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ScienceDirect

Procedia Manufacturing 22 (2018) 180–185

Procedia MANUFACTURING

www.elsevier.com/locate/procedia

11th International Conference Interdisciplinarity in Engineering, INTER-ENG 2017, 5-6 October 2017, Tirgu-Mures, Romania

Experimental analysis of biocomposite Raphia fiber/Chitosan influence of weaving process on mechanical properties

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Abstract

Recently, the natural fibers have been used to reinforce materials due to its recyclability, biodegradability and environmentally friendly. They have been employed in combination with polymers. This paper presents the mechanical properties of Raphia fibers reinforced by chitosan polymer with different weaving process. The tensile properties of the unidirectional biocomposite have been compared with "Tafta" configuration. The samples "Tafta" weaving provides better tensile strength (125.34 MPa) and ensures better bonding with the matrix. The morphology of the biocomposite has a homogeneous appearance for all the samples which confirms the previous results.

Peer-review under responsibility of the scientific committee of the 11th International Conference Interdisciplinarity in Engineering.

Keywords: Biocomposite; Weaving process; Raphia Fiber; Chitosan; Morphology; Mechanical properties.

1. Introduction

In terms of sustainable development of countries, industrials are oriented towards the use of more efficient packaging. A packaging based on natural materials has several economic and environmental advantages. The development of commercially "green products" based on natural resources for both matrix and reinforcements for a

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2351-9789
Peer-review under responsibility of the scientific committee of the 11th International Conference Interdisciplinarity in Engineering.
10.1016/j.promfg.2018.03.028

wide range of applications is on the rise. This orientation includes new ways to produce biocomposite with better mechanical properties and thermal stability using nanotechnology [1].

Packaging based on natural polymers can also be used in conjunction with natural fibers for the products of biological origin. They do not cause allergic sensation and irritation of human skin.The use of natural fibers in composites is increasing over the years. The biocomposite based on natural fibers[2, 3]are attracting attention because of their low cost, low density, biodegradability, availability, high specific module and their ability to be recycled. These advantages are interest for applications in various fields [4].

Raphia fibers are traditionally used to make clothes, carpets and art objects [5]. Today, like other plant fibers, it could potentially be used as reinforcement in polymer matrix composites [6, 7].Most studies carried out on composites are based on synthetic matrix such as polyethylene and PLA. In our study, we are interested in using chitosan as a biocomposite matrix with fiber reinforcement. However, chitosan is one of the biological polymers which offer remarkable advantages due to its non-toxicity, biodegradability and antibacterial appearance [8].

The objective of this work is to develop a biocomposite based on Raphia fiber / chitosan with different weaving process to characterize the morphological aspect and the mechanical properties.

2. Materials and methods

2.1. *Extraction of chitosan polymer*

The chitosan polymer (CS) with a degree of deacetylation ~ 80% was prepared in laboratory. Chitosan was obtained by crustaceans shells powder, following a demineralization using hydrochloric acid 2 mol/l, ratio 1:20 (w/v) for 24 h at 25 ^{o}C. After, the powder was treated to eliminate the protein with sodium hydroxide solution 2mol/l.Removal of acetyl groups by the chitin was achieved by high concentrated sodium hydroxide and temperature at 100 ^{o}C. The resulting chitosan CS was washed to neutrality with distilled water and dissolved in 1% (w / v) of acetic acid solution [9].

2.2. *Development of biocomposite*

The method of preparing the biocomposite consists to reinforce the chitosan matrix by Raphia fibers according to two weaving process:

- Unidirectional: all Raphia fibers were placed in vertical direction.
- “Tafta”: the Raphia fibers were placed side-by side in the x–y plane and alternately wound around them. The weaving structures were obtained by repeating the weaving sequence.

The chitosan solution measured by syringe was deposited on the weaving structures obtained. The elaborated samples are then dried at room temperature for 24 hours (Fig. 1).

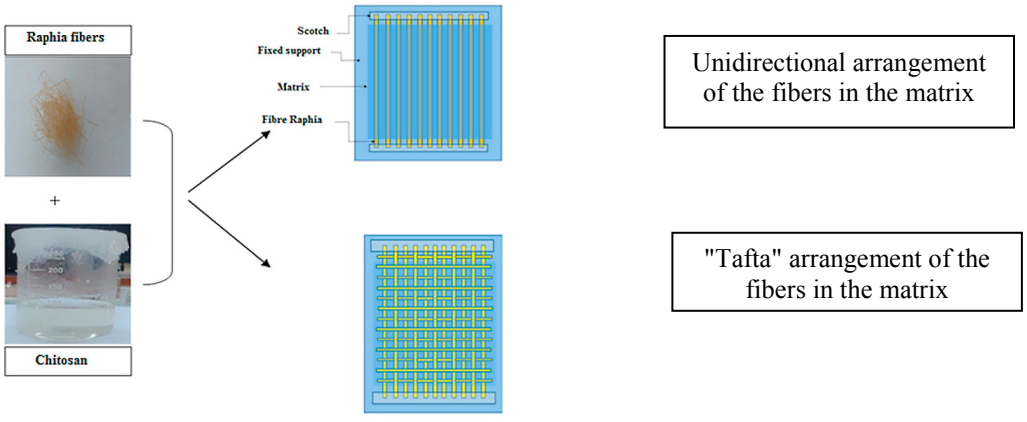

Fig.1. Method of developing weaving process of the biocompositeRaphia fiber / chitosan.