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Composites Wood Fiber / HDPE. Characterization by SEM

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Abstract. The present research deals with the surface modification of pine wood fiber (*Pinus arizona Engl.*) through a double esterification in anhydrous media. Modification was performed in a mixing chamber (Plasticorder Brabender) under controlled conditions. Reaction product composites fiber / HDPE were characterized by SEM and other techniques.

Introduction

The production of fiber / thermoplastic composites, where the fiber is a lignocellulosic, has become in recent years an important application for recovering, reuse and recycling a variety of byproducts related to natural resources industrial exploitation. However, lignocellulosics and thermoplastics commonly used are not compatible enough to produce composites with appropriate properties for some particular applications, in special when high strength resistance is required. The incompatibility between lignocellulosics and thermoplastics is related to polarity differences, since the high content of hydroxyl (OH) groups in lignocellulosics (cellulose, hemicelluloses or lignin) makes them hydrophilic by nature; however, thermoplastics commonly used as matrix (polyethylene, polypropylene or polyvinyl chloride) are low polarity compounds. Therefore, the interfacial interaction between those materials tends to be poor, with analogy to a water / oil mixture [1-3].

Experimental

Materials. Reagents and materials used for fiber modification are listed next: oxalic acid (J.T. Baker), cetyl alcohol (Aldrich Co.), hexanes (Aldrich Co.) and tridistillated quality water. All reagents were used as received. High density polyethylene (HDPE) from Chevron (Marflex Hi-D94312; MI=12; ρ=0.943 gcm^{-3}) was used as the matrix. The wood fiber (*ponderosa pine*) was milled and selected to ± 60 sieve (250 μ) and dried at 110 C for 24 h before reaction.

Results and discussion

After treatment it was evident that the fiber had suffered of certain degree of degradation. Thus, some fiber samples (treated and untreated) were analyzed by scanning electron microscopy (SEM) in order to determine the morphological changes of the fiber as effect of the treatment. Figure 1 illustrates a couple of micrographs for both the treated (a) and the untreated fiber (b). It is observed that the surface on the treated fiber is smoother than on the untreated one, which was attributed to friction effect on the fiber during the reaction, induced by the paddle and the chamber surface. In general, it can be mentioned that, indeed, the treatment affected the fiber; however, it was considered that the mechanical effect was more important than the chemical, which let us to assume that the thermal stability would not be importantly affected, as it was shown by TGA analysis.

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Fiber surface modification was achieved in order to enhance the interfacial interaction between the fiber (high polarity) and the thermoplastic matrix (low polarity). Figure 2 shows micrographs for composites formulated with untreated (a) and treated fiber (b) at a rate of 30 / 70 % wt - fiber to HDPE -. Micrograph a) shows that the interface fiber / matrix was not good enough since it presents a lot of cavities, where fibers were supposed to be imbedded. It was assumed that due to the impact, during sample preparation, the fibers slipped away from the matrix because of a deficient adhesion. On the other hand, on micrograph b) it was clear that the fiber was perfectly attached to the matrix, since there is no visible interfacial separation and it is also evident that the fiber is strongly imbedded in the matrix, indicating the efficiency of the fiber treatment, which was attributed to a good interfacial interaction favored by the length of the alkyl radical entangled to the fiber.

Conclusion

Results indicated that fiber treatment was successfully performed in a non-solvent system and in a very short period of time. It was also found that even though the fiber size was slightly affected, by the friction during the treatment, it did not cause reduction in fiber thermal stability. Scanning electron microscopy images showed that the treatment produced a very good fiber/HDPE interfacial interaction, since both the fiber impregnation and the sticking of the fiber with the matrix were excellent.

References

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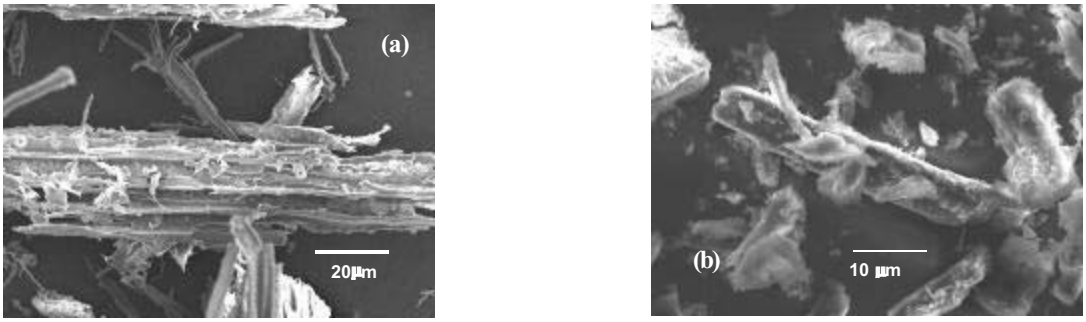

Figure 1. SEM micrographs for a) non treated wood fiber, b) treated fiber

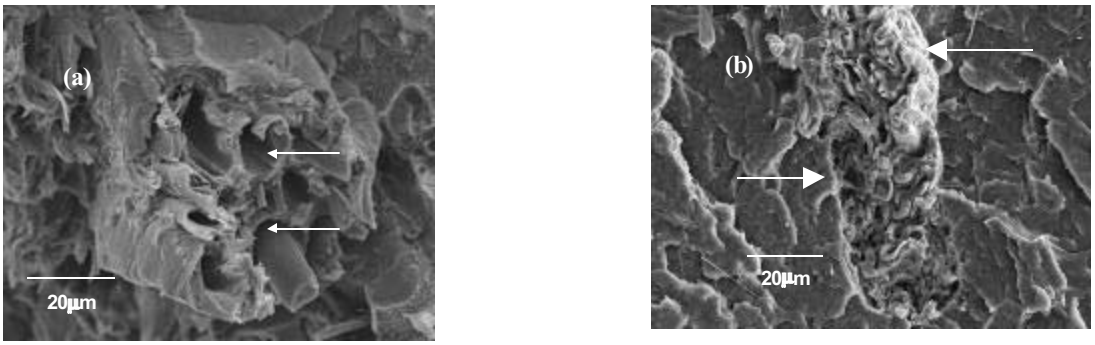

Figure 2. SEM micrographs of composites fiber / HDPE. a) with non modified fiber, b) with modified fiber

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