Polymer Degradation and Stability 175 (2020) 109131

Contents lists available at ScienceDirect

Polymer Degradation and Stability

journal homepage: www.elsevier.com/locate/polydegstab

Effects of various surface treatments on Aloe Vera fibers used as reinforcement in poly(3-hydroxybutyrate-co-3-hydroxyhexanoate) (PHBHHx) biocomposites

Nadjet Dehouche [a], Celia Idres [a], Mustapha Kaci [a], Idris Zembouai [a], Stéphane Bruzaud [b, *]

[a] Laboratoire des Matériaux Polymères Avancés (LMPA), Université de Bejaia, 06000, Algeria
[b] Institut de Recherche Dupuy de Lôme (IRDL), UMR CNRS 6027, Université de Bretagne-Sud, Rue Saint Maudé, 56321, Lorient Cedex, France

ARTICLE INFO

Article history:
Received 29 October 2019
Received in revised form
31 January 2020
Accepted 6 March 2020
Available online 12 March 2020

Keywords:
PHBHHx
Aloe Vera fibers (AVF)
Biocomposites
Fiber surface treatment
Morphology

ABSTRACT

The aim of this study was to assess the effect of various surface treatments on Aloe Vera fibers (AVF) used as reinforcement in PHBHHx biocomposites prepared by melt compounding. AVF were subjected to various surface treatments including alkaline, organo-silanes and combined alkaline/organo-silanes treatments. Both untreated and treated AVF were added to PHBHHx at filler content of 20 wt% and the resulted biocomposites were characterized using scanning electron microscopy (SEM), differential scanning calorimetry (DSC), thermogravimetric analysis (TGA), water absorption test and rheological measurements. The study showed that the combined alkaline/organo-silanes treatment of AVF resulted in better morphology and properties of PHBHHx biocomposite compared to untreated AVF and those treated either with alkaline or with organosilanes. Indeed, SEM analysis of the fracture surface of PHBHHx/AVF treated with combined alkaline-organosilanes showed better fiber-matrix interactions compared to the other samples. As a result, rheological properties, i.e., complex viscosity (η*), storage modulus (G′) and loss modulus (G″) were increased. Higher resistance to water absorption was observed for PHBHHx/AVF treated with combined alkaline-organosilanes. Whereas, the various surface fiber treatments led to no noticeable change in thermal characteristics of the biocomposites. This study highlights the effectiveness of combined alkaline/organo-silanes treatment of AVF over alkaline and organo-silanes and their applications in PHBHHx biocomposites as an interesting source of cellulosic reinforcing materials.

1. Introduction

In recent years, biodegradable polymers and natural fibers are gaining growing interest from both industry and academia towards developing environmentally friendly materials as an alternative to petroleum based products [1]. In addition, natural fiber reinforced polymer composite technology focuses also on low cost and performance [2]. Hence, the use of original raw materials should be defined in terms of sustainability to elaborate new products based on biocomposites [3]. New developments in the field of renewable and biodegradable polymers are being intensified. In this context, polyhydroxyalcanoates (PHA) are derived from renewable resources and are fully biodegradable thermoplastics [4]. They are totally synthesized by microorganism as an intracellular storage product [5,6]. Under, specific conditions of nitrogen limitation and an excess of carbon food source, which can be a saccharide (sugar), the bacteria transform the excess of their feeding into intracellular grains of polymer and stored in the cell cytoplasm [5–8]. The main limitations of PHA to extend their industrial applications are mainly high thermal sensitivity and low mechanical resistance [9]. To overcome these drawbacks, block copolymers have been developed introducing different monomeric units in PHAs. This is the case of poly(3-hydroxybutyrate-co-3-hydroxyhexanoate) (PHBHHx), which is a random copolymer of 3-hydroxybutyrate and 3-hydroxyhexanoate [7]. Due to its ductile nature and wider processing window compared to poly(3-hydroxybutyrate), PHBHHx has a broad range of applications in various industries such as biomedical sector including tissue engineering, bio-implant patches, drug delivery, surgery,

* Corresponding author.
E-mail address: stephane.bruzaud@univ-ubs.fr (S. Bruzaud).

https://doi.org/10.1016/j.polymdegradstab.2020.109131
0141-3910/