Biopolymer-based Composites: Poly(3-hydroxybutyrate-co-3-hydroxyvalerate) (PHBV)/Microcrystalline Cellulose (MCC) and PHBV/whisker nanocomposites

Research by Erving W. Morelius, Dr. Michael P. Wolcott, Dr. Long ‘Edward’ Jiang

Introduction

With the world trying to become more environmental friendly, much attention has been focused on biodegradable material. Such materials include Poly(3-hydroxybutyrate-co-3-hydroxyvalerate) (PHBV). PHBV is a copolymer of Poly-beta-hydroxybutyrate (PHB), which is naturally produced by the bacterial known as Alcaligenes eutrophus, and hydroxyvalerate (HV). The availability of biopolymers are insufficient with the range of properties and therefore, using nanofillers is a good way to increase the properties while maintaining a single base polymer. Using nanowhiskers from cellulose will help maintain biodegradability and biocompatibility. The purpose of this project is to produce nanowhiskers from cellulose and use them to reinforce PHBV.

Objectives

1. Produce whiskers by sulfuric hydrolysis.
2. Prepare whisker reinforced PHBV composites.

Methods

Cellulose whiskers was prepared by acid hydrolyzing microcrystalline cellulose (MCC). MCC and sulfuric acid (64%) were vigorously stirred for two hours at 44 °C. The suspension was then centrifuged in cycles of 5 min at 5000 rpm until the supernate became turbid. The supernate was dialyzed in deionized water and then concentrated by polyethylene glycol (PEG) solution. The whisker solution was then neutralized by adding NaOH solution. The whisker powder was obtained by freeze-drying and subsequent grinding. The composite samples were then produced by extrusion blending of PHBV, the whisker powder and boron nitride (BN) (used as a nucleating agent). Mechanical testing samples were finally prepared by injection molding.

Results and Discussion

Tensile Testing Analysis

Figure 6 reveals that the modulus of the composites was increased by the addition of the whiskers.

Figure 7 reveals that the strength of the composite remained unchanged with the addition of the whiskers.

Figure 8 reveals that the whiskers decreased strain-at-break of the composites.

Scanning Electron Microscope (SEM)

Based on the SEM results, the micrograph PHBV+BN reveals the even dispersion of BN (white particles) throughout the composite. The composite containing PHBV+PEG+BN revealed a thorough mixture. Micrographs of the 2 and 5 % whisker composites exhibit whisker agglomerates.

Transmission Electron Microscopy (TEM)

TEM images confirm the formation of the whiskers by acid hydrolysis.

Conclusion

Cellulose whiskers were obtained by the sulfuric acid hydrolysis technique and were confirmed by the cross polarization filters, as well as images from the TEM. SEM images revealed the dispersion of the whiskers in the 2 and 5 % concentrations. The modulus of the composites was increased, but the strength remained unchanged by the whiskers. This is due to poor dispersion of the nanowhiskers.

References


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