

MODIFICATION EFFECT OF RICE HUSK SURFACE BY LENR ON MECHANICAL PROPERTIES OF COMPOSITE NR/HDPE REINFORCED RICE HUSK

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ABSTRACT

In this study, Composites derived from 60% natural rubber (NR), 40% high density polyethylene (HDPE) and reinforced with variable compositions of rice husk (RH) powder were prepared using an internal mixer. The degree of mechanical reinforcement of the thermoplastic natural rubber (TPNR) matrix by rice husk (RH) powder was studied as a function of fiber surface modification via alkali treatment and liquid epoxidized natural rubber (LENR) coating. The tensile strength of the composite evaluated showed that pre-treatment of rice husk with 5% NaOH followed by coating with 10% LENR solution produced the maximum interaction and strong adhesion between fiber and matrix.

Keywords: high density polyethylene, liquid epoxidized natural rubber, rice husks

INTRODUCTION

Rice husk is a lignocellulose-based fiber, has been widely utilized in the manufacture of composite panels. Rice husk fiber is able to impart the composite with certain benefits such as low cost, low density, high specific strength and modulus, less machine wear, no health hazard and recyclability. However, despite those benefits, the main drawback of using rice husk as composite fillers is a lack of a good adhesion to most polymeric matrix. The hydrophilic nature of lignocellulosic fibers adversely affects adhesion to a hydrophobic matrix and as a result, it may cause a loss of strength. Compatibility with non-polar matrices which are mostly hydrophobic is problematic due to the highly polar nature of cellulose fibers and thus hydrophilic in character. Hence, modification of lignocellulosic fiber surface represents the natural process used to increase the hydrophobic character or decreased the hydrophilicity of the fibers. Coating rice husk with Liquid epoxidized natural rubber (LENR), was considered as it helps to enhance hydrophobic character or reduce hydrophilicity and improve interfacial compatibility between the fiber and matrix leading to high mechanical properties composites. The use of RH as a filler for NR/HDPE blend and effects of surface treatment of the RH powder through soaking in LENR solution were reported. NaOH alkalization and coating with LENR of RH powder and the variation of mechanical properties of NR/HDPE/RH composites were the main objectives of the investigation.

RESEARCH METHODE

Treatment with NaOH was carried out by soaking and stirring the RH powder in 5% wt/v NaOH aqueous solution for ± 3 hr at room temperature. RH powder was then filtered out and washed several times with distilled water before being dried up in an oven at 60°C for 24 hours. RH was then stirred using mechanical stirrer in 5%, 10% and 20% LENR solution in toluene for about 1 hr at 25°C. The NR/HDPE matrix blends were prepared by melt-blending using an internal mixer (Brabender Plasticoder) with a composition ratio of 60:40 v/v for 12 min at 135°C and mixing rate of 50 rpm. Meanwhile, NR/HDPE/RH composites were prepared at a composition of 90v% NR/HDPE matrix and 10v% rice husk for 12 min at 135°C. Finally, all the composites were compression molded at 135°C for 7 min (obtain 1 mm and 3 mm thick specimens). The tensile test was carried out using a Universal Testing Machine (INSTRON 5560) according to ASTM D412 98a standard with a load cell of 1kN. Tensile properties of composite such as tensile strength and modulus were recorded.

RESULT AND DISCUSSION

Fig. 1 and 2 show the variation of tensile strength and tensile modulus of the different composites with differently treated RH respectively. As shown in Fig. 1, generally, addition of filler seems to decrease the tensile strength of composites which is due to the incompatibility between the filler particles and matrix. Addition of RH into the TPNR matrix has caused a significant drop in tensile

strength but a slight improvement occurs on treating the powder with alkaline solution. A slight improvement is shown in the tensile strength when the filler particles are coated with LENR. In the treatment process, the active groups like $-OH$ will be exposed and subject to chemical interaction with the rubber coat. A compatibilizer is thus introduced between the filler particles and the TPNR matrix and hence an improvement in the tensile strength. However a thicker coat as in RHiNaLE3 caused the tensile strength to drop. The rationalization is coating of RH with a thin layer of LENR helps to increase interaction between the filler particles and matrix but a thicker coat as in RHiNaLE3 leads to increase interaction between the particles and hence promotes agglomeration or hinders homogeneous distribution of particles in the matrix. The agglomerated particles were also difficult to segregate and disperse during the initial mixing. Overcoating with LENR caused the particles to be sticky and hinders homogeneous dispersal of filler particles in the TPNR matrix. The tensile modulus of composites, however, increases with the addition of treated and untreated RH powder, as shown in Fig. 2. RH particle is rigid compared to the TPNR matrix and alkalization caused edging of the particles which become brittle and dimensionally reduced in size. An increase in tensile modulus can be observed for the untreated filler but the modulus decreases slightly after treating the RH with alkali and LENR. The result shows that no significant changes in tensile modulus as the amount of fillers in the composite are unchanged. Obviously, this indicates that tensile strength is more dependent on surface treatment than tensile modulus. TPNR/RHiNaLE2 shows a value closer to that of the untreated filler as a direct result of improvement in the homogeneity of filler particles in the matrix even though the particle is thinner. For TPNR/RHiNaLE3, a further drop in modulus is observed arising from the inhomogeneous distribution of the filler due to stronger particle-particle interaction.

Table 1. The different types of treated RH.

Sample	Description
RH	RH without treatment
RHiNa	RH treated with 5% NaOH aqueous solution
RHiNaLE1	RH treated with 5% NaOH aqueous solution and followed by soaking in 5% LENR toluene solution
RHiNaLE2	RH treated with 5% NaOH aqueous solution and followed soaking in 10% LENR toluene solution
RHiNaLE3	RH treated with 5% NaOH aqueous solution and followed by soaking in 20% LENR toluene solution

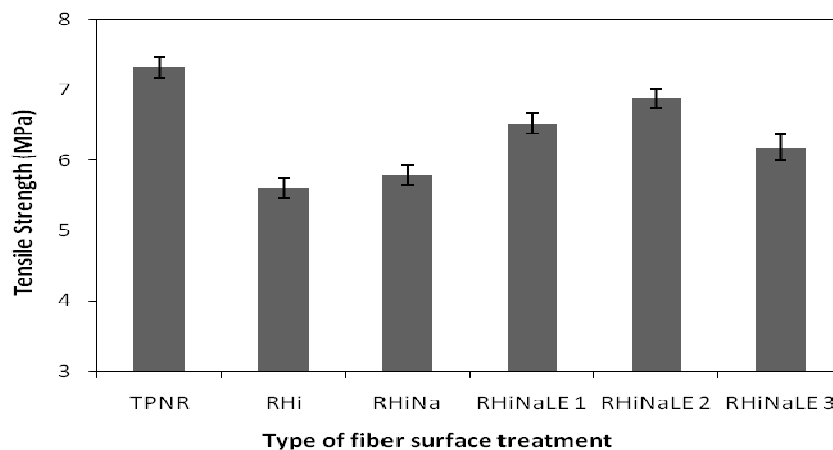


Figure 1. Tensile strength of a (NR/HDPE)/RH (90:10 v/v) composite, plotted as a function of RH surface treatment and TPNR it self as comparison.

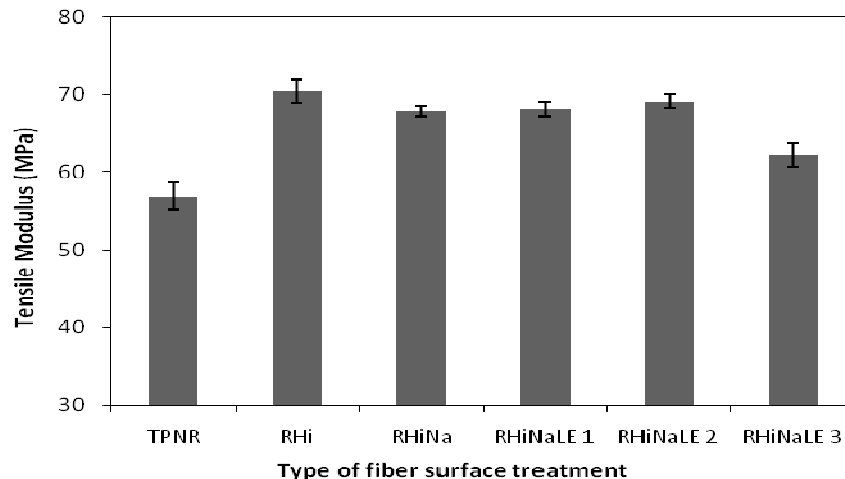


Figure 2. Tensile modulus of a (NR/HDPE)/RH (90:10 v/v) composite, plotted as a function of RH surface treatment and TPNR itself as comparison.

CONCLUSION

The study investigated the effect of surface modification of rice husk with LENR on the mechanical properties of NR/HDPE blends reinforced with rice husk. LENR formed a film on the surface of RH and the rubber-cellulose interaction was made possible by the removal of RH surface off impurities and lignin and thereby exposing some active hydroxyl sites for the interaction. The specific chemical interaction was not indentified although the potential interaction involving the oxygen groups on the cellulose surface and rubber chains were most feasible. Modification of RH via treating with 5% NaOH solution and followed by LENR solution proved to very successful. The optimum tensile strength and modulus of composites was shown by RH filler treated with 5% NaOH and 10% LENR. An ideal coating layer of LENR seemed to form providing better TPNR matrix-filler interaction over filler-filler interaction during blending. Compatibilization of the phases occurred and the composite exhibited high mechanical properties.

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