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Preparation of biodegradable composite from water hyacinth reinforced poly(lactic acid)

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Abstract : This research is to develop biodegradable composite sheet from natural fiber reinforced polymer composite. Natural fiber of water hyacinth was used as reinforcing fiber for preparing composites with biodegradable polymer, poly(lactic acid) (PLA). Water hyacinth was washed, ground then treated in NaOH and dried. Biodegradable composite sheets were prepared from PLA and water hyacinth fiber by hot press machine at temperature set of 190 °C with pressure set of 20 bar. Morphology of composite sheet of PLA/water hyacinth fiber was investigated by scanning electron microscope. The composites sheet properties were characterized by density measurement, moisture contents, dimensional change, thermal properties and mechanical performance. Overall properties were investigated according to TISI standard No. 876-2532. From the results, the composite sheets of water hyacinth/PLA passed through TISI standard No. 876-2532. Therefore, this biodegradable composite is possible for preparing as an environmental friendly composite for further applying in industries.

Introduction

Water hyacinth is classified as weed, which is widely spread on river of Thailand. It is general taken out from the river and left as garbage. Fiber reinforced composites is exhibited excellent specific strength and light weight. In this research, water hyacint fiber was prepared to fiber reinforced composites with biodegradable polymer such as poly(lactic acid) or PLA. The aim of the research is developing environmental friendly composites.

Experimental

Materials and Sample Preparation

Water hyacinth was dried before grinding in a fiber mill machine. After that ground hyacinth fibers were sieved with mesh size of 3-15 mm. The fibers were treated with 1 M of sodium hydroxide for 24 h then washed with water and dried. Poly(lactic acid) (PLA) of 0-40 wt% was mixed with the hyacinth fibers in compression molding. The hydraulic pressure was 20 bar at 190 °C for 20 min. The size of the sample was 300 m wide 300 m long 8 mm thick.

Characterization

The sample was characterized on physical and mechanical properties according to TISI 876-2532. The characterizations were carried out on density, moisture content, water absorption, dimension change, modulus of rupture and thermal conductivity. Morphology was observed using scanning electron microscope.

Results and Discussion

Figure 1 shows SEM photograph of water hyacinth/PLA composite at PLA content of 10 wt%. It can be seen a lot of void inside the composite (indicated with arrows). Figure 2 presents density of water hyacinth/PLA composites at various contents of PLA from 10-40 wt%. Density of the composites increased with increasing PLA contents. The increment of density in the composites was considered that PLA resin could be filled and penetrated into water hyacinth fiber and reduced void in the composites when increasing PLA contents. In addition, the results showed the reduction of moisture contents of the composites at higher contents of PLA as shown in Figure 3. Therefore, the water hyacinth/PLA composites exhibited low in dimension change when increased PLA contents as exhibited in Figure 4.

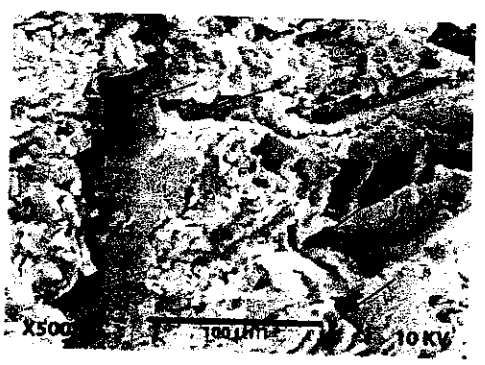

Figure 1 SEM photograph of water hyacinth/PLA composite at PLA content 10 wt%.

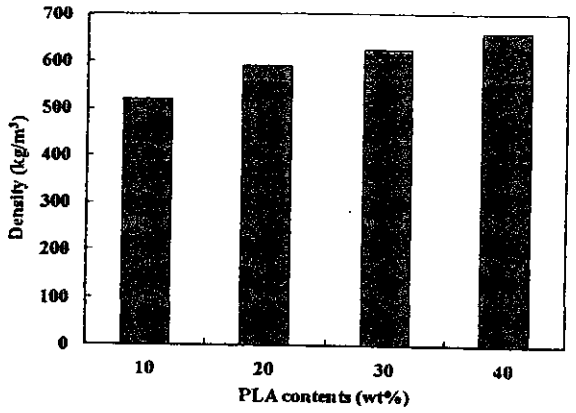

Figure 2 Density of water hyacinth/PLA composites.

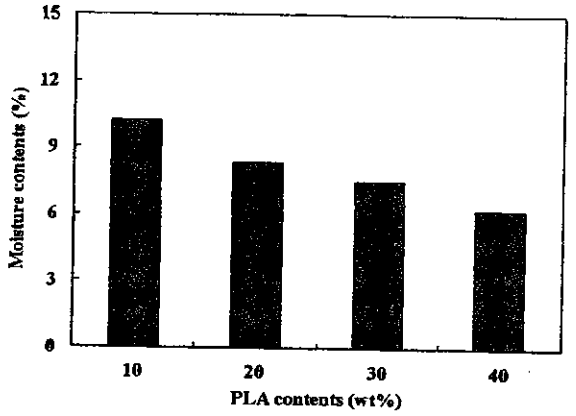

Figure 3 Moisture contents of water hyacinth/PLA composites.

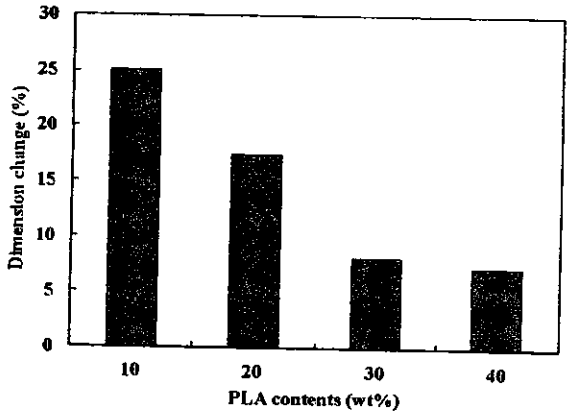

Figure 4 Dimension change of water hyacinth/PLA composites.

Mechanical property and thermal conductivity of the composites are illustrated in Figures 5 and 6, resoectively. Modulus of rupture of the composites would relate to strength of fiber in the composites under load until fractured. From Figure 5, modulus of rupture of the composites drastically increased with increasing PLA contents, which was due to strength and stiffness of PLA. At higher PLA contents, PLA could be well penetrated and good adhesion with water hyacinth fiber. It would support load transferring of the fibers, which resulting in enhancing modulus of rupture of the composites.

From Figure 6, thermal conductivity of the composites increased with increasing PLA contents. Polymer is general good thermal insulation. Therefore,

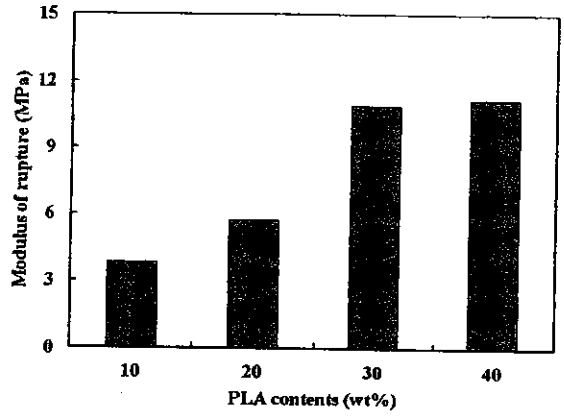

Figure 5 Modulus of rupture of water hyacinth/PLA composites.

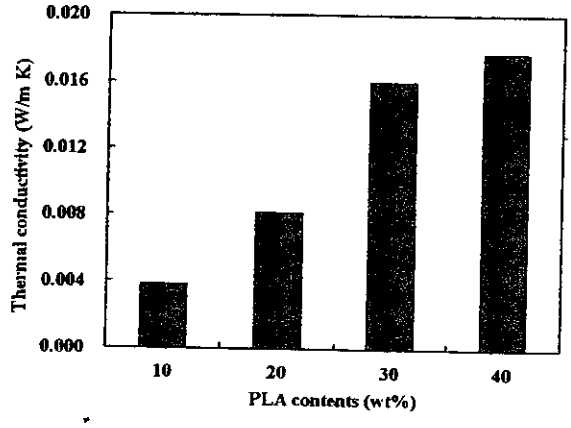

Figure 6 Thermal conductivity of water hyacinth/PLA composites.

Conclusions

Water hyacinth fiber was developed as fiber composites with biodegradable polymer of poly(lactic acid). Density of water hyacinth/PLA composites increased with increasing PLA contents due to the resin penetration and less void contents. This result could aid low moisture absorption and improve dimension stability of the compistes at higher PLA contents. In addition, modulus of rupture and thermal conductivity of the composites was enhanch, which was due to the increment of resin prenetration and good adhesion between PLA and water hyacinth. The properties of the composites were fallen in TISI standard No. 876-2532.

References

1. A. G Supri, S. J. Tan, H. Ismail and P. L. Teh, *Polym. Plas. Tech. Eng.*, **50**, 898 (2011).