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TENSILE BEHAVIOURS OF ACTIVATED CARBON COCONUT SHELL FILLED EPOXY COMPOSITES

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ABSTRACT

This research is to develop a carbon composite prepared from carbon coconut shell reinforced with epoxy resin. Carbon coconut shell were selected from three types of coconut shell specifically namely as carbon *Komeng* coconut shell (CKCS), carbon young coconut shell (CYCS) and carbon ripe coconut shell (CRCS). The samples were prepared using epoxy resin reinforced with four different weight percentages of three types of carbon coconut shells starting with 0wt.%, 5wt.%, 10wt.% and 15wt.%. The Tensile behaviour of all samples was investigated to characterize the quality of the samples. The morphological study of reinforced samples was also conducted in this research by using SEM machine. The chemical composition and surface chemistry of these coconut shells were also determined to evaluate its importance in determining the end-use properties of composites.

***Keywords*:** Coconut; Epoxy Resin; Reinforced; Tensile.

INTRODUCTION

Coconut shell is non-food part of coconut which is hard lignocellulosic agro waste. It was reported that contain of coconut shell ratio to overall coconut fruit itself in percentage, it has only 15–20% (Andrzej et al., 2010). Asia region, Malaysia, Indonesia, Thailand, and Sri Lanka are major producing country of natural filler coconut shell. In 2011, nearly 100,000 hectares of land have been utilised for coconut plantation that yields over 577,000MT of coconuts annually thus putting Malaysia as the 10th largest coconut producing country in the world (UNCTAD 2012). Agro waste product such as coconut shell is an annually increase every years and is available in abundant volume throughout the world. Agro waste raw materials could be a potential alternative replacing wood for making composite material particularly for automobile, packaging and construction applications. In fact, several automobile makers in Europe are using natural fibre composites in their car like a Mercedes Benz sedan (Monteiro et al., 2010). Previous research already discovered that lignocellulosic raw material such as coir fibre has been used for making composites reinforced with polymeric resin such as polyester (Santafé Júnior et al., 2010). Another part of coconut such as coconut shell reinforced Polypropylene also reported (Bledzki et al., 2010). Previous report also indicated that fibre length of coconut fibre reinforced epoxy resin varied the mechanical properties of composites (Sandhyarani at al., 2011). Apart from composite materials, the particleboards from agro by-product could be another potential alternative (Awang et al., 2012). Nowadays, special concern has been manifested towards ‘‘green composites”. Some of the effort has been based on the use of new waste sources, with the aim to obtain biologically active compounds which can be applied in different fields and applications (Awang et al., 2012). The waste of coconut fruit shell or crust are totally not being used and normally discarded as garbage (Monteiro et al., 2010). Currently, defective coconut such as *Komeng* coconuts are considered as having no economic value and not utilise for composite in engineering application (Andrzej et al., 2010). In this paper, three types of coconuts have been used such as CKCS, CYCS and CRCS for investigating the tensile behaviour. Activated Carbon (AC) was produced and reinforced with all these carbon to fabricated composite.

MATERIALS AND METHODS

All the coconuts shells firstly were weighed using digital weighing machine; then they were cleaned with fresh water and lastly dried at room temperature. After that all the coconuts shell were burnt in the oven with temperature ~80^{o}C until 5 minutes so that it become coal or powdered ash. Epoxy resin and hardener were used type 3554A with the density of 1.15 g/cm^3. The dumbbell-shape samples were prepared according to the standard ASTM D2099 for tensile test. Tensile tests were carried out using an Instron machine at Mechanical Engineering Department UPM Serdang Malaysia. The surfaces of the specimens are examined directly by scanning electron microscope model Hitachi accompanied with XRF to determine the chemical composition of the specimens.

RESULTS AND DISCUSSION

Figure 1 shows the tensile stress for all samples CKCS, CYCS and CRCS with different weight percentage (wt.%). It was shown that tensile stress trend for CKCS coconut carbon composite slightly increased start from 5 wt.% to 15 wt.%. Compared with CYCS and CRCS strengthen coconut carbon composite decreased dramatically even though CRCS a little bit increased at 10 wt.% of carbon content. The increasing of carbon content internally occurred might make the strength of CKCS sample higher than CYCS and CRCS samples. It can be seen that tensile stress of the composites increase with an increase of the filler content. The composites demonstrate somewhat linear behaviour. Mechanical properties of the coconut carbon shell composites depend on several factors such as the stress–strain behaviours of carbon and matrix phases, the phase volume fractions, the carbon concentration, the distribution and orientation of the carbon or fillers relative to one another. The increase of the filler content, results in the increase in tensile stress. This is due to the fact that coconut carbon filler particles strengthen the interface of resin matrix and filler materials. The maximum tensile strength of 10% filler composite was higher (18.34 MPa) belong CYCS at Figure 1(a) compared to other two combinations. While the trend for CKCS shows slightly increase at 15% with 15.55MPa starting from 5% carbon content at Figure 1(b). At lower concentration of the filler material, specimen CYCS and CRCS demonstrated slightly linear behaviour prior to sharp failure or fracture. This means that specimen deformed plastically immediate after elastic deformation.

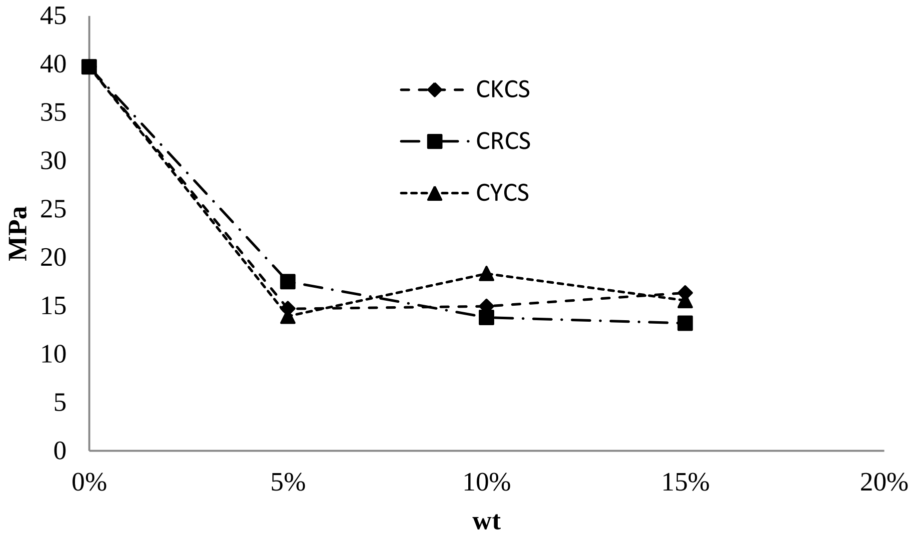

Figure 1. Tensile stress CKCS, CRCS CYCS composites.

Figure 2 shows the tensile strain for all samples CKCS, CYCS and CRCS with different weight percentage (wt.%). The graph shows tensile strain varied with difference weight percentage of AC contents. Starting with 5wt%, tensile strain at break for CKCS sample shows maximum value with 1.47% compared with CYCS and CRCS samples. Tensile strain drastically decreased from 1.50% to 0.80% for CKCS samples until met together at 15wt% with strain value is ranging from 0.60% to 0.70%.

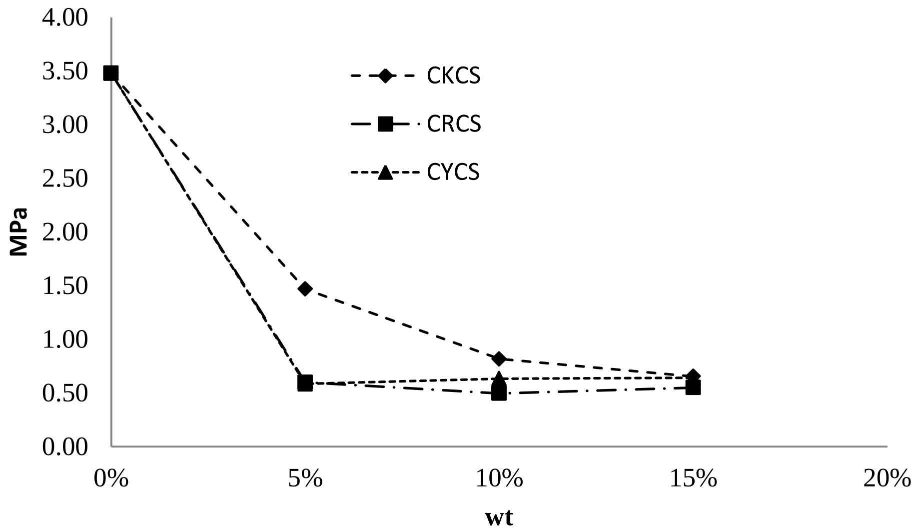

Figure 2. Tensile strain CKCS, CRCS and CYCS composites.

Figure 3 shows the tensile modulus for all samples. From the graph, CKCS composite show spontaneously increased their modulus when compare with CRCS and CYCS even though CYCS achieved the maximum tensile modulus 3161MPa.

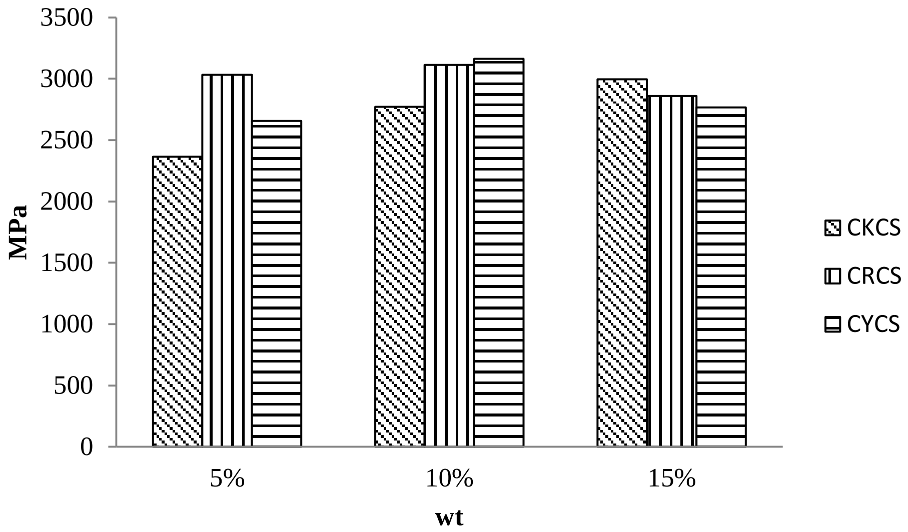

Figure 3. Tensile modulus CKCS, CRCS and CYCS composites.

Chemical compositions with microphotographs of the selected for coconut shell are shown in Figures 4, 5 and 6 show that the inspection spectra of coconut shell internal surface elements acquired for CKCS, CYCS and CRCS respectively. The samples exhibit spectra containing mainly carbon, chlorine, kalium, oxygen and small amount of silicon, potassium, sulphur, and magnesium. The higher proportion of carbon in coconut shell can be attributed to the presence of hydrocarbon rich waxy coating on the cuticle of endocarp of coconut shell when present on the surface as activated carbon applications (Awang et al., 2012). The silicon contains in samples may have the influence on the properties of activated carbon reinforced composites. The oxygen content for CKCS also contributed for the toughness of the composite as usual if compared with CYCS and CRCS samples. This can be determined with the CKCS sample where the tensile behaviour is drastically increase when contents of AC are proportional increased. All these two composition made the composites more strength compared to others natural composite materials (Andrzej et al., 2010).

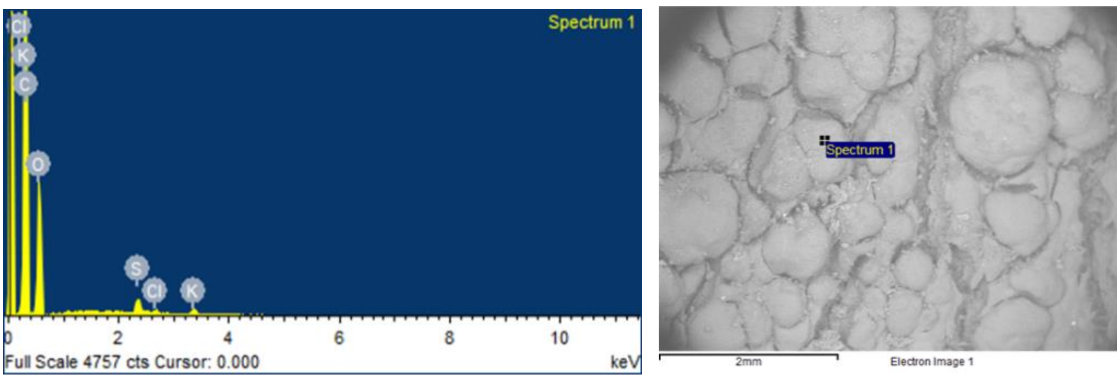

Figure 4. Elementary analysis of coconut shell CKCS.

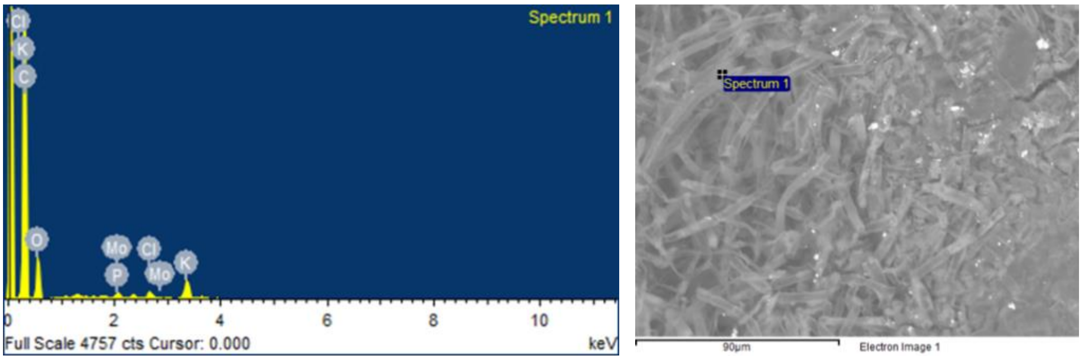

Figure 5. Elementary analysis of coconut shell CYCS.

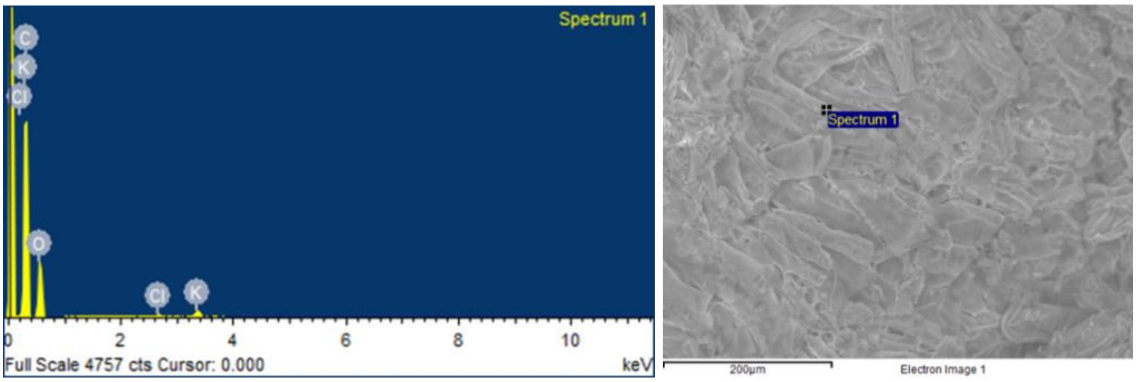

Figure 6. Elementary analysis of coconut shell CRCS.

CONCLUSIONS

In conclusion, CKCS carbon composites show the good achievement for tensile behaviour because they have the better results for tensile stress, tensile strain and tensile modulus when compared with CRCS and CYCS carbon composites. From the results it was obtained that, the toughness of the samples especially CKCS carbon composite increased when rich with the carbon, silicon and oxygen contents. The maximum tensile stress was led by CYCS sample with 18MPa but CKCS has a continuing higher stress with 16MPa for 15wt.% carbon content.

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REFERENCES

Andrzel K., Bledzki A., Abdullah A., Mamuna, Juϋrgen Volk 2010.Barley husk and coconut shell reinforced polypropylene composites:The effect of fibre physical, chemical and surface properties, *Composites Science and Technology,* 70, 840-846.

Awang L., Salleh Z., Yusop M.Y.M., Roslee A.A., Sapuan S.M and Ishak M.R., 2012. Mechanical Properties and Microstructure of Cocos Nucifera (Coconut) Coir Fibres. *The Asian International Conference on Materials, Minerals, and Polymer (MAMIP2012) Proceeding, Vistana Hotel, Penang, Malaysia, 23-24 March 2012*, 34-40.

Bledzki A.K, Abdullah, Abdullah A. And Volk, J. 2010. Barley Husk and Coconut Shell Reinforced Polypropylene Composites: The Effect of Fibre Physical, Chemical and Surface Properties, *Composites Science and Technology,* 70, 840–846.

Monteiro S.N, Satyanrayana K.G, Ferreira A.S, Nascimento D.C.O, Lopes F.P.D, Silva L.D, Bevitori A.B, Inacio W.P, Bravo Neto J, And Portela T.G, 2010. Selection of High Strength Natural Fibres. *Journal of Revista Matéria,* 15,488-505.

Monteiro S.N, Terrones L.A.H, Lopesa F.P.D And Jose Roberto M. Mechanical Strength of Polyester Matrix Composites Reinforced with Coconut Fibre Wastes. *Journal of Revista Matéria*, 10, 571-576.

Santafe Junior H.P.G, Lopes F.P.D., Costa L.L, Monteiro S.N.,2010. Tensile Behaviour of Lignocellulosic Reinforced Polyester Composites: Part III Coir Fibre. *Journal of Revista Matéria*, 15, 202-207.

Sandhyarani Biswas, Sanjay Kindo And Amar Patnaik, 2011. Effect of Fibre Length on Mechanical Behaviour of Coir Fibre Reinforced Epoxy Composites. *Journal of Fibres and Polymers*, 12, 73-78.

United Nations Conference on Trade & Development, AAACP Products, Coconut, Retrieved April 23, 2012, from http://www.unctad.info/en/Infocomm/AACP-Products/Commodity-Profile---Coconut2/