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Research Article

Physical, Mechanical, and Thermal Analysis of Polylactic Acid/Fumed Silica/Clay (1.28E) Nanocomposites

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Polylactic acid/fumed silica/clay (PLA/FS/clay) (1.28E) nanocomposites have been successfully prepared by solution-intercalation film-casting technique. The resultant nanocomposites were characterized by Fourier Transform Infrared Spectroscopy (FT-IR), Scanning Electron Microscopy (SEM), tensile test, thermogravimetric analysis (TGA), and moisture absorption test. The FT-IR spectrum indicated that PLA/FS/clay with 2 wt% had much broader peak compared to 5 wt%, 10 wt%, and 15 wt% nanocomposites. Incorporation of clay (1.28E) with 2 wt% showed the best compatibility with PLA/FS matrix. PLA/FS/clay (1.28E) nanocomposite with 2 wt% of clay loading had higher tensile strength and modulus compared to other nanocomposites. The thermal stability and activation energy of 2 wt% of PLA/FS/clay (1.28E) nanocomposite are the highest among all the nanocomposites. The moisture absorbed into PLA/FS/clay (1.28E) nanocomposite was significantly reduced with clay loading of 2 wt%.

1. Introduction

In recent years, biodegradable polymers have gained great attention from both academic and industrial researchers as they are one of the renewable materials with excellent characteristics such as biodegradability, biocompatibility, low toxicity, and low cost [1, 2]. Besides, the green environment implemented worldwide encourages the usage of biodegradable polymers. Polylactic acid (PLA) is linear aliphatic thermoplastic polyester that can be synthesized from lactic acid monomer or by ring-opening polymerization of lactide monomers [3]. It is one of the biodegradable polymers with reasonably good mechanical properties that can be widely applied in agriculture, medical devices, packaging, and textiles [4].

Despite numerous advantages, pure PLA is unable to perform better due to its low draw ability [5] and insufficient toughness [6]. In order to improve the PLA properties, organic or inorganic fillers should be incorporated into polymer matrix which significantly enhances the mechanical properties. Fillers that are commonly introduced into polymer nanocomposites are fumed silica (FS) and nanoclay (clay). FS is filler that functioned as nucleation agent to improve the mechanical properties as well as the surface morphology [7]. It is a good alternative to incorporate FS as second filler because FS has large, uniform, and nonporous surface [8]. This will enhance strong interfacial bonding between FS nanoparticles and PLA matrix that leads to better polymer-particle interaction [9]. On the other hand, clay is introduced to enhance the reinforcement between the polymer matrix and fillers [10]. Besides, it also performs as a compatibilizer that aids to improve the bonding adhesion with the polymer matrix [11].

The effect of introducing FS into PLA matrix has been investigated. The addition of silica nanoparticles into PLA matrix can greatly improve the tensile strength and modulus value of the PLA-based composites [4]. In addition, the presence of FS in the polymer matrix does not only