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Physico-mechanical, thermal and morphological properties of furfuryl alcohol/2-ethylhexyl methacrylate/halloysite nanoclay wood polymer nanocomposites (WPNCs)

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Abstract

In this study, the physical, morphological, mechanical and thermal properties of furfuryl alcohol/2-ethylhexyl methacrylate/halloysite nanoclay wood polymer nanocomposites (FA-co-EHMA-HNC WPNCs) were investigated. FA-co-EHMA-HNC WPNCs were prepared *via* an impregnation method and the properties of the nanocomposites were characterized through the weight percent gain, Fourier transform infrared (FT-IR) spectroscopy, scanning electron microscopy (SEM), three-point flexural test, dynamic mechanical thermal analysis (DMTA), thermogravimetric analysis (TGA), differential scanning calorimetry (DSC) analysis and moisture absorption test. The weight percent gain in the 50:50

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FA-co-EHMA-HNC WPNC was the highest compared with the raw wood (RW) and other WPNCs. The FT-IR results confirmed that polymerization took place in the nanocomposites, especially 50:50 FA-co-EHMA-HNC WPNC, which had a reduced amount of hydroxyl groups. The SEM results revealed that the 50:50 FA-co-EHMA-HNC WPNC had the smoothest and most uniform surface among all of the nanocomposites. The 50:50 FA-co-EHMA-HNC WPNC showed the highest flexural strength and modulus of elasticity. The results revealed that the storage modulus and loss modulus of the FA-co-EHMA-HNC WPNCs were higher and the tan δ of FA-co-EHMA-HNC WNPCs was lower compared with the RW. The FA-co-EHMA-HNC WPNCs exhibited the higher thermal stability in the TGA and DSC analysis. The 50:50 FA-co-EHMA-HNC WPNC exhibited remarkably lower moisture absorption compared with the RW. Overall, this study proved that the ratio 50:50 FA-co-EHMA ratio was the most suitable for introduction in the in the RW.

Keywords: Nanotechnology, Materials science

1. Introduction

The rapid growth in the demand of resources increases to the importance of their sustainable and efficient resource utilization is proportionally growing (Brown et al., 2011). The constituents of wood include lignin with hemicelluloses, which act as a soft polymer matrix and lignocellulosic fibers, which act as rigid cellulosic microfibrils for reinforcement (Rong et al., 2001). Wood fiber is the most broadly used reinforcement in composite materials. However, wood is a hygroscopic material that adsorbs the surrounding moisture (Ramage et al., 2017). Besides, wood is an organic material that can be easily deteriorated by the fungi attack. Due to the sustainable applications of wood materials, it is important to improve the wood properties through polymer impregnation. Therefore, the introduction of a polymer matrix into wood cells to fabricate wood polymer nanocomposites (WPNCs) which has been widely used for many applications.

Wood polymer nanocomposites (WPNCs) are thermoplastic polymers that have attracted both researchers and industrialists because of their environmental friendliness (Markarian, 2005). WPNCs product show good durability in wet environments due to the hydrophobic polymer matrix, which allows for wood to be substituted with WPNCs in outdoor applications (Cheung et al., 2009). These products can be manufactured easily and rapidly using forming techniques that are typical of thermoplastic polymers (Zini and Scandola, 2011). The growing usage of renewable resources helps to counter various environmental problems caused by climate change and biodiversity threats (Lenzen et al., 2012).

Furfuryl alcohol (FA) is a monomer that improves the mechanical and thermal properties of the nanocomposites compared to pure FA (Ahmad et al., 2013).

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