LDPE BIOCOMPOSITES: EFFECT OF ECO DEGRADANT

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Abstract
This research investigates the effect of corn stalk content and third agent eco degradant on tensile properties and morphology of Low Density Polyethylene (LDPE)/Corn Stalk (CS) biocomposites. It was found that the increasing of corn stalk content, tensile strength and elongation at break decreased while Young’s modulus increased. The dispersion and interfacial adhesion between the corn stalk filler and thermoplastic were important factors affecting the tensile properties of composites system. In order to improve the compatibility and interfacial adhesion, the incorporation of eco degradant into LDPE/CS composites is recommended. The addition of eco degradant has enhanced tensile properties and interfacial interaction between corn stalk and LDPE biocomposites was proven by SEM study.

Keyword: Low density polyethylene, corn stalk, biocomposites, composites.

1. Introduction

Biocomposites is a material resulting from the formation of matrix resin and a reinforcement of natural fibers generally derived from plants or cellulose. According to the previous researchers, composites consist of a plastic matrix and natural fibers as reinforcement are biocomposites (Ana et al., 2004). Mohanty et al., (2000) has defined biocomposites as a material that is made of biodegradable polymer as the matrix material and natural fiber is used as the reinforcing element. Joshi et al., (2004) has described natural fiber composites will probably be more environmentally attractive compared to glass fiber. Sherely et al., (2008) has defined biocomposites material acts as natural fillers in the form of fibers or particles which are processed with polymers to obtain materials of desired thermal, mechanical and electrical properties.

Low density polyethylene (LDPE) is widely used for manufacturing various containers, dispensing bottles, wash bottles, tubing, plastic bags for computer components, and various molded laboratory equipment. Its most common use is in plastic bags. Made in translucent or opaque variations, it is quite flexible, tough also having a good combination properties such as excellent resistance (no attack) to dilute and concentrated acids, alcohols, bases and esters, good resistance (minor attack) to aldehydes, ketones and vegetable oils.
Interfacial adhesions between the natural reinforcing filler and matrix polymers, is the most important issue associated with these composites. The compatibility problem may be due to the fact that the polyolefin is non-polar and hydrophobic, whereas the natural polymer, which is a lignocellulosic material, is polar due to the $-\text{OH}$ groups in cellulose. This results in poor adhesion and prevents the reinforcing filler from acting effectively in the composite. The good properties of these composites can be obtained by improving the compatibility between these two materials. In order to solve these problems, studies have been performed on surface modification or treatment of filler using a compatibilizing agent or coupling agent or third agent in order to reduce the hydrophilicity of the filler (Belgacem & Gandini, 2005).

In this study was focus to investigate the effect of filler loading of CS and third agent Eco Degradant into LDPE/CS bicomposites on mechanical properties, and morphology.

2. Experimental

2.1 Materials
The Light Density Polyethylene grade LDF200YZ (film extrusion general purpose) was supplied by Titan Chemicals Corp. Bhd. The corn stalk was obtained from Kodiang Plantations, Kedah and cleaned manually. After cleaned, the corn stalk was crushed and grinded into powder. The corn stalk powder (CSP) was dried at 80°C for 24 hours. The average particle size of the CSP was 29.96µm, by using Malvern Particle Size Analyzer Instrument. Eco-degradant PD 04 was obtained from Behn Meyer Polymer Sdn Bhd. Eco-degradant PD 04 is a Polyolefins based Controlled Degradation Masterbatch.

2.2 Preparation of Biocomposites
The LDPE/CS biocomposites was prepared by using Brabender Plastograph mixer Model EC PLUS at temperature 160°C and rotor speed of 50 rpm LDPE and Eco degradant was charged into mixing chamber for two minute until it completely melts. After two minute, CS powder was added and mixing continued for six minutes. The total mixing time was eight minutes. The biocomposites was compressed into tensile bar by using compression molding machine model GT 7014A. Tensile bar was reference to ASTM D638 tensile bar type IV with 1mm thickness. The compression procedure involved preheating at 160°C for 4 minute follow by compressing for 1 minute and subsequent cooling under pressure for five minutes. The similar procedure was done for LDPE/CS with Eco degradant. The formulation of LDPE/CS biocomposites with different filler loading was shown in Table 1.
Table 1: Formulation of LDPE/CS biocomposites

<table>
<thead>
<tr>
<th>Materials</th>
<th>LDPE/CS without Eco Degradant</th>
<th>LDPE/CS with Eco Degradant</th>
</tr>
</thead>
<tbody>
<tr>
<td>LDPE (php)</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>CS (php)</td>
<td>0, 10, 20, 30, 40</td>
<td>0, 10, 20, 30, 40</td>
</tr>
<tr>
<td>Eco degradant (php)*</td>
<td>-</td>
<td>3</td>
</tr>
</tbody>
</table>

*3 php from weight LDPE.

2.3 Tensile Testing

The tensile testing was done according to ASTM D638 using Instron Machine model 5569. The cross head speed of 50 mm/min was used and the tests were performed at 25 ± 3 °C. Tensile properties for five identical samples of each composition were measured and the average values were reported. The tensile strength, elongation at break and Young’s modulus were measured from stress-strain curve and automatically calculated.

2.4 Morphology Analysis

Scanning Electron Microscope (SEM) model JEOL JSM-6460LA was used to examine the dispersion of corn stalk in LDPE matrix. The fracture ends of the specimen were mounted on an aluminum stub and sputter coated with a thin layers of palladium electrostatic charging during examination.

3. Results and Discussion

3.1 Tensile Properties

Figure 1 shows the effect of filler loading on tensile strength of LDPE/CS biocomposites with and without eco-degradant. According to the results provided the tensile strength of LDPE/CS biocomposites without and with eco-degradant has decreased when the CS loading is increases.

The decreased of tensile strength with the increasing CS content explained that the weak interfacial adhesion as well as poor dispersion between filler and polymer matrix. However the biocomposites with eco-degradant show higher tensile strength compared to biocomposites without eco-degradant. The addition of eco-degradant, it has improved the tensile properties as well as developed the interfacial interaction between low density polyethylene and corn stalk. The better wettability, dispersion and orientation of the corn stalk in low density polyethylene matrix have clarified the effectiveness of eco-degradant in increasing the strength of the biocomposites.
Figure 1: The effect of filler loading on tensile strength of LDPE/CS biocomposites with and without eco degradant.

The effect of filler loading on elongation at break of LDPE/CS biocomposites with and without eco-degradant is present in Figure 2. The elongation at break has decreased progressively when the filler loading is increases. The decreasing trend on elongation at break could be seen in both biocomposites. At similar loading, elongations at break biocomposites without eco-degradant is lower than biocomposites with eco-degradant. The adding of eco degradant has increased the ductility of biocomposites and was clearly marked for biocomposites with eco degradant because of adhesion between filler and LDPE matrix restricts deformation capacity of matrix in the elastic zone in addition to the plastic zone.

Figure 2: The effect of filler loading on elongation at break of LDPE/CS biocomposites with and without eco-degradant.
Figure 3 shows Young’s modulus of LDPE/CS biocomposites without and with eco-degradant has been affected by filler loading where it has increased with the increasing of CS content. The Young’s modulus of the biocomposites with eco-degradant is lower compared to biocomposites without eco-degradant at the similar filler loading. The ductility of LDPE/CS biocomposites has been improved while the stiffness has been reduced due to the existence of eco-degradant.

![Figure 3: The effect of filler loading on Young’s modulus of LDPE/CS biocomposites with and without eco-degradant.](image)

3.2 Morphology Study.

Figures 4 and 5 shows the micrograph of tensile fractured surface for LDPE/CS biocomposites with eco degradant at 20 and 40 php of filler loading. Based on these figures, it can be concluded that with the presence of eco degradant, the corn stalk was well dispersed in LDPE matrix. Both micrographs show the ductility behavior from matrix tearing. It is supported from the result of the elongation at break for LDPE/CS biocomposites with eco degradant which is better compared to LDPE/CS biocomposites without eco degradant as well as rough surfaces while the matrix was used to coat filler. This shows the compatibility between the fiber and matrix. The improvement of the adhesion between fiber and matrix takes place due to the eco degradant. Therefore, these outcomes provide as clear evidence that the compatibility between the filler and the matrix was compatible and well developed when they are reacted to the eco degradant.
4. Conclusion

The compatibility between corn stalk (CS) and LDPE matrix was improved by the addition of eco degradant as a coupling agent. The tensile strength and elongation at break of LDPE/CS biocomposites with eco degradant higher than LDPE/CS biocomposites without eco degradant. The ductility of LDPE/CS biocomposites has been improved. SEM studies indicate that the interfacial adhesion between CS and LDPE matrix improved with presence of eco degradant.
5. Reference


