flax/epoxy laminate with stacking sequence $[0/90]_{4S}$. The unidirectional laminate exhibited poor and brittle behaviour under impact loading, with an energy penetration threshold of 10J and an impact toughness of 34 kJ/m^2. On the other hand, the cross-ply laminate showed better impact performance, with its energy penetration threshold and impact toughness being three and 2.5 times higher than that of the unidirectional laminate, respectively.

1 INTRODUCTION

In the last few decades, fiber-reinforced composites have been widely used in the automotive, aerospace, military, civil and sports industries for many applications [1]. Traditional synthetic fibers such as carbon and glass have allowed these industries to produce strong, light-weight and high-performing composite structures; however, one of the problems with using such materials is their impact on the environment especially with regards to recyclability, biodegradability and green-house gas emission [1]. In recent years, government and environmental groups have put a strong emphasis on sustainability and recyclability, which have challenged these industries to find alternative ecofriendly materials to produce compatible composites [2, 3, 4]. This had led to the emergence of natural fibers as alternative to traditional synthetic fiber reinforcement materials [4].

The use of lignocellulosic natural fibers as reinforcement in a composite structure is not new. In fact, history has shown that they have been used by multiple civilizations to enhance the stiffness and strength of a material or structure. Nowadays, natural fibers have attracted the interest of both scientists and manufacturers because they offer sustainability, biodegradability, abundance, cost savings and lower specific gravity when compared to synthetic fibers like glass [2, 5]. Although their strengths are relatively lower than traditional synthetic fibers, they have comparable specific strength and stiffness [6], and acceptable mechanical properties such as elongation, flexural strength, impact resistance, non-abrasiveness and acoustic absorption [5].