Effect of pineapple leaf fiber as a reinforced for automotive interior parts

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ABSTRACT - The purpose of this study is to investigate the effects of pineapple leaf fiber as a reinforced in polymer matrix composite. The specimen made of varying percentage composition of pineapple leaf fiber (PALF) and polypropylene (PP). The process was starting with preparation from raw pineapple leaf and then treated with alkaline treatment. PALF and PP were compounded using hot compression process by using hot press and cooling machine to create a sample. The composite samples were prepared according to the standard requirement to perform for tensile test (ASTM D3039) and density test (ASTM D792). From this study, can be identified that 10 wt% of fiber loading is the best achiever for the composition structure of PALF/PP composite.

1. INTRODUCTION

Automotive industry is among the first industries to introduce the use of natural fibers as filler in polymeric matrix (BFRP). In 1940s, Henry Ford began experimenting and producing natural composite using hemp fiber reinforced soy resin in the manufacturing of exterior body panels [1]. During that time, soy based plastic is not economical important due to the availability of the petroleum based plastics which were cheap [2]. Decades after, new environmental regulation and the depletion of petroleum sources have revived the interest of researchers to develop a unique and superior material that can is biodegradable and contribute to saving the world from pollution.

Lots of researches have been done in order to apply the BFRPs composite in automotive application. For example, car manufactures in Europe have done various research to increase the applications of BFRP composites in automotive industry, especially in car interior parts such as door-trim panels, boot linens, truck linens, seat backs, parcel shelves, rear and front door linens [3,4].

The objective of this study is to determine the effect of pineapple leaf fiber as a reinforced in polymer matrix composite and to study characteristics of pineapple leaf fiber in polymer matrix composite including mechanical properties and physical properties.

2. METHODOLOGY

The PALF/PP composites with different compositions were prepared by using manual mixing method and were compression-moulded to form a sheet of composites. The compositions ratio of the PALF/PP composite is based on Table 2.1. After mixing the two materials, the mixture was transferred into the mould. The size of mould is 140 mm x 60 mm. The compounded composites were presses by using hot press machine to fabricate the sample. The melting point temperature of PP is 170ºC. The time of preheat is 5 minutes which to transfer the heat to the mould and the time for compress also is 5 minutes under a pressure 2.5 MPa. The time for cooling is 15 minutes.

A tensile test is performed according to ASTM D3039 which is Standard Test Method for Tensile Properties of Polymer Matrix Composite Materials. A thin flat strip of material composite specimen having a dimension of 140 mm length, 25 mm width, and 2 mm thickness is mounted in the grips of Instron Universal Testing Machine (Model 5585H) controlled by Bluehill 2 software with a 1 kN ad test and activated at constant head-speed tests of 2 min/mm.

For the physical test, the density of the PALF/PP composite was measured using a digital electronic densimeter (MD-300S) according to the ASTM D792. The specimens apparent mass was measured and then, the specimens were immersed in a liquid. The value of specific gravity and volume can be obtained.

Table 2.1 Samples of PALF/PP for each composition

PALF/PP (wt.%)	Composite
10/90	
20/80	
30/70	
40/60	

3. RESULTS AND DISCUSSION

3.1 Effect of PLF loading on tensile.

Figure 3.1 shows the result between the tensile stress (MPa) against the percentage loading of PALF (wt.%). According to the results obtained, tensile stress at maximum load for 10 wt.% loading of PALF is the highest value which is 25.26 MPa. However, for 40 wt.% loading of PALF fiber is 21.46 MPa which is the lowest value of tensile stress at maximum load. For the 20 wt.% and 30 wt.% loading percentage of PALF, the values are 23.90 MPa and 23.54 MPa. The pattern of the graph showed that increasing the fiber loading reduced the tensile strength. This is because the PALF/PP composite that have less fiber are more elastic than PALF/PP composite that have more fiber. Also, the addition of fibers were disturbing the PP segment mobility and causing the plastic turn to be more brittle.

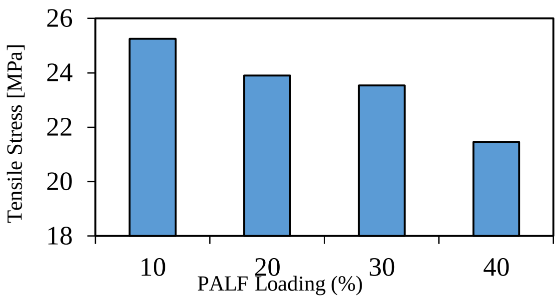

Figure 3.1 Tensile Stress (MPa) against PALF Loading (wt%)

Figure 3.2 shows the result between Load (N) against Extension (mm) during tensile test for the PALF/PP composite sample with different percentage of loading (wt.%). According to Figure-3, the result shows the extension increase with the decrement of fiber loading. The addition of 10 wt.% fiber loading shows the highest extension followed by 20 wt.%, 30 wt.% and 40 wt% fiber loading respectively. The increment in extension of the composite was caused by ductility properties of PP. For the 10 wt% have the lowest value of fiber loading in the PALF/PP composite sample. Thus, the ductility level is the highest, so it can be extended with the highest maximum level than others percentage fiber loading before it ruptured. The samples that have more fiber loading tend to easily ruptured because of their low ductility.

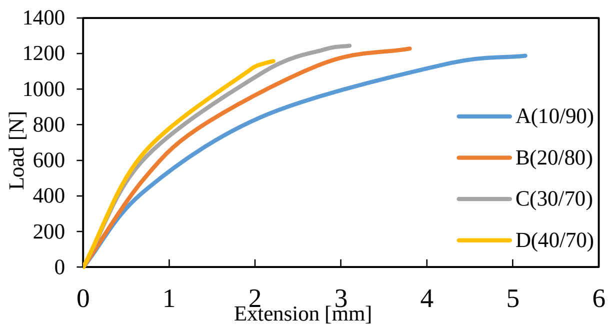

Figure 3.2 Load (N) against Extension (mm) with the different percentage of fiber loading (wt.%)

3.2 Effect of PLF loading on density.

Table 3.1 shows the results of density (g/cm^3) and the percentage of PALF loading for PALF/PP composite. The result shows that the value of density increases with the increment of PALF loading. For the 10 wt.% of PALF loading has the lowest value of density which is 0.9940 g/cm^3 while 40 wt.% of PALF got the highest density, 1.0045 g/cm^3. For the 20 wt.% and 30 wt.%, both of them have the constant value of density which is 0.9970 g/cm^3. This increasing trend obtained due to the increment of fiber loading that effects the composition in the composite. When there is much fiber loading, the space between fiber and matrix are more closer which indicate the composition is more pack.

Table 3.1 Density properties of the samples

PALF loading (wt.%)	Density (g/cm^3)
10	0.9940
20	0.9970
30	0.9970
40	1.0045

4. CONCLUSIONS

In conclusion, the 10 wt.% of fiber loading shows the highest value of tensile strength which is 25.26 MPa. Moreover, the density result, 40 wt% shows the highest value which is 1.0045 g/cm^3. The decrement of PALF loading will give beneficial for mixed properly with the PP during fabrication process. Thus, can be classified that the natural composite that have less percentage of fiber loading would become a good potential to produce the superior composite materials that would be apply as interior part in automotive.

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