Materials Research Express

PAPER

Mechanical properties of the Jute fibers-activated carbon filled reinforced polyester composites

RECEIVED
27 August 2019

REVISED
20 October 2019

ACCEPTED FOR PUBLICATION
7 November 2019

PUBLISHED
15 November 2019

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Keywords: mechanical properties, activated carbon particles, jute fiber, hybrid composite

Abstract

Effects of adding activated carbon particles (AC) on the mechanical properties of the bulk polyester and jute fibers/polyester composites were investigated. Four loading ratios of AC particles (1, 3, 5, and 10 wt%) were used to fill the polyester matrix. Jute fibers were treated in NaOH solution to improve their adhesion with the polyester matrix. Tensile, flexural and impact tests were conducted to specimens prepared from bulk polyester, AC-filled polyester, and jute fibers/polyester with and without AC filler. The results showed that tensile strength, flexural strength, and strain-to-failure of the polyester and jute/polyester specimens decreased as the AC particles loading was increased. However, tensile and flexural moduli increased with increasing the AC filler loading up to 3 wt% and then started to decrease after reaching their maximum values. The impact strength of the bulk polyester decreased as the AC loading was increased. However, incorporation of 3 wt% of AC into the jute/polyester composite increased its impact strength from ~4.3 to ~6.4 kJ m^{-2}. The key conclusion suggests that adding of AC particle into jute fibers/polyester composites can improve their stiffness; meanwhile, their strength and ductility have been sacrificed.

Introduction

In the last few decades composite materials were widely used in many structural applications for their good physical and mechanical properties. Synthetic fibers were commonly used as reinforcements within the composites, but due to their relatively higher cost and the environment concerns the searchers are now looking for the eco-friendly materials with good mechanical properties to weight ratio [1]. Natural materials, in forms of fibers or particles, extracted from plant-based are recently attracted many researchers to be used as alternatives for their low cost, abundance, sustainability and biodegradability [2]. Natural fibers could partially replace the synthetic reinforcement materials in composites for applications that require further weight reduction with very low cost. Several types of plant fibers are available such as jute, sisal, kenaf, flax, coir, and hemp [3]. Recently, using of natural materials has been increased rapidly in manufacturing of composite materials [4]. According to industry research, about U$2.1 billion was invested worldwide to produce natural fiber reinforced composites [5]. Recent studies showed that some applications of using natural fibers reinforced composites could be potentially applied in several fields such as biomedical applications [6], automotive industry [7, 8], and military applications [9]. Jute composites were investigated extensively by many researchers in the last two decades. Jute fibers have been found in several applications such as door frames and shutters, roofing sheets, chip boards, furniture and floor tiles [5, 10]. Gowda *et al* [11] found that even though jute/polyester composites did not have strength and modulus as high as those of other synthetic fiber reinforced composites, they could have better strength than wood composites and some neat plastics. Therefore, these composites could be considered for future applications such as shelves, tabletops, wash basins, drainage pipes, automobile components as well as larger items such as lightweight fishing boats.

Using of jute fibers alone within the composite are not sufficient for competing the synthetic fiber reinforced composites regarding their mechanical properties. Therefore, researchers have tried enhancing the mechanical