MECHANICAL PROPERTIES OF THE OIL PALM EMPTY FRUIT BUNCH FIBER (OPEFBF)/GLASS REINFORCED IN ALUMINIUM COMPOSITE LAMINATES

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Introduction

In some applications, aluminium is used to provide a good mechanical surface. For mechanical surface applications, the thickness of the aluminium can be replaced using composite laminates. This would significantly reduce aluminium usage and lower the cost of the material. Composite materials have the potential to replace conventional metals in some automotive and other components. Glass fibers were commonly used as the reinforcement materials. In relation to this, research works have been conducted to determine its properties. However, these materials are very expensive and their use is justified only in aerospace applications. Research works have been conducted on alternative fibers such as jute and oil palm fruit bunch fibers [1–4].

Experimentation

Materials

Unsaturated polyester resins and oil palm empty fruit brunches (OPEFB) were obtained from local sources. Plain weave, multidirectional glass strand mats and aluminium plates (1060) with thickness of 0.6mm and 3.0mm were used.

Apparatus and Procedures

Oil palm fibers were soaked in 5% sodium hydroxide for 48 hours. This is then washed many times in distilled water. The final washed is with water containing acid and then dried [3-4, 6].

Oil palm fiber loading for which optimum properties of the composite was observed was at 40%wt respectively [3-4, 7]. Two types of fibers were prepared: long fibers and short fibers. The various orientations of fibers prepreg were prepared by hand lay-up technique.

The glass fiber loading was also 40% which was observed to be optimum [3-4]. Two types of mats were prepared: plain weave fabric mat and multidirectional fibers mat. The preparation technique was the same as the preparation of OPEFB fibers prepregs.

The specimen type is referred to UP, UPII, RP, RR, TP, UR and AL and the details of each specimen were shown in Table 1.

Table 1. Types of the specimens prepared.

Specimens	OPEFBF	Glass fiber
UP	Long, Unidirectional	Plain weave
UPII	Long, Unidirectional	Plain weave (double layers)
RP	Long, Random	Plain weave
RR	Short, Random	Plain weave
TP	Untreated, Unidirectional	Plain weave
UR	Long, Unidirectional	Multidirectional
AL	-	-

Hybrid composites were prepared by arranging glass mat and palm fiber mat in such manner so as to get maximum intermingling between the fibers. The fiber was soaked in polyester resin and cured under hot press. Test specimens were cut from the composite sheets. Tensile testing and fatigue test were carried out according to ASTM D3552.Fractography of the failure of the composite samples was examined by scanning electron microscope.

Results and Discussion

Figure 1 and Figure 2 show the tensile strength and the tensile modulus of various oriented hybrid composite laminates of oil palm empty fruit brunches fibers (OPEFBF) and glass fiber reinforced aluminium laminates respectively. The overall results show that the composite laminates have better mechanical performance compared to the aluminum alloys 1060 plates expect UR and RR samples. The modulus and tensile strength of the composite laminates become higher and larger as the glass fiber content increased. Therefore UPII has the higher value of tensile strength and tensile modulus compared to UP. The cooperation

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of high tensile performance of glass fibers increases the total tensile performance of the composite laminates.

Figure 1. Tensile strength of the aluminium composite aluminium laminates.

Figure 2. Tensile modulus of the aluminium composite aluminium laminates.

TP have a lower performance in tensile strength and tensile modulus compared to the UP because alkali treatment of the OPEFBF increases the roughness to the fiber.

Figure 3 and Figure 4 show S-N curve for aluminium and hybrid composites laminates. It is evident from these graphs that the AL generally has a superior fatigue performance compared to UR and RP. This means that for the same stress levels, the AL samples have consistently longer life times. UP samples have a longer life times compared with AL at the same stress levels before 7×10^5 cycles. After 7×10^5 cycles, AL has better fatigue performance than UP. For UP and UR lay-ups, the difference in fatigue strength resins is slight, confirming that these lay-ups are fiber dominated.

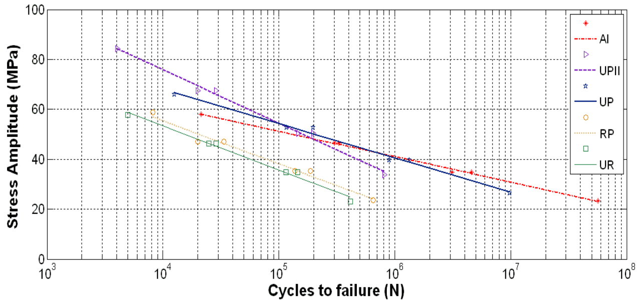

Figure 3: S-N curve for aluminium and hybrid composites laminates.

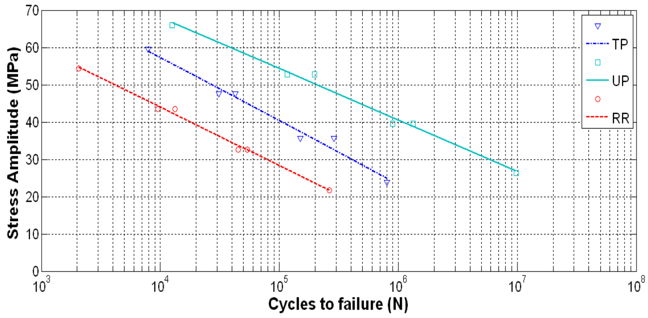

Figure 4: S-N curve for UP, TP, and RR hybrid composites laminates.

Figure 5 and Figure 6 show that the fractographs using Scanning Electron Microscope (SEM) of the glass and OPEFBF reinforced polyester layer in the hybrid aluminium laminates. The fiber pullout is clearly observed. The hybrid composite (Figure 5) is without the fiber surface treatments shows the poor interfacial bonding between fiber and matrix that produces a relatively clean surface over the pulled out fibers due to greater extent of delamination. In the case of the alkali treated hybrid composite laminate the interfacial adhesion between the fiber and matrix is comparatively stronger as indicated from Figure6.

Conclusion

The mechanical performance of glass/OPEFBF hybrid/Polyester aluminum composites laminates was studied. Hybridisation of plain weave fabric and unidirectional OPEFB fibers in aluminum laminates resulted the better mechanical performance. The ratio of the reinforcement is important to optimize the performance of the composite. UPII composite show the best results in tensile test and fatigue test. Thus the glass and OPEFBF hybrid fiber reinforcement in polyester resin with aluminum laminates was cost effective and maintains light weight, surface characteristic of aluminum.

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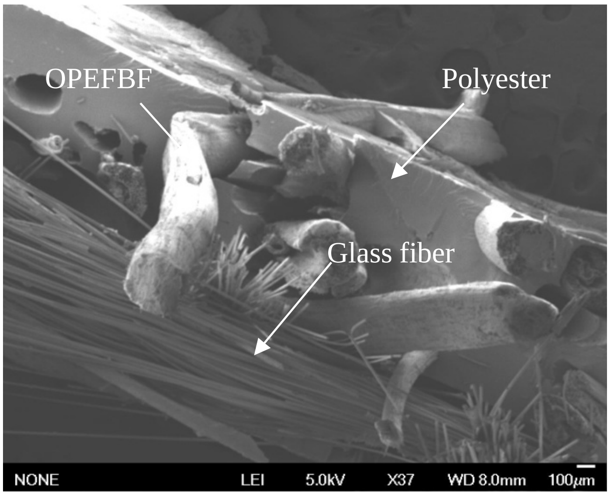

Figure 8. Scanning electron micrograph of tensile fractured surface of untreated hybrid aluminium composite laminates. (magnification X37)

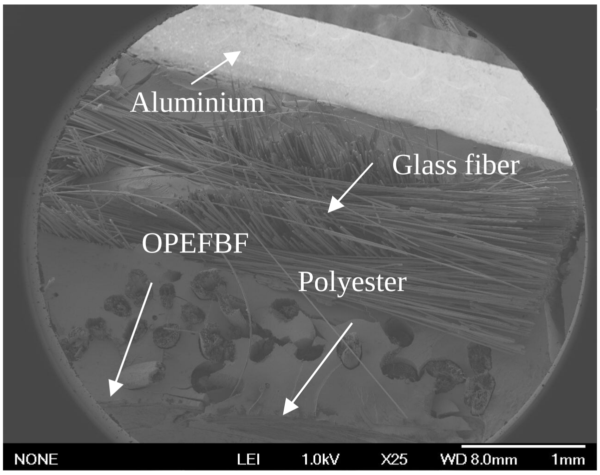

Figure 9. Scanning electron micrograph of tensile fractured surface of alkali treated hybrid aluminium composite laminates. (magnification X 37)

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