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# *Mechanical Properties of Polystyrene/Polypropylene Reinforced Coconut and Jute Fibers*

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*Abstract*— **In this study, polystyrene/polypropylene (PS/PP) reinforced coconut and jute fibers were prepared by injection moulding. The total fiber content was fixed at 10wt% with the ratios of 100/0, 75/25, 50/50, 25/75 and 0/100 weight of coconut fiber/jute fiber. The effects of reinforced coconut and jute fibers on mechanical properties of polystyrene (PS) and polypropylene (PP) have been investigated. Generally, the addition of 10wt% of fiber (consisted of coconut and jute fiber) has increased tensile properties of composites. The tensile strength for composites reinforced 100wt% of jute fiber ratio was higher than composites reinforced 100wt% of coconut fiber ratio due to better mechanical properties of single fiber. However the value of young's modulus were contrast which composite reinforced 100% of coconut fiber ratio shows the highest value and decreased with the increasing of jute fiber. Impact strength of the composites was decreased by adding of 10wt% fibers. The morphology of impact fracture surface was observed by SEM to determine the fracture mode of the composite.**

***Keywords- Natural fibers, Polymer blend composites, Mechanical properties***

## I. INTRODUCTION

Nowadays agriculture resources have been exploded in high technology revolution. The interest in using natural fibers such as jute fibers and coconut fibers as reinforcement in plastic materials has increased dramatically. Non-biodegradable and high cost of synthetic filler has attracted attention researcher to use natural fiber as organic filler. Natural fibers have many advantages compared to the synthetic fiber, for example they have low density, recyclable and biodegradable. Additionally they are renewable material and have relatively high strength and stiffness [2,5]. Combination of low density and good mechanical properties of natural fiber has produced a composite which suitable for structural applications.

Combination of different polymers represents a very attractive route towards new materials. It is also contributed to improve some deficient properties of common plastic. However the mainly disadvantage of this purpose is the weak interfacial adhesion and poor stability of the phase dispersion. The incompatibility between different polymeric phases is affected to the poor mechanical properties of polymer blends. This problem however has been solvent by using various compatibilizers such as ethylene vinyl acetate and sodium salt hydrate. The addition of compatiblizer has significantly improved the mechanical properties of the blend by reducing the by enhancing phase adhesion [1].

In this research, a composite was prepared from polystyrene/polypropylene blend as matrix and combination of jute fibers and coconut fibers. The ratio of coconut fibers and jute fibers were manipulated from the total of 10wt% of fiber loading. The effects of different ratio of coconut/jute fibers on the mechanical properties of composite were investigated.

## II. EXPERIMENTAL

### *A. Material*

Polystyrene (PP) was obtained from recycled mineral water bottle. The PP was crushed and granulated into pellet by using granulator. Polystyrene (PS) with industrial grade HH30 was supplied by Petrochemical (M) Sdn. Bhd.

Coconut fiber and jute fiber were used for reinforcement. The coconut fiber was supplied by T&H Coconut Fiber Sdn. Bhd, Senggarang, Batu Pahat and jute fiber was obtained from recycled rope.

### *B. Composite preparation*

The fibers used were chopped in to the length of 2 – 4 mm. The fibers were soaked and cleaned by 5% ammonia hydroxide (NH4) in distilled water for 24 hours before drying in oven at temperature of 70°C for 12 hours.

Composites were prepared from 90wt% of polymer blend matrix and 10wt% of fiber reinforcement by injection moulding. The temperature was set up based on melting temperature of PS/PP blend which obtained from Different Thermal Analysis (DTA). Polestyrene and polypropylene

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were blended together with ratio 50:50. For the fiber reinforcement, the composition of coconut fiber/jute fiber were controlled into the range of 100%/0%, 75%/25%, 50%/50%, 25%/75% and 0%/100% from the total of 10wt% of fiber loading.

### *C. Measurement of mechanical properties of composite*

A universal testing machine, model Shidmazu AG-10KN was used to measure the tensile properties of composite according to ISO 527 Standard. Charpy Impact test was carried out using Impact tester type Wolpert in accordance with ASTM D256.

### *D. Scanning Electron Microscopy (SEM)*

The morphology of impact fracture surface of the composite was observed by Scanning Electron Microscopy (SEM) JEOL (model JSM-6380LA). The samples were viewed perpendicular to the fracture surface.

## III. RESULTS AND DISCUSSION

### *A. Tensile properties*

The tensile strength of composites with difference ratio of coconut fiber and jute fiber are shown in figure 1. Generally the tensile strength of polystyrene/polypropylene blend is increased when adding 10% of fibers show the role of reinforcement. The increasing of tensile strength is different at difference fiber ratio of coconut and jute fiber. Composite with 100% of jute fiber ratio shows the highest value of tensile strength while the PS/PP blend composite without fiber ratio has the lowest tensile strength. As expected, a decrease in jute fiber ratio would result in the reduction of tensile strength. Only small reduction is observed when the ratio of jute fiber reduces to 75%. It is about 1.61% lesser than 100% of jute fiber ratio. The high value of tensile strength of composite content more jute fiber are related to its single fiber properties which the tensile strength of single fiber of jute fiber is higher compared to the coconut fiber. It has been reported that the tensile strength of any composite are related to the chemical composition of the fiber and its internal structure. Coconut fiber has low strength due to its low cellulose content which play important role in contribute to the strength of natural fiber [2].

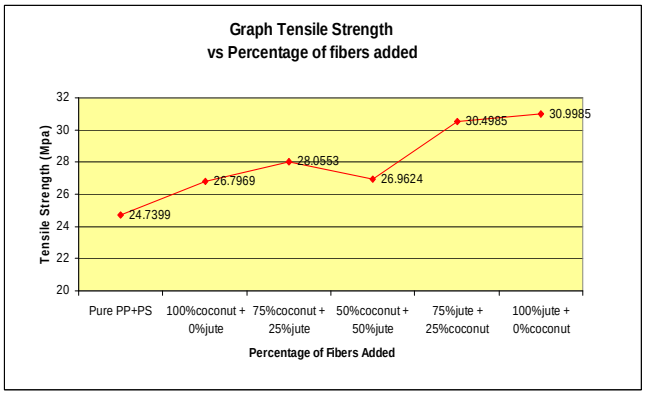


Figure 1. Tensile Strength of composite with difference ratio of coconut fiber/jute fiber.

Figure 2 shows the results of young's modulus. In overall, the young's modulus of composites with 10% fiber loading are higher than PS/PP blend means the adding of fiber has increased the stiffness of composite [7]. The trend of young's modulus value is contrast to the tensile strength which composite with 100% of coconut fiber ratio has the highest value and the composite with 100% of jute fiber ratio has the lowest value. However even the composite with 100% of jute fiber has the lowest young's modulus, it is observed that no significant differences compared to the composites with 75%, 50%, 25% of coconut fiber ratios. The values of young's modulus were in the range of 1.2163 GPa to 1.2244 GPa respectively.

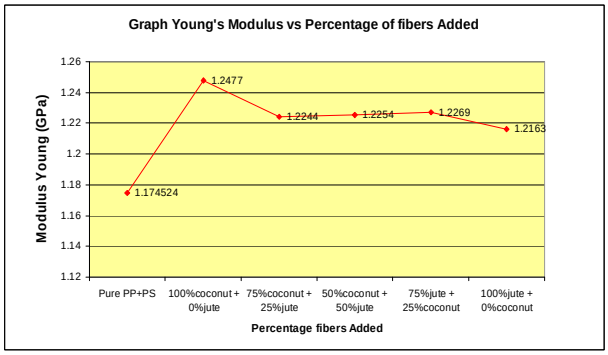


Figure 2. Young's modulus of composite with difference ratio of coconut fiber/jute fiber.

### *B. Impact strength*

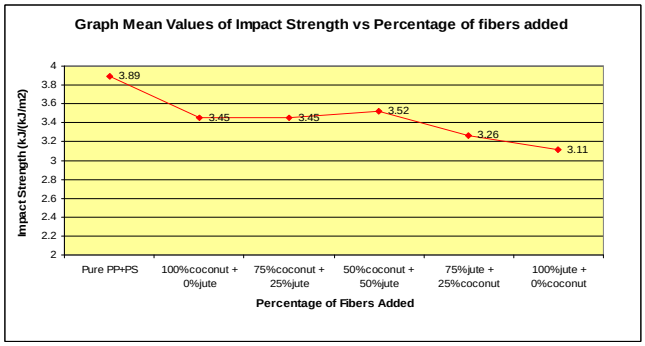


Figure 3. Impact strength of composite with difference ratio of coconut fiber/jute fiber.

Figure 3 represents the results of Charpy impact test. The PP/PS blend has impact strength of 3.89 kJ/m$^2$ and after addition of fiber, the impact strength decreased slightly. As noted by Sanadi et al [10], the impact resistance of thermoplastic generally decreases in the presence of natural fiber. It is known that the interfacial bond strength, the matrix and fiber properties are influenced the impact properties of composites. Impact energy is dissipated by debonding, fiber

and/or matrix fracture and fiber pull out. Fiber fracture dissipates less energy compared to fiber pull out. The failure mechanism of these composite was mainly by fiber pull out due to the weakness of interfacial strength between fiber and matrix. This is revealed by SEM micrograph in figure 4 which shows the fiber pull out at the fracture surface [2,9].

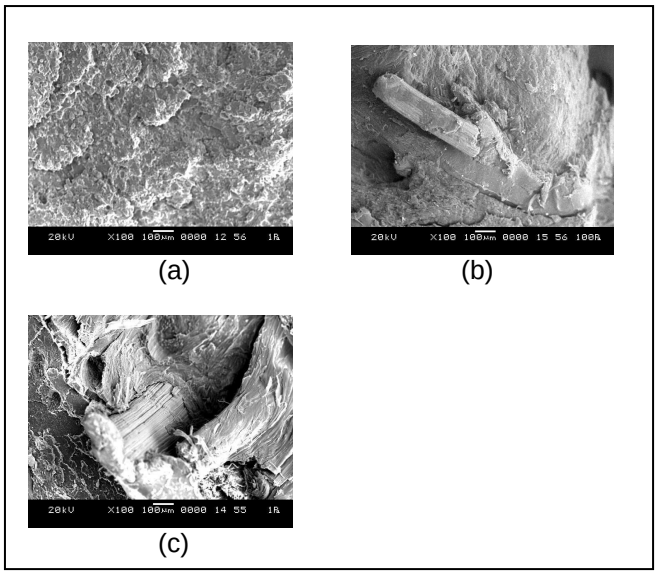


Figure 4. SEM micrographs of impact fracture surface of (a) PS/PP blend, (b) composite with ratio of 0%coconut/100%jute fiber and (c) composite with ratio of 100%coconut/0%jute fiber.

The composites with high volume of jute fiber show the lower impact strength compared to the composite with high volume coconut fiber. In spite of the low tensile strength, coconut fibers demonstrate better impact properties than jute fiber. This is probably due to high strain to failure of the coconut single fiber [2].

## IV. CONCLUSION

The incorporation of coconut fiber and jute fiber into PS/PP blend has increased the tensile strength and young's modulus indicates a better stress transfer from matrix to fiber and stiffness of composites. Jute fiber has contributed in the high value tensile strength of composites compared to coconut fibers due to its single fiber's properties. The impact strength of PS/PP blend were decreased when added fiber. It is observed by SEM that the fracture surface shows the failure mechanism by pull-out indicates the weak interfacial strength between fiber and matrix and effects to the low impact strength of composites.

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