Physical, Mechanical, Thermal and Morphology Properties of Biodegradable Polymer Nanocomposites and Its Comparison

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Abstract. Polyvinyl alcohol (PVA) and Polylactic acid (PLA) were fabricated with the addition of nanofiller such as nanoclay and fumed silica through suitable technique namely solution intercalation film casting. These nanocomposites undergo Fourier transform infrared spectroscopy, scanning electron microscopy, tensile test and thermogravimetric analysis. FT-IR results showed that both nanocomposites were well intercalated with fumed silica and clay with the reduction of hydroxyl groups. From SEM results, it proved that clay 1.28E is more suitable to be intercalated with PLA matrix while clay 1.30E is more suitable to be introduced into PVA matrix. The addition of both nanofillers improved the tensile properties of the nanocomposites. TGA results showed that polyvinyl alcohol/fumed silica/clay (PVA/fsi/clay) had better thermal stability compared to polylactic acid/fumed silica/clay (PLA/fsi/clay) nanocomposites. Both nanocomposites are applicable in the biomedical field.

1 Introduction

The great improvement of the thermal and mechanical properties on the polymer nanocomposites leads them to be widely applied in many fields such as paper coating, articular cartilage, thickener materials in paints, detergent and adhesives due to its with excellent biocompatibility and attractive properties [1-2].

Biodegradable polymers such as polyvinyl alcohol (PVA) and polylactic acid (PLA) were greatly applied to form nanocomposites. PVA is prepared using the polymerization of vinyl acetate followed by alcoholysis while PLA is linear aliphatic polyester [3]. However, pure PVA and PLA had poor physical and mechanical properties [4]. Therefore, both polymer matrices should be deeply improved by introducing various types of filler.

Nowadays, nanofiller such as fumed silica and nanoclay were introduced into polymer matrix to enhance the properties of the nanocomposites. Fumed silica particles usually exist in a form of fine powder or colloid suspension. It was embedded in a polymer matrix for its large surface area and smooth nonporous surface [5]. For nanoclay, it is defined as a class of materials made up of layered silicates. Montmorillonite (MMT) was one of the common nanoclay that was introduced into polymer matrix to improve the physical and mechanical properties of nanocomposites [6].

The Na ion-exchanged clay was easily dispersed into PVA matrix which significantly enhanced the thermal and mechanical properties [7]. Besides, the solvent casted PVA/clay nanocomposites showed better surface morphology and stronger polymer-clay bonding that reduced water absorption [8]. Addition of fumed silica into PVA matrix improved the thermal degradation of the PVA/fumed silica nanocomposites [9]. Besides, incorporation of clay into PLA matrix enhanced the thermal stability of the nanocomposites by increasing the glass transition temperature consistently [10]. Sol-gel PLA/fumed silica nanocomposites were fabricated which improved the tensile properties as well as the thermal degradation with the introduction of fumed silica [11]. In addition, the fumed silica was incorporated into PLA matrix to improve the tensile strength and thermal stability of the nanocomposites [12].

In this present work, solution-intercalation and solution-intercalation film-casting technique were used to produce PVA/fsi/clay and PLA/fsi/clay nanocomposites respectively using different two types of clays (1.28E and 1.30E). Physical, mechanical, thermal and morphological properties of nanocomposites were investigated. The compatibility of the clays towards the polymer matrices was also investigated.

2 Methodology

2.1 Materials

The silica powders used in this study was obtained in a mesh size of 8 microns which is white to off-white in colour. The chemicals used polyvinyl alcohol (PVA), polylactic acid (PLA), Nanoclay, Nanomer 1.28E and

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