MECHANICAL CHARACTERIZATION OF LDPE/PLA BLENDS/WOOD FLOUR COMPOSITES

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Abstract
In this work, biocomposites based on low density polyethylene (LDPE), a current thermoplastic, and polylactic acid (PLA), a biodegradable thermoplastic, blends were prepared in presence of various amounts of wood flour (0 to 40 wt %). For that purpose, the following LDPE/PLA/wood flour composites were considered: 20/80/0, 2080/5, 20/80/10, 20/80/20, 20/80/30, 20/80/40).
The evolution of elongation at break, strength at break and Young's modulus was followed as a function of the wood flour concentration.
The results showed that the properties of the considered composites depend on the level of wood flour.

1 Introduction

The interest for biodegradable polymers and natural fiber-reinforced polymers or the polymer blends has grown because of increasing environmental consciousness. Thus, the recent research and development efforts have led to new products based on natural resources.
Recently, with growing pressure on the world's resources as well as concerns about disposal of plastics intensifying interest and commercial activity, biodegradable polymers have received much attention [1]. Biopolymers are materials that have the potential to keep our world sustainable, as they can completely decompose into environmentally benign components such as carbon dioxide, water, and humus-like matter [2]. Poly (lactic acid (PLA),a thermoplastic polyester, is a biodegradable polymer based on natural resources which received much attention [3]. PLA has good mechanical properties in comparison with many current thermoplastic polymers like PE, PP, and PVC. A way to enhance the properties of neat biopolymers is addition of fibers [1]. For many applications, natural fiber-reinforced polymer composites have attracted more and more research interests owing to their potential as an alternative for synthetic fiber composites [1-3]. Natural fibers have many advantages compared to synthetic fibers such as low density, recyclability, and biodegradability. Adding organic fillers to the polymer matrix to form composites improves its properties. Wood is a renewable material of low density and cost, recyclable and biodegradable. For this reason wood- reinforced composites are increasingly being used in various applications.

Natural fiber such wood, bamboo, jute and kenaf are generally used to reinforce thermoplastics due to advantages such as renewability of raw material, low cost, light weight and high specific strength and stiffness. The potential advantages of natural fibers have been well documented and are generally based on environmental friendliness as well as health and safety factors. Because of this and because of its properties, reinforced PLA composite has been investigated. The use of natural fibers as reinforcing material is the latest invention of polymer science in order to get higher strength with lower weight composite materials.

In the present study, wood flour reinforced LDPE/PLA composites were prepared. The mechanical properties of different blending weight ratio composite LDPE/ PLA/wood flour (20/80/0, 20/80/5, 20/80/10, 20/80/20, 20/80/30, 20/80/40) were studied.

2 Experimental

2.1 Materials

The PLA 2002D and LDPE NA980 supplied, respectively, from NatureWorks andPetrothene were used in this study. The wood flour used, was a mixed aleppo pine, eucalyptus and cider.

The pellets of PLA and wood flour were dried, respectively, at 90°C for two hours and 100°C for 20 hours.
The properties of LDPE and PLA were determined experimentally and are shown in table 1.

Polymers	Melt Flow (g/10min)	Melting point (°C)	Density (g/cm^3)
PLA	6.18	153.73	1.23
LDPE	0.22	114.71	0.90

Table 1. Physical properties of LDPE and PLA.

2.2 Blends preparation

The pellets of PLA were dried in a vacuum oven at 90°C for 2 hours before use. The LDPE/PLA/wood flour composites were prepared in a hydraulic type injection molding machine (Battenfeld Austria Unilog.

2.3 Mechanical properties

Testing of the tensile properties of the blends was done using a Zwick Roell, N°2ML apparatus. The samples tested are test-tubes dumbbells of 150 mm length, 4 mm thickness and 10 mm of width. A crosshead speed of 150 mm/min was used.

3 Results and Discussion

The results of the mechanical characterization are shown in Figures 1 à 3. It can be noted that elongation at break decreased after the addition of 5wt % of wood flour and then remained practically constant (Figure 1). This is due to a poor interfacial bonding and indicates that the brittleness of PLA increased with the addition of wood flour.
Strength at break (Figure 2) as well as Young's modulus (Figure 3) increased and reached a maximum value at wood flour loading of 10wt%. Further increase of wood flour loading (20-40wt %) resulted in a decrease of both properties. The increase in both mechanical properties with wood flour loading is primarily due to the reinforcing effect imparted by the wood flour which allowed a uniform stress distribution from the polymer matrix to the dispersed wood flour phase. At higher loading, wood flour agglomeration takes place within the polymer matrix and the lack of proper adhesion between the matrix and the wood flour results in insufficient stress transfer and leads to lower mechanical properties.

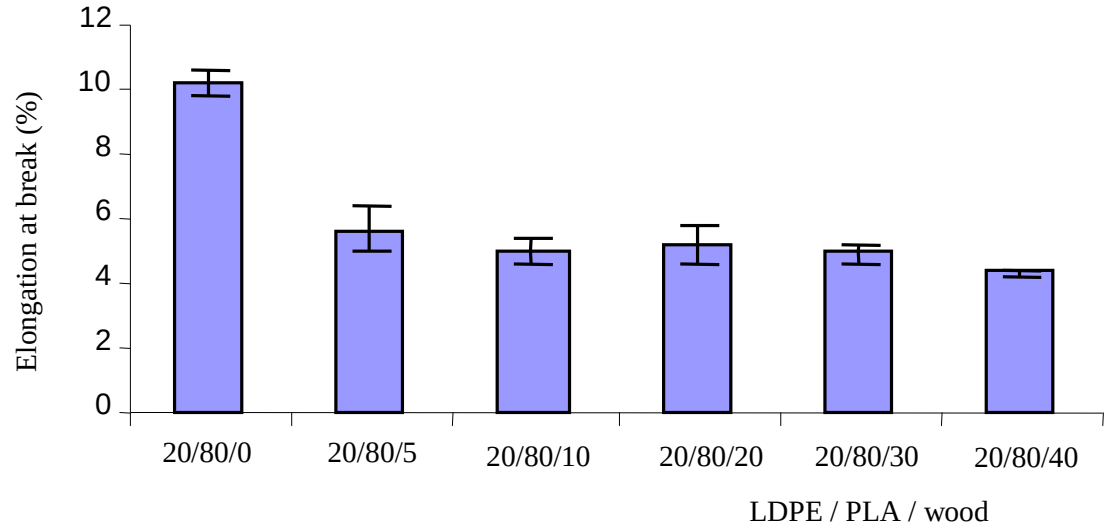

Figure 1. Elongation at break of LDPE/PLA/wood flour composite.

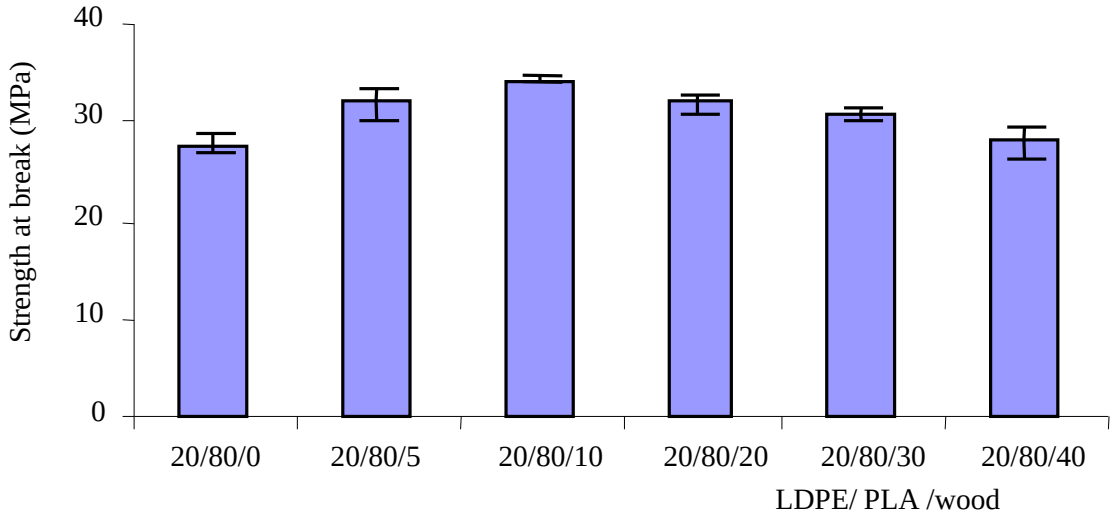

Figure 2. Strength at break of LDPE/PLA/wood flour composite.

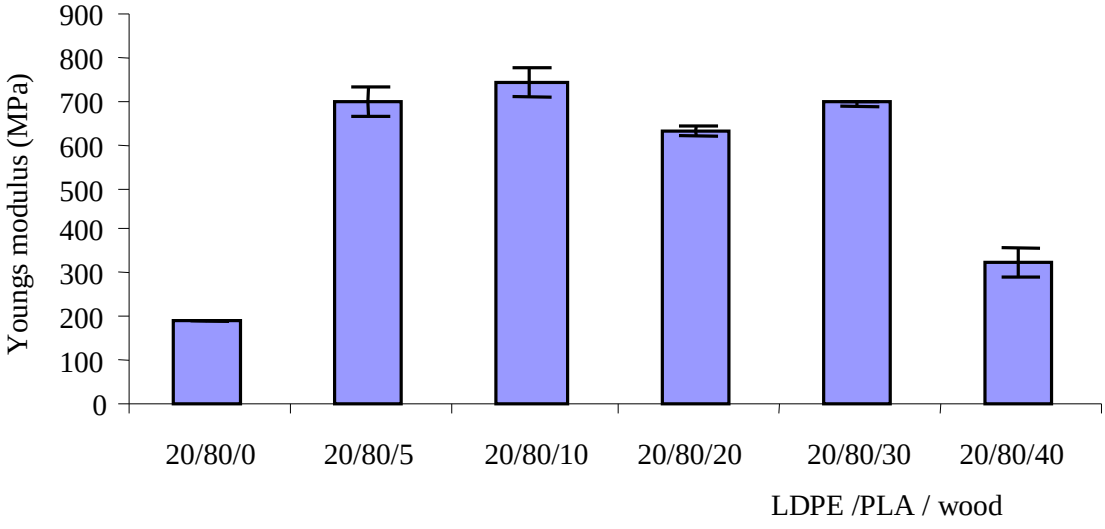

Figure 3. Young's modulus of LDPE/PLA/wood flour composite.

Conclusion

LDPE/PLA/wood floor composites were prepared. The mechanical properties were investigated. The results showed a decrease in elongation at break. Optimal values of stress at break and Young's modulus were obtained for the composite LDPE/PLA/wood floor 20/80/10.

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