BIO-BASED COMPOSITES DERIVED FROM THERMOSET PHENOLIC-TYPE MATRICES AND LIGNOCELLULOSIC FIBERS

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Summary. Our goal is to explore the potential for new applications that use lignocellulosic fibers and/or their components. Valorization of lignins and their derivatives might be accomplished through their use as “macoreagents” to synthesize phenolic-type resins, to modify fiber surfaces (by way of chemical reactions or adsorption processes not described here), or both. Briefly, the set of results indicates that phenolic-type composites with superior impact strength may be produced when phenol is substituted for lignin (or one of its derivatives). The low viscosity of the pre-polymers allows good wettability of the fiber and the presence of hydroxyl groups, as well as moiety of lignin, in matrices and fiber, facilitate strong interactions at the interface and allow efficient load transfer from the matrices to the fibers.

1 INTRODUCTION

The properties of fiber reinforced composites strongly depend on the wettability of the fiber by the polymer and of the interactions at the interface fiber-matrix. These are some of the reasons that favor the use of thermoset phenolic-type polymers as matrices, since the fibers can be wetted before curing by using a low viscosity pre-polymer. Additionally, when lignocellulosic fibers are used, the interactions at the fiber-matrix interface are maximized by the presence of polar hydroxyl groups and aromatic rings that are present in both lignocellulosic fibers and matrix materials [1, 2].

2 RESULTS

Phenolic pre-polymer composites and thermo-pressed phenolic (PC), lignophenolic (LPC) and Na-lignosulphonate (NaLPC) composites, reinforced with different fibers, were prepared and characterized as described previously [1, 2]. The measured impact strength of PCcoconut was lower than that of PCsisal. Since both matrices are phenolic resins, this difference was probably related to the superior mechanical properties of the sisal fibers [1,2]. However, when lignin was used to substitute phenol in the matrix resin formulation, the affinity of the matrix and coconut fibers (with a high lignin content) was increased at the fiber/matrix interface as shown in Figure 1b (LPCcoconut). The impact strength of the LPCcoconut composite was higher than that of the PCcoconut composite (Figure 1a), which indicated that strong adhesion at the interface between the coconut fiber and lignophenolic matrix (LPC) promoted efficient transfer of the applied load from the matrix to the fibers and that the maximum coconut fiber strength was used.
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Figure 1. (a) Izod impact strength of phenolic (PT) and lignophenolic (LPT) thermosets, phenolic (PC_{coconut}, PC_{sisal}, PC_{cotton}), lignophenolic (LPC_{sisal}), and Na-lignosulfonate (NaLPC_{sisal}, NaLPC_{cotton}) composites (fibers: length approximately 30 mm, 30 wt%, randomly distributed); (b) SEM images of the fractured surfaces of the composites.

When sisal was used to reinforce a lignophenolic matrix (Figure 1a, LPC_{sisal}) the impact strength increased relative to that of PC_{sisal}, but this increase was not as high as that found for coconut fibers. When the low viscosity resin prepared from Na-lignosulfonate was used to wet the sisal fibers a good interface has been formed (Figure 1b, NaLPC_{sisal}). In this instance, transfer of the applied load through the interface was considerably improved and the composite exhibited superior impact strength (Figure 1a). For comparison, textile cotton fiber was used to reinforce composites. The fibers were filled by the phenolic resin and a strong interface was formed (Figure 1b, PC_{cotton}). Only a slight increase in impact strength was found when cotton fiber was impregnated with the low viscosity Na-lignosulfonate resin (Figure 1a, PC_{cotton} and NaLPC_{cotton}). Thus, probably for cotton almost the maximum impact strength may have been attained using phenolic matrices (PC_{cotton}).

3 CONCLUSIONS

The set of results [including data not described here (using different aldehydes, other reinforcements, treatments of fiber surfaces)] has pointed that a detailed examination of the interactions between a given matrix and different natural fibers is important, since changes in the fiber composition, the formulation of the matrix, or both, can lead to considerably different results.

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REFERENCES
