International Journal of Applied Engineering Research
ISSN 0973-4562 Volume 10, Number 7 (2015) pp. 17037-17045

http://www.ripublication.com

Effects of Sugar Palm Fiber Immersed In Sea Water Toward the Palm Fiber Tensile Strength As A Composite Strengthen

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Abstract

This study aims to find out the effects of palm fiber soaked in sea water toward the palm fiber tensile strength and surface roughness. The palm fiber was soaked in sea water with a variation of 1 week, 2 weeks, 3 weeks and 4 weeks soaking time. After soaked in sea water the palm fiber was then dried at a room temperature for 3 hours. The last process is putting the palm fiber inside an oven for 6 hours at 80°.The result showed that for the fiber immersion time of 1 to 2 weeks would decrease the fiber strength, but for the 3 to 4 weeks fiber immersion time the fiber tensile strength increases. For the fiber surface roughness level on the fiber immersion time, the fiber surface roughness increases the highest level on the 4 weeks fiber immersion. Different fiber immersion time would result a different fiber tensile strength and a different palm fiber surface (arenga pinnata) roughness. The longer the fiber immersed in seawater, the higher the mechanical properties and surface roughness increases. The palm fiber properties changes could be seen in the fiber tensile test and the fiber surface roughness graph chart.

Keyword: palm, sea water, soaking and drying, strength, surface roughness

Introduction

The main element of the natural fiber is lignin, cellulose and hemicellulose. Lignin is a substance together with cellulose is a cell contained in fiber. Lignin is useful in fiber such as glue or cement that binds cells one to another other in a single unit that can increase the fiber mechanical strength. The lignin chemical structure has branches and shape of three-dimensional polymer. The basic molecule lignin is a propane profile. Lignin molecules have a high degree of polymerization. The lignin serves as cement

or glue that binds the fibers and gives hardness fiber structure, due to the size and the three-dimensional structure. The fiber walls also contain lignin. In the cell wall lignin together with hemicelluloses form the matrix which bind the cellulose fine fibers.

Hemicellulose is functioned as a cell wall support and act as an adhesive between single cells contained in fiber and other plants [1, 2]. Hemicellulose has a non-crystalline nature and is not a fiber, easy to inflate, soluble in water, very hydro-folic, and easily soluble in alkali. The high hemicellulose content, contribute to the bonding between the fibers, because hemicellulose acts as an adhesive in every single fiber during the treatment process. At the time of hemicellulose softened it becomes stringy fibers [6,7]. A treatment by immersing fibers in sea water to remove elements such as wax, dust on the fiber surface which causes the fiber surface becomes slippery, with immersing in sea water the elements could be dissolved in seawater.

Composite strengthen with natural fibers emerge as an alternative fiber glass composites in many applications [1,4,9]. Natural fiber composite such as hemp fiber-epoxy, flax-polypropylene (PP) and seratchina reed-PP is an interesting material to be observe mainly on automotive applications because it is more economical and has a low specific weight [3,8]. Natural fiber composites are also claimed to offer an environmental benefits such as reducing the dependence on non-renewable materials sources, lower exhaust emissions and greenhouse gases and biodegradable materials [2, 4, 12]. The use of natural fibers as reinforcement in the composite is an attractive alternative for the study because of low production costs, environmentally friendly, low density, infinite availability and sustainable [4, 5]. The increase in choosing and implementing of bio composites in many engineering materials is caused by the impact on the environment issue and the availability of fiber sources [10].

Over the past few years, a large ecological concern toward the natural materials to produce green products and increasedthe environmental awareness. The high-cost trigger the sustainable development concept and review the renewable resource materials [9,11,12]. Natural fibers have formed an achievement as a reinforcing material in automotive components. Natural fibers such as jute, sisal, coconut fiber has proved to be a good strengthener in thermoset and thermoplastic matrix and is also well used in the automotive componentsapplication, construction and industrial packaging [1-5].

This study was to investigate the changes in fiber properties when soaked in sea water to provide the information that serves as a reference in order to introduce other ways of treatment and modification a cheap, easy, better and safer than chemical treatment fiber properties [10]. The fiber surface roughness was measured using a surface roughness measuring instrument before and after sea water immersion. The arithmetic roughness (Ra) with an absolute value would shows the roughness level of every fiber surface which was sea water treated.

Material and Methods

Palm fiber was taken from sugar palm stem (arenga pinnata) which is black in color is obtained from the North Luwu in South Sulawesi Indonesia. Fibers used are intact and black colored which was taken manually from sugar palm trees. The sea water as the

immersion medium is taken from Makassar Strait coast Indonesia. To maintain the sea water salinity levels remain normal then sea water taken from a location away from river water contain fresh water influence and the industrial waste influence.

Treatment Process

Fiber fibers soaked in seawater with a time variation of 1 week, 2 weeks, 3 weeks and 4 weeks. This study was only treated fiber until up to 4 weeks of immersion and dos not proceed until 5 weeks. After the soaking process finished, fiber was then dried for 6 hours at a room temperature of 32°C and finally was heated up in an oven at a temperature of 80°C for 6 hours.

Specimen preparation

Choosing material for a single fiber tensile test refers to the ASTM 3379-75 as shown in Figure 1 using a tensile testing machine universal testing LR10K Plus models with twin columns with a load capacity of 10 kN. The specimens for SEM observation with a specimen length of 4 mm using a model TESCAN VEGA 3 SB, XRD test specimens using a model Rigaku MiniFlex II Desktop X-ray Diffractometer and test specimens using a surface roughness testing machine Mitutoyo SJ.301 models.

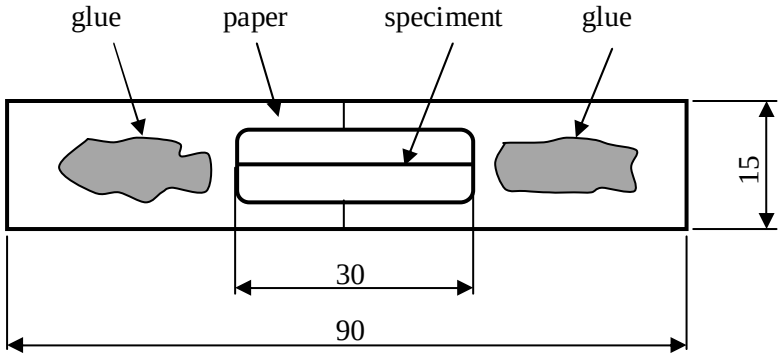


Figure 1: Single Fiber Tensile Test Specimens ASTM - 3379-75

Result and Discussion

Hydrolysis Process

The hydrolysis process results shown in the figure 2 are discussing a lignin without soaking has a value of 71.13% and decreased in week 2 with a value of 35.14%. A lignin decrease is caused by the elements of cellulose increased to 37.8%, while the hemicellulose decreased with a value of 5.19%. The lignin cellulose increased is due to lignin cellulose element which was compressed on the hemicellulose fibers. In the 2 weeks fiber immersion the lignin value decreased due to the cellulose increased while hemicellulose decreased is due at 2-weeks immersion the fiber swelled and become soft so that the fibers undergo extensional and no longer could be able to provide a fiber tensile strength. From the fiber structure SEM test result the fiber

crystalline form it is not clear as the crystalline form in fibers without soaking treatment. On The 3 to 4 weeks immersion the lignin is tightened back to the fiber this is because of the increase of the cellulose and hemicellulose, lignin bound as a function as a binder between the lignin to cellulose. Hemicellulose has a non-crystalline nature which has an easily expands nature, soluble in water and very hydrophobic. High hemicellulose content on fiber would contribute to the bonding between fibers, because hemicellulose acts as an adhesive in a single fiber. At the time that the hemicellulose softened, the fiber has to be more easily separated into fibers.

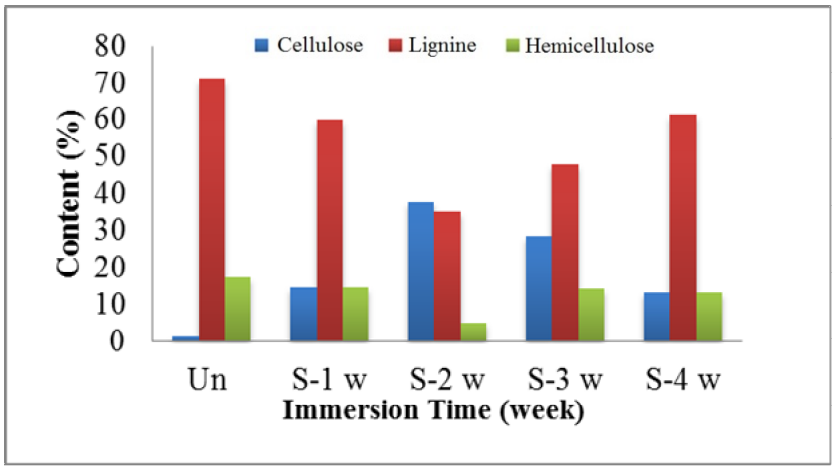


Figure 2: The Sugar Palm Fiber Main Elements Difference Graph

Tensile Test

The tensile test results are shown in Figure 3. From Figure 3 it is shown that the two weeks immersion decreased the tensile strength σ = 56.703 N/mm^2, this is due to the increase of silicon = 44.33% compare with other elements (table 1). Due to silicon element increased causing the fibers to become brittle and fragile so that the tensile stress decreases. Furthermore for the three weeks fiber immersion the tensile strength value σ = 115.350 N/mm^2 and for the four weeks fiber immersion the tensile stress increased to σ = 173.96 N/mm^2. The tensile strength increase is because of some elements infiltrated into the fibers that cause the cellulose and hemicellulose element increased. The tensile strength increase is due to the element changes in potassium, magnesium, calcium addition in which these elements are the main elements contained in sea water. A compound occurs that can provide interfacial energy reinforcement on the fiber as shown in Table (1). To measure a single fiber tensile stress then a formula is used as follows:

$$\sigma = \frac{F}{A} \quad (1)$$

Where: σ = tensile stress (N/mm^2)
F = Fiber tensile load (N)
A = Fiber average cross sectional area (mm^2)

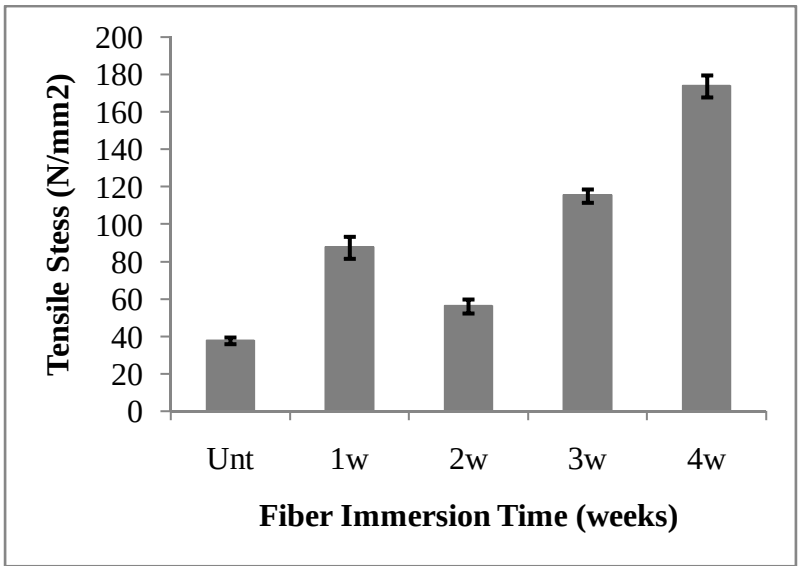


Figure 3: Fiber Tensile Strength

Table 1: Sugar Palm Fiber Chemical Composition Soaked in Seawater, XRD Test

Chemical element	Oxides	Untreated (%)	Soaked 1 W (%)	Soaked 2 W's (%)	Soaked 3 W's (%)	Soaked 4 W's (%)
Silicon	SiO2	30,45	35,95	44,33	33,25	40,67
Aluminum	Al2O3	21,9	9,49	10,38	16,76	14,23
Sodium	Na2O	18,44	14,78	16,87	15,25	12,17
Magnesium	MgO	9	12,06	11,23	14,14	12,52
Potassium	K2O	0,71	1,73	0,3	1,23	1,07
Calcium	CaO	-	4,04	0,98	2,42	0,36
Phosporus	P2O5	5,06	7,72	7,49	7,33	8,93
Sulphur	SO3	4,74	11,54	6,82	7,74	8,32
Chlorine		-	-	-	-	1,74

Roughness Test

Surface roughness was measured using a surface roughness measuring instrument before and after fiber immersion in seawater. The average arithmetic deviation (Ra) of the average line profiles are used to determine the surface roughness average value been generated. Arithmetic roughness (Ra) with the absolute roughness level value shows the differences of all fiber surface treated. The formula used to calculate the roughness arithmetic is as follows:

$$Ra = \frac{1}{\ell}\sum_{i=1}^{n}|Y| \quad (2)$$

Where: Ra = Average Roughness Arithmetic (μm)

ℓ = Sample length (mm)
Y = Curve profile ordinate

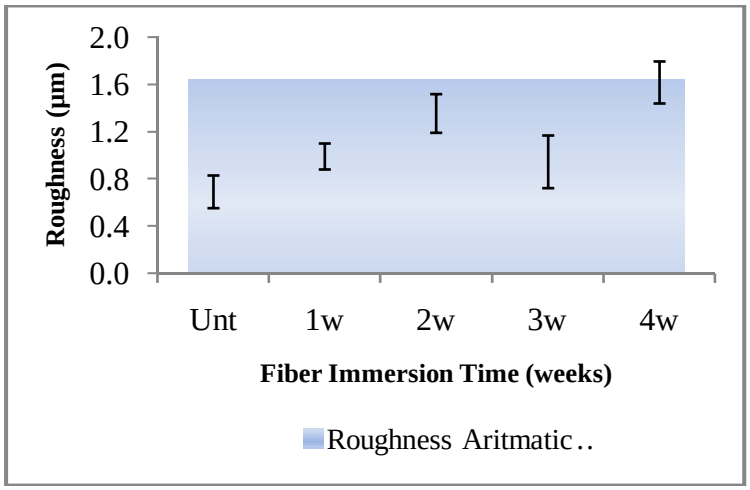
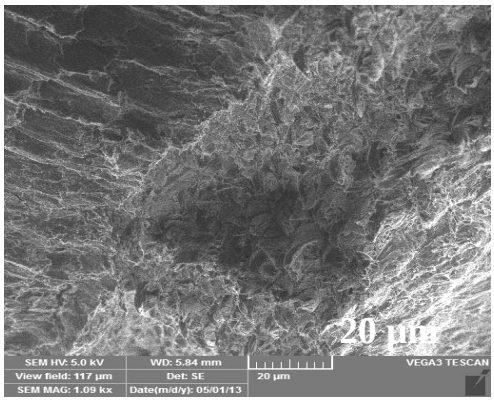
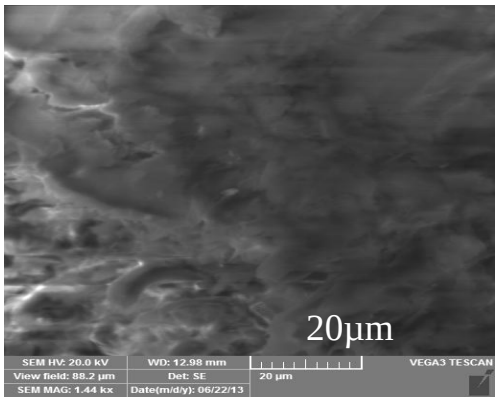


Figure 4: Sugar Palm Fiber Surface Roughness Value

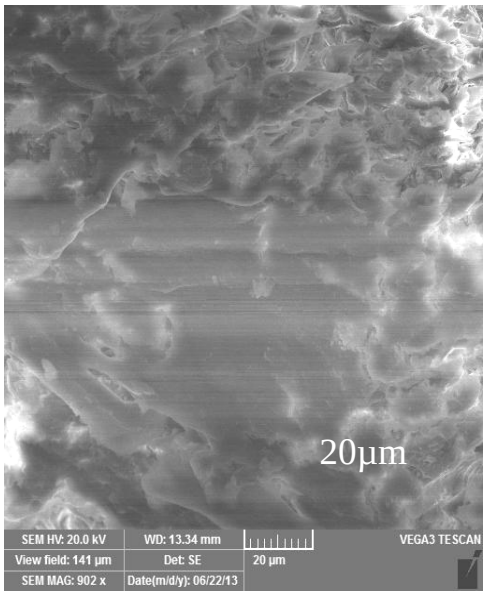
Scanning Electron Microscopy (SEM) is used to describe the fiber crystals shape as shown in Figure 5a to Figure 5e. The SEM images shows a clearer crystal form in the fiber without soaking treatment compared with the fiber soak in seawater for 2 weeks.



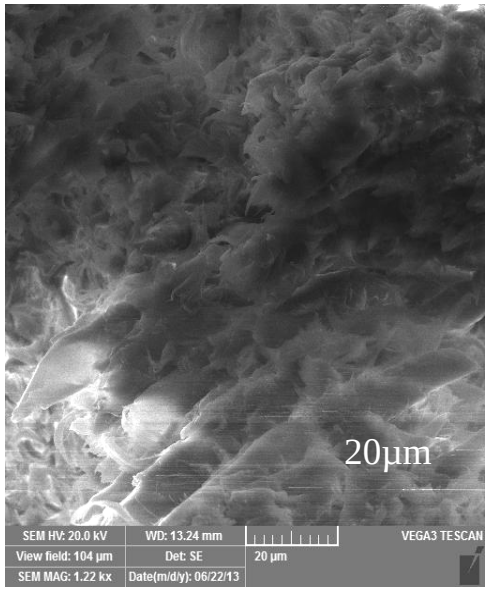
(a) Untreated



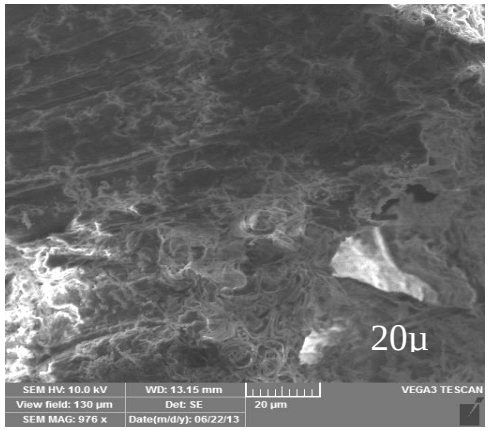
(b) 1 weekimmerse in seawater



(c) 2 weeksimmerse in seawater



(d) 3 weeksimmerse in seawater



(e) 4 weeksimmerse in seawater

Figure 5: SEM Sugar Palm Fiber Cross Section Immersed In Sea Water Results

Surface roughness of the treated fibers showed a significant difference toward the fiber immersion in seawater time.

Discussion

The fiber tensile strength increased under a four weeks seawater immersion is due to the increase of some elements contained in the fiber such as silicon SiO2 increased from 30.45 to 40.67 which is about 75% rising, where other additional elements contained is the chlorine level value increase to 1.74 as seen in Table 3. These elements addition is due to the reaction between seawater and elements contained in the sugar palm fiber and it would possibly improve the fiber tensile strength. The Scanning Electron Microscope (SEM) was used to observe the fiber shape.For each treatment the fiber surface diameter showsa different value. Then roughness

measurement is performed to determine the fiber surface contours under a different seawater immersion time treatment.

Conclusions

The result shows that:

1. At a two weeks seawater sugar palm fiber immersion the lignin and hemicellulose elements decline while the cellulose element increased.
2. The one week sugar palm fiber immersion, the fiber strength is as big as σ = 87.703 N/mm^2 and decline at an immersion treatment time of two weeks to be σ = 56.316 N/mm^2, then at an immersion time of three weeks the sugar palm fiber strength increase to be σ = 115.350 N/mm^2 and continue increase at the four weeks immersion treatment time to be σ = 173 N/mm^2.
3. The sugar palm fiber surface roughness starts from untreated fiber until the sugar palm fiber four weeks immersion treatment resulted a significant increase.

Acknowledgement

The author would like to thank for their support of this research by the Dean of the Faculty of Engineering, University of Muslim Indonesia Makassar, head and all assistant Physics Laboratory, State University of Makassar who helped analyze the data.

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