Metroxylon Sago Fiber Reinforced Composite Processed by Vacuum

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Introduction

Natural fibers used for reinforcement of the composite have still an interest object to be investigated. Several advantages owned by natural fibers are cheeps, renewable, abundant, and biodegradable. One of the natural fibers used in this study for making the natural fiber reinforced composite was taken from fiber of Metroxylon Sago plant. Many sago trees were found and grow well in West Sumatera, Indonesia. The genus Metroxylon belongs to the Palmae family. Sago palm reaches a maximum height of 25 m and a diameter of 40 cm [1]. It consists of leaflets, rachis, trunk cortex and pith. Usually only pith section was used as animal feed and because of that the trunk cortex becomes the waste material in which many fibers were found and still stuck well. Therefore, it is very interesting to research the sago palm fiber to become a useful material such as fibers which can be used for reinforcement of a natural fiber composite. The investigation was focused on effect of sago fiber untreated and treated on tensile strength of the composite manufactured by vacuum.

Method

Treatment of sago fibers

Sago fibers investigated were taken from waste trunk cortex of palm sago that grows in Padang, Indonesia. Trunk cortex was cleaned from residual pith by using steel wire brush so that the fibers were easier pulled out from the tree skin. The fibers were then prepared for tensile testing by two different conditions, namely treated and untreated alkali treatment. The sago fibers were immersed in 5% sodium hydroxide solution at room temperature for two hours. The fibers were additionally neutralized several times with fresh water for three hours to remove any traces of alkali solution until a neutral pH. The cleaned fibers were dried then continuously by using low humidity air produced by dehumidifier for 24 hours.

Sample preparation of composite

The matrix used to fabricate the composite specimen was bright epoxy resin of density 1.1 g/ml and its hardener of density was 1.13 g/ml. The resin as matrix was heated at 100^0C for 10 minutes in order to improve its fluidity before mixing with fibers. Heated resin weight of 160 gram was mixed within hardener of 5 ml. The treated sago fiber was cut in length of 5mm and mixed in epoxy at room temperature with volume fraction of fiber in resin of about 6%. The mixing solution was poured in moulds in which the fibers were already available. The chamber was, then, entered in vacuum apparatus in order to vacuum the sago/resin composite. Each composite sample was vacuumed under variations of -300, -400 and -500 mmHg. After fully drying of composite sample, it was separated from the moulds and cut to make a specimen of tensile testing with dimension of specimen (length x width x thickness; 60 x 6 x 4) mm.

Apparatus and procedures

The tensile testing of fibers and composite was conducted by tensile speed of 5 mm/min at room temperature.

Fracture surface

Fracture surface of composite sample was observed by using the scanning electron microscope (SEM). The attention was given to boundary layer between sago fibers and epoxy matrix.

Result and discussion

Effect of alkali treatment on tensile strength

Figure 1 presents tensile strength of sago fibers on untreated and treated condition. It is clearly seen that ultimate strength of both fibers is quite different. There is significantly increasing of the strength fiber after alkali treatment.

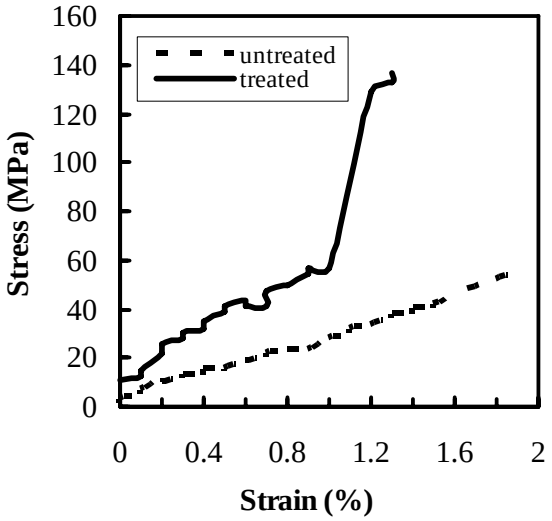

Figure 1. Stress-strain curve of a sago palm fiber in treated and untreated condition [2].

Before fiber was treated, the maximum strength was measured of 55 MPa and significantly improved to 137 MPa after chemical treatment. The improvement of

fiber mechanical properties may be due to change of fiber microstructure [3]. The average ultimate strength of 15 pieces MS fiber tested without alkali treatment was measured 46 MPa and after alkali treatment it was measured 163 MPa.

Tensile strength of composite

Figure 2 shows average tensile stress of composite processed by non vacuum and vacuum. The lowest tensile strength of composite was obtained by non vacuum and the highest by vacuum state.

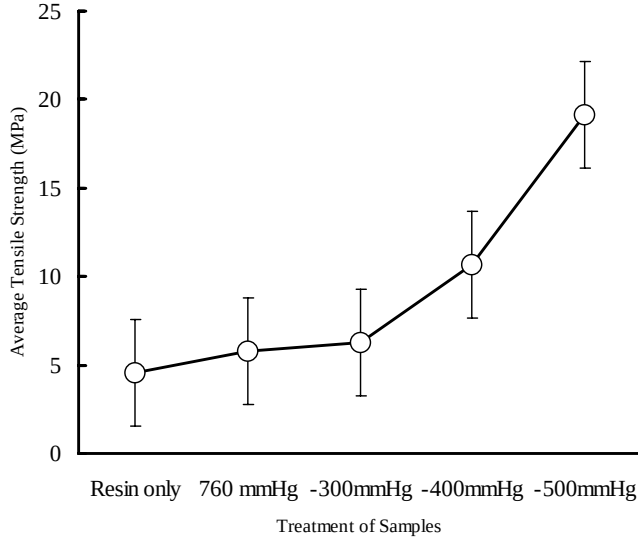

Figure 2. Average tensile strength of sago fiber composite.

The sago fiber composite produced in vacuum condition presented the fracture surface in which there was no evidence of boundary layer between sago fiber and resin so that its tensile strength was higher than that of non vacuumed composite. In the Fig. 3, the boundary layer was observed between fiber and resin matrix.

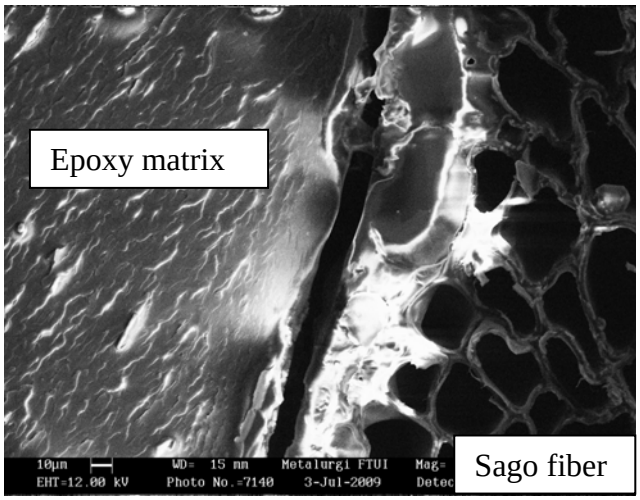

Figure 3. SEM fracture surface of sago fiber composite manufactured by non vacuum.

On the contrary, fracture surface of sago composite vacuumed presents sago fibers enclosed or stuck well by resin that has given a big effect on improvement of tensile strength of sago composite (Fig. 4).

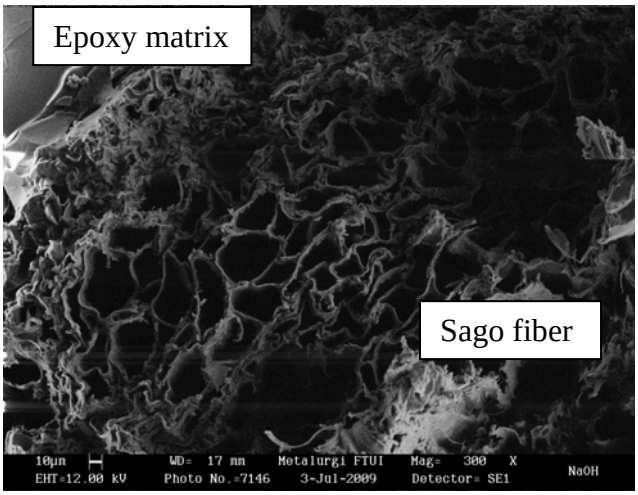

Figure 4. SEM fracture surface of sago fiber composite manufactured by vacuum.

Conclusion

Alkali treatment of 5% sodium hydroxide solution on palm sago fibers has changed its properties. From tensile testing of the untreated sago palm fiber, the ultimate strength was recorded only of 46 MPa. After fibers were treated with 5% NaOH in solution, the tensile strength of the fibers was significantly increased. Average ultimate strength of the treated sago fibers was obtained 163 MPa. Vacuum process has increased significantly tensile strength of composite due to no boundary layer between sago fiber and resin matrix.

Acknowledgement

The authors are grateful to Directorate General of Higher Education Ministry of National Education for the financial support of this research.

References

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