HYGROTHERMAL PROPERTY OF JUTE-POLYESTER COMPOSITES

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Abstract

The application of the material technology for the utilization of natural fibers as reinforcement in polymer matrix took place in comparatively recent years. The moisture absorption, interfacial delamination, mechanical strength and durability of composite materials impose great challenge on processing and utilizing these materials for several end-use applications. In this study, Jute fiber reinforced woven fabric composite was fabricated from natural and bleached jute fabrics and the mechanical properties were studied. Then, hygrothermal degradation behavior of the composite under hot water was investigated through weight change and mechanical testing. The fractured surface morphologies of tested composite specimens were studied through SEM The mechanical performance and hygrothermal degradation behavior of composite laminates were investigated from the evaluated properties.

1 Introduction

Natural fiber composites have been widely used in various industrial fields such as portable phone, car body and so on. Thermoset, thermoplastic and rubber based composites reinforced with jute fiber have been reviewed by Mohanty et al [1]. Natural fibers are the prospective reinforcing materials but their use until now has been more traditional than technical. The application of the material technology for the utilization of natural fibers as reinforcement in polymer matrix took place in comparatively recent years. The moisture absorption, interfacial delamination, mechanical strength and durability of composite materials impose great challenge on processing and utilizing these materials for several end-use applications.

Natural fiber reinforced thermosetting composites have been reported by several researchers [2-5] still, the study of hygrothermal behavior is in infant stage.

In this study, Jute fiber reinforced woven fabric composite was fabricated from natural and bleached jute fabrics and the mechanical and hygrothermal properties were studied.

2 Experimental

2.1 Materials and Methods

Materials used in this study were Jute fabrics and unsaturated polyester resin with a hardener MEKP. There are two different types of jute fabrics used in the experiment as bleaching and natural (untreated). The hand lay up method has been used for specimen processing.

2.2 Characterization of Composites

- Both tensile and flexural tests of composite specimen were carried out using Instron Universal Testing Machine (type 4206) using JIS standards (Span length for tensile testing was 100 mm., gage length 28mm, rectangular specimen with crosshead speed of 1mm/min).
- Hygrothemal properties were studied by hot water immersion test of specimens for several hours at 80^0C.
- SEM photographs of tensile fractured surfaces of composite samples were recorded using JEOLJSM-5200 scanning electron microscope.

3 Results and Discussion

3.1 Weight Change with Immersion Time

Fig.1 shows the weight change of both specimens with square root of immersion time (√T). Initially weight increased linearly, reached a maximum then became almost constant. This phenomenon indicates

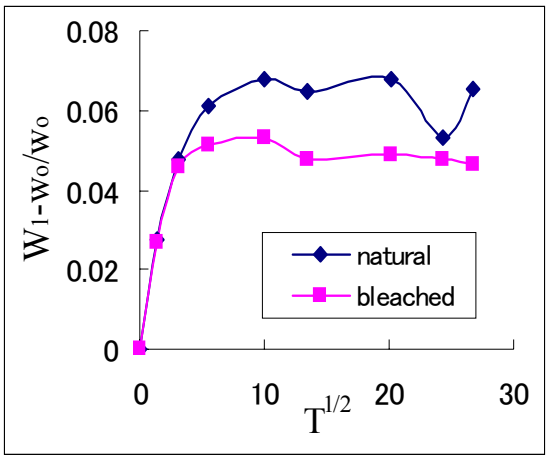

Fig 1. Weight change (water absorption) with Immersion time

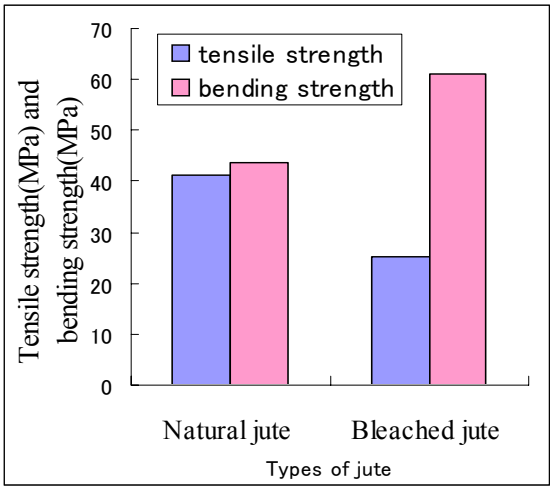

Fig. 2 Mechanical strength of composites

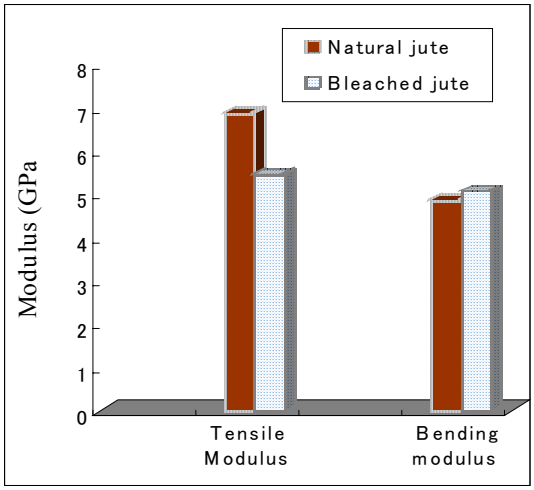

Fig. 3 Mechanical modulus of composites

Fickian diffusion. The saturation value of natural material is higher than that of bleached material.

3.2 Decrease of Mechanical strength with Immersion Time

From the investigated result it was observed that tensile strength and modulus of natural jute composite is greater than that of bleached jute composite, Fig 2 & 3. After several hours of degradation tensile strength of composites were decreased. The decrease of strength is more in case of natural jute composites than that of bleached jute composites as shown in Fig.4. It may be believed that interface is stronger in case of bleached jute composites which reduces the water uptake and strength reduction possibility in the said composites than the natural jute composites.

3.3 SEM Analysis

More number of fiber pullouts and more number of holes were observed in the Scanning electron micrograph of tensile fractured surface of natural jute composites, Fig. 5, which indicates a weaker interface in natural jute composites. Fiber splitting, absence of holes and fibers strongly adhered to resin matrix in case of bleached jute composites (Fig. 6) is the clear indication of good interfacial adhesion in bleached jute composites. Fig 7 and fig. 8 is the SEM picture of tensile fractured surface of natural and bleached jute composites respectively after 588h hot water immersion. Slippage of fiber in Fig. 7 (natural specimen) is clearly observed which indicates more degradation of natural jute composites which is caused due to a weaker interface. In bleached jute composite (Fig. 8), it seems as if there is no degradation of composites,

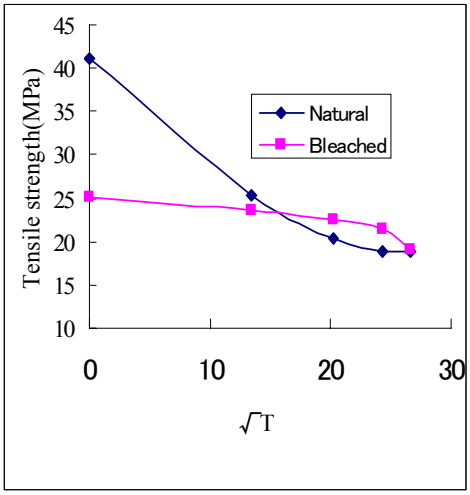

Fig. 4 Decrease of tensile strength with immersion time

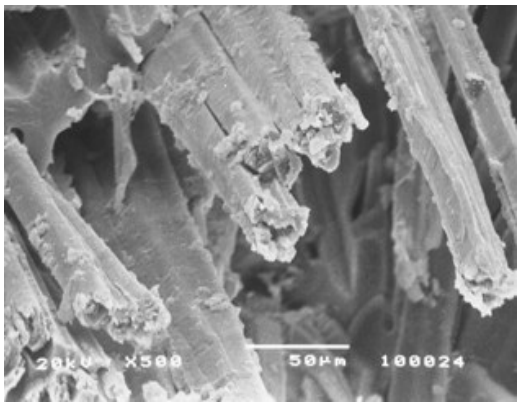

Fig. 5 SEM micrograph of tensile fractured Surface of natural jut- polyester composites

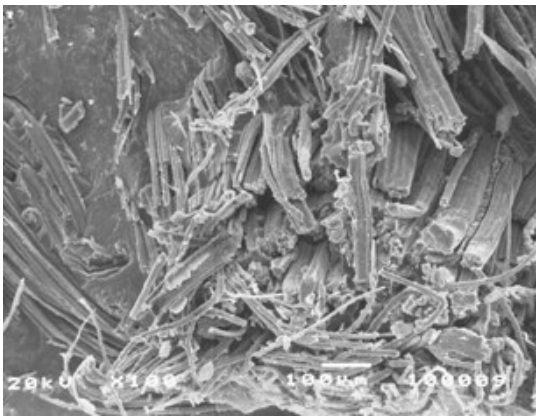

Fig. 6 SEM micrograph of tensile fractured Surface of bleached jut- polyester composites

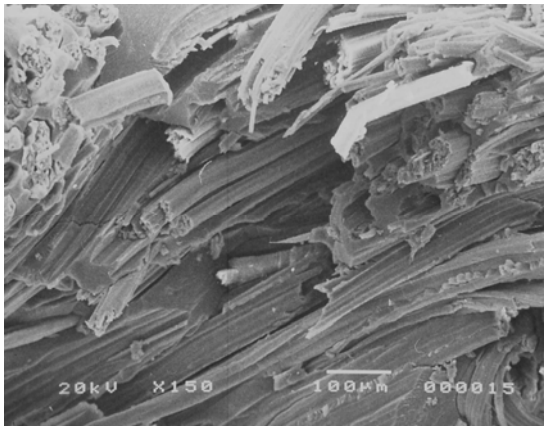

Fig. 7 SEM of tensile fractures surface of natural jute composites after 588h

mechanical properties. Finally, bleached treatment can develop reliable material system.

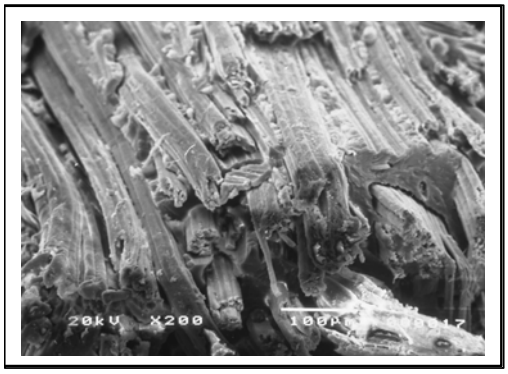

Fig. 8. SEM of tensile fractures surface of bleached jute composites after 588h

4 Conclusions

Jute fabric thermosetting composites were fabricated. Two different materials were used; bleached and natural material. Hot water degradation behavior was evaluated. Surface treatment greatly affected water uptake behavior as well as mechanical properties. Finally, bleached treatment can develop reliable material system.

5 References

[1] Mohanty A. K., Misra M. and Hinrichsen. G. "Biofibres, biodegradable polymers and biocomposites" – An overview". Macromol. Mater. Eng., 276/277, 1-24, 2000.

[2] Tripathy S. S., Landro L. D., Fontanelli D., Marchetti A. and Levita G.," Mechanical properties of jute fibers and interface strength with an epoxy resin". J. Appl. Polym. Sci., Vol. 75, 1585, 2000.

[3] Rout J., Misra M., Tripathy S. S., Nayak S. K. and Mohanty A. K., "The influence of fibre surface modification on the mechanical properties of coir polyester composites." Polym. Compos., Vol. 22,468, 2001

[4] Mishra S., Misra M.,. Tripathy S. S., Nayak S. K. and Mohanty A. K., "The influence of chemical surface modification on the performance of sisal polyester biocomposites." Polym Compos., Vol. 23, No. 2, 164, 2002.

[5] Dash B. N., Rana A. K., Misra H. K., Nayak S. K and Tripathy S. S., "Novel Low-cost jute-polyester composites, part-I: processing, mechanical properties and SEM analysis." polym. Compos., Vol. 20, 62, 1999.