Effect of Silicon Dioxide/Nanoclay on the Properties of Jute Fiber/Polyethylene Biocomposites

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In this study, (jute fiber)/polyethylene biocomposites were prepared by using a hot press machine. Jute fiber was investigated as a reinforcing filler material for producing structural composites with better environmental performance. The effects of clay and silica addition on the physical, mechanical, and thermal properties of (jute fiber)-reinforced polyethylene biocomposites with different fiber loadings (5, 10, 15, and 20 wt%) were investigated. The biocomposites were characterized by Fourier-transform infrared spectroscopy, scanning electron microscopy, and thermogravimetric analysis. The composite surface area and pore volume were determined by using the Brunauer-Emmett-Teller equation. The mechanical properties were investigated by using a Universal Testing Machine. Because of Si-O-Si stretching vibration, the O-H group from 3,200 to 3,400 cm^{-1} disappeared. The scanning electron microscopy results proved that a significant difference among the composites was present due to the interfacial bonding between the fiber and the matrix. J. VINYL ADDIT. TECHNOL., 23:E107–E112, 2017. © 2015 Society of Plastics Engineers

INTRODUCTION

In recent years, increasing environmental awareness has focused attention on the use of natural fibers as reinforcements in polymer matrixes because of the associated environmental advantages [1]. Natural fibers, like wood, kenaf, banana, cotton, coir, sisal, and jute, have attracted the attention of scientists because of their potential in the production of consumer goods [2]. Among all types of natural fiber, jute appears promising because it is inexpensive and commercially available in the required form. It has higher strength and modulus than plastics [3], due to its unique properties; thus, it could be substituted as reinforcing filler instead of other types of fiber.

Jute is a natural, biodegradable fiber. The largest producers of jute are India, China, and Bangladesh. Because of increasing environmental awareness, the development of biodegradable materials from renewable sources is becoming more common [4]. The availability of large quantities of fiber with well-defined mechanical properties is a general requirement for their successful use. Jute fibers are durable, low-cost, and lightweight [5]. Jute is a commercially available type of bast fiber conventionally used in sacking, bags, jute hessian cloth/burlap, jute gunny sacks, jute gunny bags, jute yarn, woven bags, packaging materials, and carpet backing [6]. The jute sector is improving the quality of fiber for its use in different areas, such as floor coverings, household textiles, technical textiles, and others [7]. The main drawback associated with using jute fibers is their hydrophilic nature, which generally complicates adhesion with hydrophobic polymer matrices [8]. Among the many types of thermoplastics, polyethylene (PE) is the most suitable matrix because of its low density, high softening point, good flexibility, good surface hardness, scratch resistance, and excellent electrical properties [9].

Reinforcing polymers with nanoclays has been shown to improve their thermal and mechanical properties [10]. The reinforcement of bio-based polymers with nanoclays has been shown to eliminate the decreases in the stiffness, thermal, and barrier properties as a result of the addition of bio-resins and can improve the rigidity–hardness balance [11]. Nanoclays are of interest from an industrial point of view because their use in small quantities (1 to 5 wt%) is enough to improve the overall properties of a composite material at a relatively low cost [12, 13]. The most successful commercial polymer–clay biocomposites are used in the automobile industry (for weight reduction) and in the food packaging industry (as a gas barrier) [14].

The positive effect of silica nanoparticles on the fracture durability of epoxies has been widely studied [15].

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