Effect of Fiber Volume Fraction Of Tensile Strength and Impact Strength biocomposite of Bacterial cellulose-Shellac

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Abstract. Composites materials usually consist of reinforcement or filler by glass or carbon fiber and the polymer matrix made of petroleum. These materials are not appropriate because it can't be degradated by environment and need alot of energy to produce them. Their waste only can be burned to produce CO2 and CO that caused global warming. Therefor research on biocomposites, that more environmental friendly are needed. The objective of this study is to investigated the effect of volume fraction of fiber on tensile and impact strength of bacterial cellulose fiber reinforced shellac biocomposites. This research is focus on biocomposites of bacterial cellulose and shellac. Bacterial cellulose is cellulose that produced from bacteria Acetobacter Xylinum. Medium that used in this research is tapioka water. Shellac is secretion of lac bug.Bacterial cellulose reinforced shellac biocomposites obtained by blending nata de cassava gel and shellac until become slurry. Volume fraction of bacterial cellulose are 0%, 30%, 50% and 60%. The result showed that the optimal tensile strength of biocomposites is the 60%. highest impact strength is obtained on 50% of bacterial cellulose.

INTRODUCTION

Since the mid-21st century, the demand for industrial materials stronger, stiffer, lighter and environmentally friendly growing. High demand for materials with better properties and environmentally friendly has prompted a broader research and development of composite material of nature both for reinforcement and matrix. This material has a low specific gravity but high specific strength and modulus. Bermatriks polymer composites are now widely used for aircraft, automotive, marine, infrastructure, industrial and military sports equipment.

At this time the composite material usually consists of reinforcement made from synthetic materials such as fiber glass or carbon fibers with a polymer matrix made from petroleum. Synthetic materials is very dangerous because the synthetic fibers can not be degraded by nature and at the time of the production process need lots of energy as well as disposal of waste produced many of exhaust gas in the form of CO_2 and CO which can degrade the quality of the environment by depleting ozone, more commonly known as the phenomenon of the greenhouse effect.

With these reasons it started a lot of research on composite materials dperkuat natural fibers with a matrix that is also of plants and animals or microbes. Natural fibers derived from plants are the main ingredients are cellulose and other ingredients are hemiselulose, lignin and pectin.

Cellulose is a biopolymer that availability is very abundant in the earth, known as the main component in plants. But cellulose is also an extracellular microbial polymers. Bacterial cellulose is a specific product of the primary metabolism. Cellulose synthesized by bacteria that comes from generation Acetobacter, Rhizobium, Agrobacterium, and Sarcina. Gram negative effective is acetic acid bacteria Acetobacter xylinum [1].

Bacterial cellulose has been applied as nata de coco, wound care products, and tissue engineering. Besides, the bacterial cellulose is also potentially as a reinforcement polymer to form the nanocomposite. Compared with cellulose fibers derived from plants, bacteria cellulose is characterized by high purity (for example, no lignin, hemiselulose or pectin fiber, as found in plants), high mechanical strength and structural mesh in three-dimensional nanometer-sized. Based on the characteristics, the cellulose bacteria became a potential candidate for the development of high-power nanocomposite [2].

This study uses a matrix of nature. At this time a lot of research that focuses on the study of the natural polymer material. Including the use of corn starch, PLA (polylactic acid), as well as other ingredients derived from nature.

Including natural polymers are shellac which is a secretion shellac louse [3]. Ticks are common in tree lak kosambi. Lak has been cultivated in Perhutani Probolinggo and in West Nusa Tenggara. At this time shellac used as coating materials in the furniture products, coatings on the drug-resistant typhoid gastric fluid. Until now there has been no research on the use of shellac as matrix biocomposite berpenguat bacterial cellulose.
The focus of this study is to examine the potential development of biocomposite material reinforced bacterial cellulose produced from food industry waste material in this case is the industrial wastewater cassava starch. With Shellac matrix that is the result of flea secretion shellac.

METHOD

1. Material

Materials used in this study was obtained from the bacterial cellulose gel nata de cassava which is fermented from tapioca water as shown on Figure 1.

Figure1. Nata De cassava

Nata de cassava to be used as composite materials do next in the surface treatment by soaking in a solution of 5% NaOH for one night [4], then in clean by washing them in running water for 6 hours. In order to be used as a reinforcement in biocomposites materials we then gel nata de cassava in the blender to obtain short cellulose fibers as shown in Figure 2.

Figure 2. Cellulose bacteria that have been blended

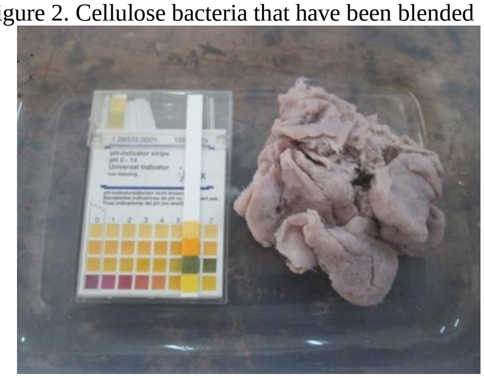

Figure 3. Short bacterial cellulose fibers

The next main ingredient is shellac. Shellac used in this study is shellac commonly used to coat furniture imported from India. Figure 4 is a shellac materials used.

Figure 4. Shellac powder

The basic ingredients shellac then dissolved in ethanol at a ratio of 1: 1 to obtain a solution shellac. This solution was allowed to stand for 24 hours to evaporate most of the ethanol content in order to obtain viscous solution as Figure 5.

Figure 5. Shellac solution

The solution is ready to use as a matrix material biocomposite bacterial cellulose-Shellac

2. Preparation of bacterial-cellulose biocomposite shellac

Biocomposites made with variations of the fiber fraction of 30%, 50% and 60%. in order to determine the effect of the amount of coating on the tensile strength of the resultant composite material (Figure 6).

Figure 6. A mixture of bacterial cellulose fiber-shellac with alcohol solvent

Manufacture of composites should pay attention to volume ratio, the fiber used will also be converted to a unit volume by taking into account the density of the cellulose fibers themselves.

Volume fraction is measured using mass data of fiber and fiber density. From this data will be obtained based on the volume fraction of the volume of the mold.

Figure 7. Bacterial cellulose fiber composite short-shellac

The first step to prepare base made of glass and then oiled nonstick liquid. Then enter the bacterial cellulose-shellac mixture into a mold as shown in Figure 6. then heated at a temperature of 1500 during 15 minutes (5). Then allowed to cool for further testing tensile and impact testing. Short fiber composites that have been printed and then ready to be used as a test specimen is shown in Figure 7.

3. Testing

Tensile test conducted by the ASTM D882 standard. Dimensions of tensile test length 55mm, 5mm width and thickness to adjust. Impact test using ASTM D-5941. Dimensional rectangular specimen with a length of 80 ± 0.2 mm, width 10 ± 0.2 mm and 4.0 ± 0.2 mm thick.

RESULTS AND DISCUSSION

Effect of short fiber volume fraction of the bacterial cellulose biocomposite tensile strength is shown in Figure 8. Proficiency level of image can be seen that the tensile strength of biocomposites increases with the increase of fiber fraction. The increase in tensile strength is probably due to a large smakin contact area between the fiber and the matrix. The tensile strength shellac without fiber reinforcement is 3 MPa, tensile strength fiber composite rose on the composition of 30% tensile strength of 4.89 MPa, whereas the fiber composition of 50% tensile strength of 6.57 MPa. The tensile strength fiber composite with a composition of 60% was 7.82 MPa, whereas the fiber composite with a composition of 7.55 MPa.

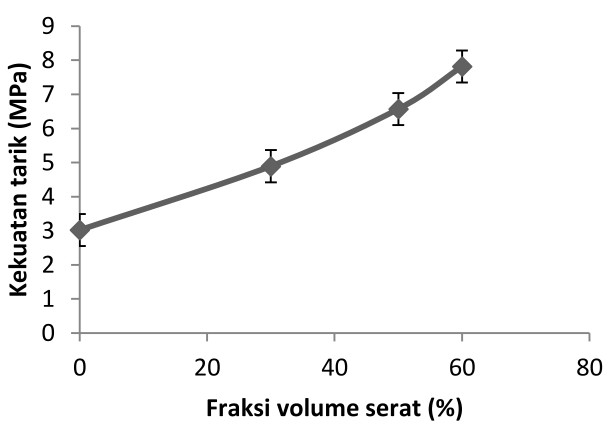

Figure 8. Effect of Volume Fraction of the tensile strength fiber composite

From Figure 8 shows that the highest tensile strength occurs in composites with a fiber composition of 60%.

Figure 8 is an optical observation bacterial cellulose fiber composite short-shellac the fiber composition of 30%. Areas that are white are bacterial cellulose fibers whereas dark colors are shellac.

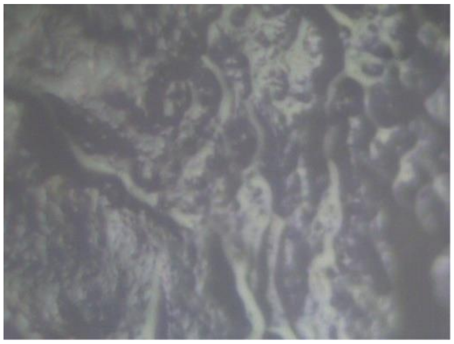

Figure 9. Optical observations of bacterial cellulose composite-fiber fraction shellac 30%

Figure 9 is an optical observation of bacterial cellulose fiber composite short-sirlak the fiber composition of 30%.

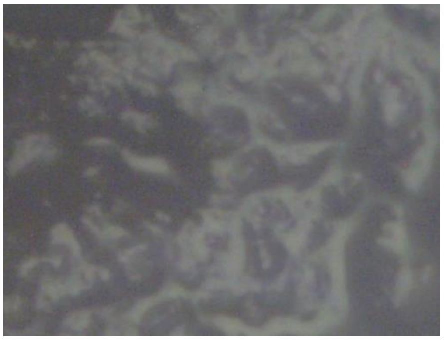

Figure 10. Optical observations of bacterial cellulose composite-fiber fraction shellac 50%

Figure 9 and Figure 10 shows the distribution of bacterial cellulose fibers in sirlak marked white area. Bacterial cellulose fibers in the composition to 50% greater than the composition 30. This situation is in line with the tensile strength fiber composites pensek bacterial cellulose-sirlak which shows its strength increases in the fiber composition of 50% compared to 30% of fiber composition.

Effect of fiber volume fraction of the impact strength are shown in Figure 11. In the fiber fraction of 30 percent of the impact strength of composite materials amounted to 0.00068 J / mm2, while the fiber fraction of 50 percent impaknya price is 0.00127 J / mm2 and the fiber fraction of 60 percent The impact of the price of 0.00067 J / mm^2.

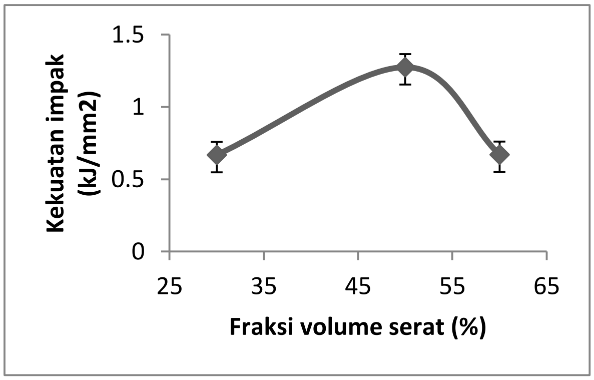

Figure 11. Effect of fiber volume fraction of the composite Impact Strength

Increased impact strength in fiber volume fraction of 0% to 50%. The tensile strength of biocomposites with the best in fiber volume fraction of 50%. Then the impact strength down to the fiber fraction of 60%.

CONCLUSION

The conclusion of this study are:

1. The tensile strength fiber composite short fiber fraction bacterial cellulose-best shellac is 60% fraction of the fiber with a tensile strength of 7.82 MPa.
2. Impact Strength is best to composites with fiber fraction of 50% amounting to 1.275 KJ / mm^2

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