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contents

Editorial	2
Change of Guard	3
“Green” Poem by Maimunah Ismail	4
Article	5-23
<ul style="list-style-type: none"> Effect of Temperature on the Strength Properties of Adhesively Single-Lap Bonded Joint for Composite Laminates Oil Palm Trunk Biocomposite: Mechanical and Morphological Properties Incorporation Of Rice Straw Into Clay Bricks Study of Cocoa Pod Husk / Polyvinyl Alcohol (PVA) as A New Biodegradable Composite Film Extending the Service Life of Crude Oil Export Line using PIPEASSURE™ Composite Overwrap Repair System Composite Polymer Electrolytes Based on MG49 and Cellulose from Kenaf as Reinforcing Filler 	
Events and activities of IMM	10-25
<ul style="list-style-type: none"> IMTCE2012 PETRONAS Skill Group 15 (Materials, Corrosion & Inspection) Pipeline Integrity Seminar & Networking Cocktail Associate Welding Engineer (AWE) and Welding Engineer (WE) Asian Welding Federation (AWF) Common Welder Certification Scheme (CWCS) Microbiologically Influenced Corrosion (MIC) PETRONAS Skilled Group 15 (Materials, Corrosion & Inspection) Coatings Course Welding and Joining Technology for Non - Welding Personnel IMM Visits Kuching Asian Welding Federation (AWF) Meetings New Approaches to Sustainable Materials Research at CSIRO Materials Science and Engineering Evening Talk on the Good and Bad Practice in Fabrication and use of Stainless Steels 	

*Wishing all Chinese members and readers
 “Gong Xi Fa Cai”*



EDITORIAL FOR THE IMM MATERIALS MIND ISSUE NO.2



Greetings to all IMM Members and intending members and a Happy New Year! 2012 saw a very exciting year for the IMM with many Firsts:-

First IMTCE event with increased participation from the academia (IMTCE2012 held in July 2012).

- First issue of the IMM magazine called “Materials Mind” to replace the IMM Newsletter.
- First Materials Lecture Competition for University students.
- First IMM Green Materials Award.
- First IMM Student Chapter established at Universiti Tunku Abdul Rahman.
- First interview by New Straits Times Press for the NST Postgraduate Special Issue.

The signature IMM International Materials Technology Conference & Exhibition “IMTCE” held its 8th conference in July 2012 at the Sunway Lagoon Resort Hotel. For the first time, there were more academic involvement from postgraduate students, lecturers and researchers highlighting latest research and advances in materials science & engineering. Papers from this event were also accepted for publication in various Scopus Index journals. IMM offers an excellent platform for industry and academia to network, exchange knowledge, experience & information, and to encourage commercialization of academic research into industrial applications.

The Organizing Committee for the next IMTCE2014 has already started its organizing activities and aims to make the next event more meaningful for everyone involved in materials science & engineering. I hope our members will help to disseminate the information about IMTCE2014 to everyone you know throughout the world. The conference theme, “ Synergizing Industry & Academia – Innovations for Industrial Applications “, is timely as the world needs materials research which can be utilized for actual industrial applications.

IMM is also the only professional society that offers free membership to members of other professional societies or associations. The Council of IMM acknowledges that professionals and skilled personnel are faced with many

annual subscriptions to pay if they have to join many related societies or associations. As such, IMM offers free affiliated “ Ordinary Member “ membership to anyone who is already a member of another society or association. IMM encourages people from all walks of life to join us to understand “Materials” better and offer their specialty skills to mankind. For example, medical prosthetics are made of special materials and as such, medical doctors and nursing specialists need to acquire a proper understanding and appreciation of prosthetics. Even dental materials are special and the public needs better knowledge and understanding of such materials. Civil engineers, Mechanical engineers, Chemists, Physicists, and many other disciplines of engineers and scientists can benefit from a better understanding of Materials Technology. So, IMM welcomes doctors, nurses, dentists, engineers, chemists, physicists, lawyers, bankers, and others to become Ordinary Members with no requirement to pay annual subscriptions if they are already a member of their own societies or associations. This is in line with IMM’s objectives to encourage education in Materials science & engineering for the public.

The Materials Mind magazine of IMM offers information on activities of the institute as well as technical papers, product updates and new technological innovations to be made available to our members. Members are encourage to contribute articles and recent technological news to the Materials Mind.

On behalf of the IMM, I invite everyone to join the institute and help us to improve everyone’s knowledge of “materials” for a better life.

Best wishes for the coming Chinese New Year celebrations,

Ir. Max Ong
Chairman – IMM Publications Committee.



Prof. Dr. Mohd Kamal Harun (R) receiving the medallion from Dato' Dr. Ong Eng Long

CHANGE OF GUARD

Congratulations! The Institute of Materials, Malaysia (IMM) is 25 years old this year and will celebrate its Silver Anniversary in 2012 in conjunction with the 8th International Materials Technology Conference and Exhibition (IMTCE2102).

The predecessor, Malaysian Materials Science & Technology Society (MMS) was registered with the Registrar of Societies on 6th November, 1987. The main objective of MMS was to actively create and promote awareness of Materials in Malaysia, which the society did so since 1988. In 1996, the change of name to the Institute of Materials, Malaysia (IMM) was effected on 16th June 1997 with a newly-elected Council. Since then, IMM has not looked back and has continued its policy of being a non-profit society of professionals who continues to promote honourable practice and professional ethics and encourage education in materials science, engineering and technology.

Twenty five years on, IMM now have several courses that are specially created to meet industry needs, such as the Blasting and Painting Certification, Coatings Inspector, Quality Control Technician, Welding Inspector schemes amongst many other technical courses. To promote awareness of materials, relevant seminars on materials, materials technology and engineering are being held at regular intervals. Biennially, the international technology conference and exhibition are held to provide an avenue to professionals, industrialists and academicians to share their research work. There will also be opportunities to network amongst the local and international materials fraternity.

For the last four years, IMM was very fortunate and privileged to have Dato' Dr OngEng Long, a rubber researcher sit as the President. With Dato Dr Ong at the helm, several milestones were achieved. These include the first IMTCE being outside Kuala Lumpur. In 2010, Kuching hosted the 7th IMTCE with much grandeur. The Annual IMM Golf Invitational was introduced in 2010 to offer networking opportunities in a relaxed and friendly environment. Three Memorandums of Understanding were signed under his leadership – with the Institute of Materials, Minerals and Mining, SSPC: The Society for Protective Coatings and the Sabah Skills and Technology Centre in Kota Kinabalu. In an unprecedented move by any society, IMM now offers free membership to active members of other societies.

In March 2012, Prof Dr Mohd Kamal Harun was installed as the President of IMM. Prof Dr Kamal completed his PhD at the University of Manchester, Institute of Science and Technology (UMIST). He served as a professor of chemistry at the Faculty of Applied Science in Universiti Teknologi MARA, Shah Alam, until his secondment to the Universiti Malaysia Kelantan (UMK) as the Head of Research. Prof Kamal's main interest is electrochemistry, in particular metallic corrosion.

IMM also salutes Dato Dr Ong for his vision, guidance and leadership during his tenure. TerimaKasih and Syabas!

Green...

*Green...is not just that... electromagnetic radiation
The wavelength which is in the visible light spectrum
Neither is it...those novices in organisation
Nor the immaturity of any governance system*

*Green...can be clever ways and actions
To sustain natural resources and environment
Purification, Remediation, and Caption
Reclaim and Recycle...deserving compliments*

*Green Technology and Green Materials
Are emerging to reduce dependency
From wasteful practices that gave denial
The time for mother-nature from recovery*

*Green in Cultures connote meanings
From Love and Lust, to Evil and Death
But civilized worlds are all agreeing
That it means Hope and prospects for mother Earth*

*Alas... if greed is allowed to prevail
Creating disharmonies in the brew
All commendable efforts are bound to fail
This blue green planet will eventually... lost its hue*

*Would we then look at outer space?
Unload our mistakes as inter-galactic litterings
Or would we eventually evolved as...
The incredible...*

Green beings?

*Maimunah Ismail
Presented at IMTCE2012*

Effect of Temperature on the Strength Properties of Adhesively Single-Lap Bonded Joint for Composite Laminates

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ABSTRACT

The use of adhesive bonding is valued in structural design in which the single-lap joint has been widely used in the manufacture of aerospace and automotive structures. It has been anticipated that improper or inadequate surface treatment is the most known cause of failure in adhesive bonding. Hence, the objective of this research was to study the effect of surface preparation with different surface roughness by using different number of grit (#220, #400 and #600) of sandpapers on the joint strength of adhesive bonding for glass fiber composites. In addition, effect of various temperatures for different surface roughness on the joint strength has also been investigated through tensile tests under different temperatures. The relationship between joint strength with its surface roughness and temperatures effect was observed. It was found that as the mesh number of grit increased, surface roughness decreased, leading to the increase in joint strength due to better mechanical resistance or interlocking of joints. At temperature below T_g , the adhesive became brittle, leading to a reduction in strength. But, as the testing performed at higher temperature (70°C), the highest strength of bonding was obtained. At 130°C, the adhesive softened and was unable to sustain the load which led to the decrease in joint strength. Finally, the failure mode on the bonded region was analyzed and categorized as adhesive failure, cohesive failure, and mixed failure.

Keywords: Adhesive bonding, joint strength, single lap joint, failure analysis

INTRODUCTION

The use of structural adhesives in engineering applications can offer substantial benefits in comparison to more traditional joining such as mechanical fastening and welding. Many authors have made various attempts to investigate the effects of various factors on the stresses in the adhesive layer and the joint strength [1-6]. These factors include spew fillet [7], bondline thickness [8], overlap length [9, 10], environmental conditions [11] and surface preparation [8, 9]. Single lap joint was widely known and used to characterize bond strength [9, 12], as its arrangement is very common in practice and simple design rules should be available for design purposes.

A proper surface pretreatment is essential for achieving good bond strength with any adhesives, which include physically, mechanically and chemically alteration of the surfaces. At minimum, the adherend surfaces that are prepared for bonding should be clean enough to provide a good adhesion. A variety of surface treatments have been used to increase surface tension and surface roughness and to change the surface chemistry, thereby increase bond strength and durability of adhesive joints [13-15]. Grant et al [12] has used acetone to degrease the adherend surfaces and followed by grit blasted to give a surface finish of 2.5 μm of surface roughness. Lucas et al [9] has used #800 SiC sandpaper to treat the surfaces of adherend, together with the acetone to degrease and clean the surface. Kim et al [8] and Katona et al [14] have observed that as mesh number of abrasive paper increased, surface roughness has decreased within the range from 0.5 to 2.1 μm , thus improving the joint strength [8]. Comyn [13] has indicated that surface treatment was very important in removing contamination and weak boundary layers and hence, changing the morphology and surface chemistry of the adherends. In addition, wet channel treatment was also proposed to improve the durability of bond in wet air.

Normally, the adhesives used for the adhesive bonding have its specific properties within the certain range of temperature. The adhesive and the adherend can become brittle due to low temperatures or may melt or decompose under conditions of extreme heat. Grant et al [16] has found that failure load of lap joints under tension at both 90°C and -40°C showed some decrease in strength of the joint as the bondline thickness increased in comparison to those joints tested at 20°C. Likewise, Zhang et al [17] has proposed the effect of low and high temperatures on tensile behavior of adhesively-bonded glass fiber reinforced polymer (GFRP) joints. The failure mechanism has changed with increasing temperature from fiber-tear to adhesive failure. The temperature changes in adhesively bonded joints would cause a wide variety of different stress states [18, 19]. As the adhesive was heated, its viscosity was reduced, thus enabled it to flow and wetted the surface. In contrast, the adhesive will turn brittle at lower temperature, leading to a reduction in strength and greater scatter in the results.

In this study, the strength and failure modes of the composite adhesive joint are presented with respect to the surface treatment with different mesh number of sandpaper (220, 400 and 600) and environmental temperature conditions (ambient, 70°C and 130°C). In addition, the effect of surface roughness of the treated surfaces is also analyzed. There are few available test methods that could be utilized to determine the joint strength of adhesive bonding, but the tensile test on a single lap joint is chosen to determine the joint shear strength.

METHODOLOGY

The adherend used was 6-layer of Glass fiber 7544/7000 plain weave with 600g/m² and the resin was a high temperature epoxy Epolam 2025 with glass transition temperature, T_g of 140°C. The laminate was cured in the oven at 100°C for 90 min and left it under vacuum for 1 atm of pressure. The average thickness of the six layers of fiberglass after curing was about 2.7mm. Araldite 2014 was selected as the adhesive for this study where it can sustain high temperature condition with good chemical resistance.

The adherend surfaces were treated using three different mesh numbers (#220, #400 and #600) of sandpapers to analyze the effect of grit number to the value of surface roughness of the adherends. Following the treatment, the specimens were placed into the ultrasonic bath with acetone solvent at 50°C for 15 minutes to clean and degrease from any contamination. A clean surface is necessary condition for adhesion [1] and is very important for the efficient bonding. Following the ultrasonic cleaning, the specimens were dried at 80°C for 15 minutes. Prior to the bonding, the surface of the adherends was analyzed using Alicona Optical machine to determine the surface roughness.

The specimens were bonded with 0.5 mm of adhesive thickness for single-lap joint (SLJ) by using the bonding jig to ensure the bonding in the good alignment and dimensions as shown in Figure 1. The SLJ specimens were then cured using vacuum bagging and were placed in the oven at temperature of 80°C for 4 hours. The vacuum bagging process was performed in order to eliminate the void at the adhesive layer, hence enhance the bonding.



Figure 1: Single-lap joint with dimensions in mm

A total of 12 specimens have been proposed for the project with the specified conditions as shown in Table 1 below. Tensile tests were conducted using Universal Testing Machine (UTM) under three different temperatures of ambient temperature (25°C), 70°C and 130°C to study the effect of temperature on the joint strength. The specimens were subjected to loading under a constant crosshead rate of 1.0mm/min until total failure.

Table 1: Testing sample with conditions

Specimen	Surface preparation	Testing temperature	Specimen	Surface preparation	Testing temperature
A	Without sanding	Ambient	G	*#400	70 °C
B	*#220	Ambient	H	*#600	70 °C
C	*#400	Ambient	I	Without sanding	130 °C
D	*#600	Ambient	J	*#220	130 °C
E	Without sanding	70 °C	K	*#400	130 °C
F	*#220	70 °C	L	*#600	130 °C

*: mesh number of sandpaper used for surface preparation

RESULTS AND DISCUSSION

Surface Roughness Analysis

Figure 2 shows the 2D and 3D profiles of the adherends for different mechanical treatments. It was noticed that the adherend surface without the sanding provided the roughest surface properties. The surface roughness of the adherend surfaces changed when treated with the sandpapers. It was found that the surface of the adherends showed some noticeable scratches on the macro-scale.

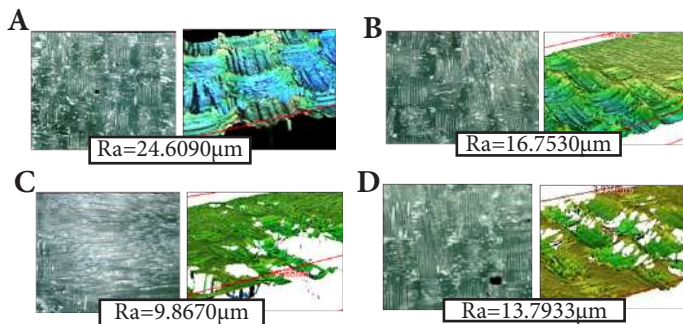


Figure 2: 2D and 3D images for glass fiber adherends: (a) without sanding, (b) sandpaper #220, (c) sandpaper #400 and (d) sandpaper #600

As the mesh number of sandpaper increased to #400, the surface roughness, Ra has found to decrease. Among the considered range of the sandpapers, the mechanical treatment using #400 sandpaper has caused the lowest surface roughness. However, the surface treated with #600 sandpaper has not changed significantly if compared to those of the #400 sandpaper. As the sandpaper with higher mesh number is extremely smooth, it is unable to create a distinct effect on the surface of the adherend. The average surface roughness, Ra for the specimens with respect to mesh number of sandpaper was given in Figure 2.

Joint strength analysis

Figure 3 indicates the joint strength of the adhesive bonding with respect to mesh number of sandpaper at three different temperatures. It was clearly shown that the SLJ strength of the adhesive bonding has increased when treated. At ambient temperature, the untreated specimen has attained the lowest SLJ strength of 26.63 MPa. The joint strength was found to increase after the treatment with #220 sandpaper. It has obtained the increase in strength of approximately 10.5% compared to the untreated counterpart. The surface sanding enables loose and unstable polymers to be removed from the surface, thus increasing the contact surface area [20]. The adhesion is resulted from the molecular contact between the adhesive and adherends, in which the surface forces are developed; as a result of spontaneous wetting.

The SLJ strength was at the highest when adherend was treated with #400 sandpaper, which was at 29.958 MPa. It was shown that the wetting ability of the specimen was better compared to those treated with #220 sandpaper. However, the SLJ strength has decreased slightly as the

#600 sandpaper was used. This was attributed to the extremely smooth abrasive materials, unable it to create a distinct effect on the adherend surface as those of using #400 sandpaper. Similar results were observed for those specimens treated in different environmental conditions with temperatures of 70°C and 130°C. The untreated specimens have achieved the lowest single lap joint strength whilst the highest single lap joint strength was obtained for the specimens treated with #400 sandpaper.

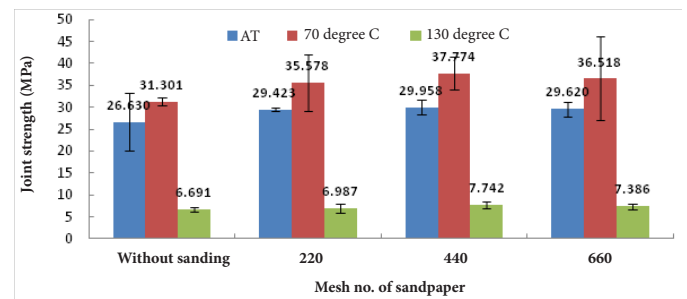


Figure 3: Joint strength of adhesive bonding with respect to mesh no. of sandpaper at AT, 70°C and 130°C

It has been noticed that the joint strengths were increased for all types of specimens when the environmental temperature changed to 70°C from the ambient temperature and were decreased when environmental temperature reached 130°C. As adhesive used is a temperature-dependent, the structural behavior of adhesively-bonded joints is expected to change significantly with temperatures. At 25°C (ambient), the adhesive behavior is relatively hard, inflexible and brittle, at very low viscosity. When the temperature (70°C) was approaching T_g, more uniform stress distribution occurred at the joint, as adhesive behavior became more soft and flexible. The adhesive viscosity was at optimum and a complete wetting of adhesives was observed uniformly over the surface of adherends. However, at temperature above T_g (i.e. 130°C), the joint strength of adhesive bonding strength and stiffness has decreased. The ductility of the adhesive was higher than those in other temperatures as strain capability was increased but the load capability was low due to extremely high viscosity.

Failure mode

The failure mode of the specimens is summarized in Table 2. Significant differences in failure mechanisms were observed at different temperatures and different surface roughness. Although in all cases cracks nucleated and propagated at both ends of the bonded region, the failure processes could be classified into three distinct categories: cohesive failure, interfacial failure and mixed failure. At ambient temperature, an interfacial failure was observed because of the brittle property of the adhesive. At 130°C, the dominant failure mode was a cohesive failure as the adhesive became ductile with lower tensile strength. But, the failure mechanism changed at the glass transition temperature, from mixed failure to cohesive failure for specimen treated with #400 sandpaper. This was attributed to the effective and good adhesion of mechanical interlocking between interface of adhesive and adherend.

Table 2: Failure mode for specimens tested

Failure mode		
Cohesive failure	Interfacial failure	Mixed failure
Without sanding (130 °C) #220* (130 °C) #400* (130 °C) #600* (130 °C) #400* (70 °C)	Without sanding (AT) #220* (AT) #600* (AT)	Without sanding (70 °C) #220* (70 °C) #600* (70 °C) #400* (AT)

*: mesh number of sandpaper used for surface abrasion; Cohesive failure: separation is within the adhesive; Interfacial failure: separation appears to be at the adhesive-adherend interface; Mixed failure: a mixture of different classes

CONCLUSION

Joint strengths were found to increase for all types of specimens at 70°C; a complete wetting of adhesives was observed uniformly over

continue page 23

Oil Palm Trunk Biocomposite: Mechanical and Morphological Properties

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ABSTRACT

In this research oil palm trunk biocomposites were produced by impregnating dried oil palm trunk with phenol formaldehyde resin. Peripheral region of oil palm trunk bottom parts were kiln dried until it attain 13%–15% moisture content, after that dried oil palm trunk impregnated with phenol formaldehyde resin by using high pressure vessel. In this study impact and compression properties of oil palm trunk biocomposites were studied. It observed that impregnation of oil palm trunk with phenol formaldehyde resin improves the impact and compression properties of oil palm trunk biocomposites. The oil palm trunk biocomposite with 60% resin loading showed better mechanical performance than other oil palm trunk biocomposites but still lower than rubberwood. Scanning electron microscope was used to study the surface morphology of oil palm trunk, and location of resin in the oil palm trunk biocomposites at different resin loading. The phenol formaldehyde resin showed better interaction in oil palm trunk impregnated with 60% resin loading and resin penetration still retain the original dried oil palm trunk structure.

Keywords: oil palm trunk biocomposite; dried oil palm trunk; rubberwood; phenol formaldehyde

INTRODUCTION

Oil palm plantations in Malaysia is close to 4.05 million hectares and during replanting process, it generates approximately 8.2 million tons of oil palm trunk (OPT). Constraint for the use of oil palm trunk as value added product making it a serious pollution problem in the field. The OPT are normally left to rot or burnt in the field and this method is now unacceptable because it could affect the process of planting new crops [1,2]. The high density variation within the oil palm trunk has a significant effect on its strength properties. Based on study by Lim and Gan [3], the modulus of rupture (MOR) and modulus of elasticity (MOE) are found to be linearly correlated to the OPT density. Therefore, the selection of OPT to be value-added product need to consider the variability over the trunk, both radially and vertically.

Phenol Formaldehyde (PF) resins are the most important and common class of resin adhesives. The PF resin is the most frequently used and environmentally more acceptable because of negligible formaldehyde emission. PF resins tend to be the most widely used adhesives for bonding wood products due to the excellent adhesion to lignocellulosic, durable, provide high quality wood bonding and suitable for use under all climatic conditions [4]. However, conventional PF adhesives are slow curing, require higher curing temperature, and are less tolerant to variations in anatomical features and wood substrate. The role of the PF resin in the oil palm trunk is to transfer the load to the stiff fibers through shear stress at the interface. In addition, with the help of PF resin properties, the fiber will act as obstacles to impede the crack propagation [5].

Studies on the enhancement of OPT characteristic to become high performance product in dimensional stability, durability, and strength has been done by Edi Suhaimi [6], Erwinsyah [2] and Bakar [7]. The thermal properties of OPT modification has been studied by Bhat et al. [1] and showed a great thermal and degradation stability. In the other hand, the biodeterioration exposure of modified OPT with termite have been done by Edi Suhaimi [6] that exhibited better resistance properties compared to unmodified OPT. Oil palm trunk is largely composed of parenchymatous tissues with numerous fibrous strands and vascular bundles. The tough vascular bundles are scattered in soft parenchyma tissue. Toughening the oil palm trunk with PF resin is novel approach to produce a new type of palm lumber and as an alternative source for wood based industries.

EXPERIMENTAL

Materials

The oil palm trunks at 25 years old were taken from KL-Kepong Berhad Plantation in Kulim, Kedah. Only bottom parts and outer region from oil palm trunk were chosen for drying and impregnation process. The phenol formaldehyde (PF) resin was obtained from Hexion Specialty Chemicals Sdn. Bhd

Preparation of Oil Palm Trunk Biocomposite (OPTB)

The outer parts of the OPT were cut into dimensions 1000 x 70 x 70 mm and later kiln dried for 20 days using kiln dried schedule IV to obtain approximately 13–15% of moisture content. The dried OPT was impregnated with PF with different resin loading (30%, 60%, and 90%) using a high-pressure vessel. The dried OPT were put in the pressure vessel for impregnation process at 5 bar pressure. Figure 1 (a) and (b) showed the schematic of impregnation process which occurs in oil palm trunk. The time of impregnation varied from 15 to 45 min for different percentages of resin loading. The oil palm trunk biocomposite (OPTB) impregnated with PF resins were cured for 2 hours in an oven at 150°C respectively.

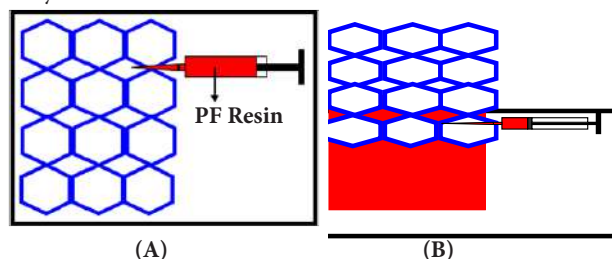


Figure 1: (a) The schematic drawing of dried oil palm trunk intercellular cavities structure, (b) PF resin penetrated into the oil palm trunk intercellular cavities structure.

Impact test

Impact tests were based on ASTM D256; Standard Test Method for determining the Izod Pendulum Impact Resistance of Plastics. Sample dimension for impact test is 60 × 20 × 12 mm. Sample was tested using Charpy test. Before test is done, V-notch must be made on the sample. V-notch can be done using Gotech V-notch machine. Depth of V-notch is 2 mm and angle of V-notch is 90°. Weight of impact pendulum is 2.72 J and speed 3.46 m/s.

Compression test

Compression test is done with sample dimension of 60 × 20 × 20 mm according to BS EN 373: 1957. This test is conducted using Instron machine with speed of moveable head is 0.64 mm/min.

Scanning Electron Microscopy (SEM)

Scanning electron microscope (Leo Supra, 50 VP, Carl Zeiss, SMT, Germany) from Unit of Microscope Electron, School of Biology, Universiti Sains Malaysia, Penang was used to analyze the morphological images of OPTB and dried OPT. A thin section of the sample was mounted on an aluminum stub using a conductive silver paint and was sputter-coated with gold prior to morphological examination. The SEM micrographs were obtained under conventional secondary electron imaging conditions with an acceleration voltage of 5 kV.

RESULT AND DISCUSSION

Impact Properties

Impact strength of OPTB with different resin loading, dried OPT and rubberwood were shown in Figure 2 at primary axis. The impact strength of OPTB increased with the increase in resin loading. However, after resin loading exceeds 60%, there was a considerable decrease in impact strength. Also, the impact strength of OPTB with 60% resin loading is comparable with rubberwood properties.

The enhancement of interfacial friction stress and chemical bonding between matrix and fiber may cause the strength to improve. Brown [8] obtained that extra energy was needed to be absorbed by composite in order to do the work of debonding between filler and matrix. Thus, the OPTB impact strength continued to increase at higher resin loading. Previous study by Seena et al. [9] suggested that the impact failure of the composite may be caused by matrix fracture, fiber/matrix debonding and fiber pull out. In this experiment, the extensive decrease of impact strength in case of OPTB with 90% resin loading was more related to the matrix fracture. The matrix fracture occurred, when the fiber and the resin were not bonded during curing process. This may be due to PF resin which not has proper interfacial adhesion between the fiber and matrix.

The impact properties were directly related to the overall toughness of the materials, which were highly influenced by the interfacial bond strength, matrix and fiber properties [10]. In case of 60% resin loading impact strength is due to greater impregnation of the resin within the pits or pores of the OPTB, thereby enhancing its impact properties. Furthermore, with the help of resin properties, the fiber acts as obstacles to impede the crack propagation. In order to move past the obstacles, more energy is needed to propagate the cracks and thus increase the impact strength [5,11].

Therefore, the impulsive forces applied during the impact test were being absorbed efficiently by the fibers of the OPTB [12]. The resin loading beyond 60% impart brittleness to the composite materials and thus the material cannot efficiently resist fracture under stress applied at high speed. This phenomenon also was due to its low strength nature, irregular cross-section and the presence of fiber bundles [13]. Besides, previous study by Lai [14], the increase of impact strength is attributed to the effective stress transfer between strongly adhered filler and matrix due to the physical and chemical bonding between them. Moreover the PF resin acts better stress transferring medium in OPTB.

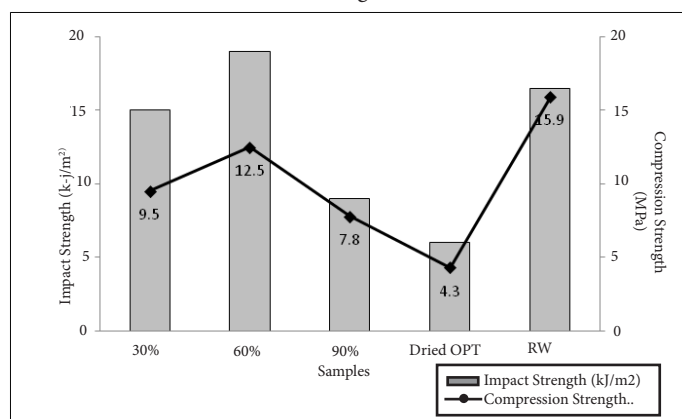


Figure 2: Impact Strength (primary axis) and compression strength (secondary axis) for OPTB with different PF resin loading compared to dried OPT and rubberwood.

Compression Properties

Compression strength of OPTB with different resin loading, dried OPT and rubberwood were displayed in Figure 2 at secondary axis. In general, OPTB with 60% of resin loading attained highest compression strength among the OPTB with 30% and 90% resin loading. However, like other mechanical properties, rubberwood again exhibited the highest compression strength as compared to OPTB. The effectiveness of PF resin in enhancing compressive properties showed a similar trend

as flexural and impact properties. This result showed that, OPTB with 60% resin loading has capability to absorb more energy during stress, whereas the OPTB with 90% resin loading showed stiffer properties due to presence of excess resin.

The compressive strength of composite is strongly dependent on the effectiveness of the matrix in supporting the fibers against buckling. Also, research by John and Reid [15] reported that, epoxy matrix acted effectively as a stress transfer medium between fibers in the composite. While, low compression strength of dried OPT probably was due to high porosity. Starnes et al. [16] stated that, a gap or holes in the epoxy laminate enhanced the degradation of compression strength. This condition will be due to the inability of impregnated OPT to resist the break under compression stress. Nevertheless, the presence of PF resin in OPTB structures is effective in resisting fiber buckling.

Scanning Electron Microscopy (SEM)

The morphological analysis of dried OPT and presence of PF resin in OPTB structures were carried out with the help of scanning electron microscope. The morphological detail about dried OPT structures, particularly vascular bundle was presented in Figure 3 (a). The micrograph was obtained using SEM and from this picture, the existence of parenchymatous ground tissue, fibers, and vessels was easily recognized and identified.

Figure 3 (b) shows the damage of parenchyma tissues when 90% resin loading were force to be located in OPTB. The high pressure intakes during impregnation process, forced the resin to locate in parenchyma tissue and of vascular bundles. In resin penetration, optimum impregnation process is an important factor. In case of high force of resin penetration, the OPT structure may collapsed and hence giving poor mechanical locking. Besides that, the rupture of parenchyma tissue may occur due to reaction of moisture evaporation during the curing process. Recent study by Siimer et al. [17], reported that the resin cured on wood substrate is different as compared to the resin cured alone. When the resin overloaded in wood structure, the diffusion for moisture evaporation would not work as usual. This reason can be related with strength reduction in the mechanical properties of the IOPT with 90% resin loading.

Views of OPTB with 60% resin loading which incorporates within the parenchyma cell is shown in Figure 3 (c). The high porous morphology of dried oil palm trunk helps the resin to be located and filled within the space which will improve the characteristics of OPTB. After impregnation and curing process, PF resin were seen located in the parenchyma tissues. The parenchyma cells which are fully covered by PF resin were quite similar by attaining elongated shape. However, the PF resin only located in the parenchyma cells showed poor bonding.

The location and interaction of PF resin in OPTB with 30% resin loading as observed from the SEM is shown in Figure 3 (d). For the samples of OPTB with 30% resin loading, there are some spaces that are not filled by resin and the presence of these voids can lead to poor interaction between resin and OPT structure. Moreover, these voids may arise due to the inadequate amount of resin during impregnation process. During curing process, the evaporation of moisture creates the compound of solid content. The presence of less PF resin generate less solid content of PF resin which located in parenchyma tissues. Based on drying studies, when moisture released from OPT structures, shrinkage process will occur. This condition can be compared with OPTB 60% resin loading where the degree of parenchyma tissues shrinkage is less because of amount of PF resin located in OPTB structure. From the observation, it can be seen that, the extreme shrinkage of composite structure related to reduction of the matrix volume and generate weak interfacial bonding which will be affect the characteristic of composite [18].

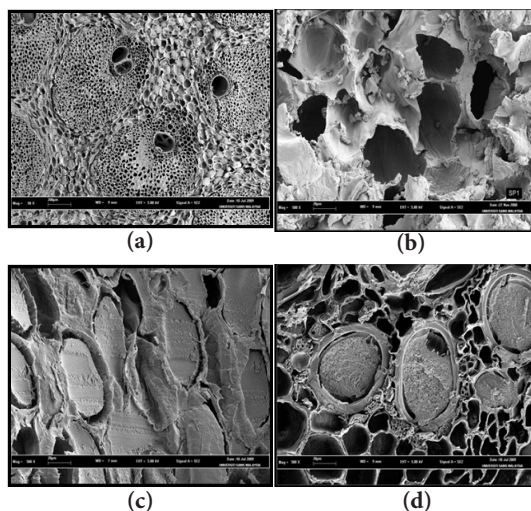


Figure 3: Scanning electron micrograph (SEM): (a) dried oil palm trunk (50x magnification), (b) OPTB with 90% PF resin loading (500x), (c) OPTB with 60% PF resin loading (500x), (d) OPTB with 30% PF resin loading (500x).

CONCLUSION

In this article, the dried OPT were impregnated using PF resin as a matrix to be a high performing products. The aim of this study was to characterize the mechanical and morphological properties of oil palm trunk biocomposite (OPTB). From our result, we conclude that usage of PF resin as matrix in the dried OPT improve properties of OPTB, such as impact and compression strength.

ACKNOWLEDGMENTS

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IMTCE2012

Sungai Way 7 July 2012

The 8th International Materials Technology Conference and Exhibition (IMTCE2012), a flagship of IMM, was held based on the theme "Green Technologies for Sustainability & Innovations in Materials". It was a joyous occasion when IMM celebrated its 25th anniversary, and setting a number of new records along the way.

IMTCE2012 had more than 350 participants in attendance over the 4-day event, with very healthy sponsorship from several organisations and companies. In addition to industrial participants, more delegates from academia are joining in the biennial conference. Other firsts were the organisation of a Masterclasses, the Green Materials Awards and Materials Lecture Competition.

Pn Hj Maimunah Ismail is fast gaining a firm reputation as a poet, when she recited a poem "Green" which she had composed specially for the occasion.





Incorporation Of Rice Straw Into Clay Bricks

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ABSTRACT

The number of manufacturing/processing industries has currently been increasing. However, this rapid development has consequently resulted to an increase in the amount of sludge (solid residue) generation, which in most times disposed by open burning, incineration, land disposal etc. either of the disposal methods used can result to an endangering degradation of our environment and the ecosystem. This research paper report the utilization of fibre sludge (Rice Straw) generated from agricultural activities as raw material in clay brick manufacturing. In order to offer an alternative solution to the environmental effects cause by the disposal of the rice straw, at the same time making sure that the required brick properties such as compressive strength, water absorption, firing shrinkage etc were within the standard acceptable range. After the clay was obtained as the main raw material, the physical and chemical characterization of the raw material was carried out and some properties of the rice Straw as well, in order to determine the feasibility of incorporating the raw materials and to identify, if necessary, any pre-treatment requirement. Bricks were produced with the rice straw ranging from 1.5% to 10% by dry-weight. The general production sequence involves moulding, drying, firing and testing. During the testing period, experiments were done to analyze some important brick properties such as water absorption, firing shrinkage, compressive strength and weight loss. The result obtained shows that the 1.5 wt. %, 2.5 wt.% and 5 wt. % rice Straw can be utilized as brick material, because the properties analyzed were within the standard limit.

Keywords: clay brick, brick, sludge, fiber sludge, rice straw

INTRODUCTION

Rice straw is an agricultural sludge generated from rice production activities. It is one of the most abundant lignocellulosic waste materials in the world [1]. Its annually production is 731 million tons, in Africa 20.9 million tons, Asia 667.6 million tons and Europe 3.9 million [1]. The disposal method of rice straw is one of challenging problem faced by many countries, the most commonly used and cheap method of disposing rice straw is through open burning; however there are numerous concerns regarding the environmental effect cause by this disposal method, due to the potential CO₂ emission into the atmosphere, air pollution and formation of haze. However it has been reported that alternative methods of utilizing rice straw are making breakthrough; such as commercial scale production of bioethanol from rice straw [3], incorporating rice straw into soil, use of rice straw as one of the ingredient to synthesis marginal food for animals [11] etc .

Even though the above mention potential methods of useful utilization of rice straw are signs of progressive approach toward tackling this problem related, the environmental concern are still worrying because of the annual increase in rice production, which is geared by the increasing world population. For example in Malaysia, according to the survey from Food and Agriculture organization of United Nation, the total rice production of the country increase from 2.20 million MT in 2002 to 2.54 million MT by the year 2010 [4]. Therefore, the need for the evolution of more potentially effective and environmental friendly methods of proper utilization of rice straw is necessary to upset this increase.

It is obvious that the recovery of sludge and utilization of sludge as building and construction raw material can be considered as an alternative to the right direction [5]. This study investigated the incorporation of rice straw into clay bricks. A proper characterization of clay was made and the effect of rice straw composition on the properties of the final products was examined.

EXPERIMENTAL PROCEDURES

Raw Materials

The raw materials used in this study were clay which was obtained from local clay brick manufacturer from Kuang, Malaysia, while the rice straw was obtained from local paddy field in Sekinchan, Malaysia.

Preparation of Raw materials

Clay bricks of 1.5%, 2.5%, 5% and 10% mixture of rice straw were prepared. The formulation of raw materials involved mixing the rice straw with the clay and appropriate amount of water added for each proportional increase of rice straw as reported in Table 1. The rice straw amended clay brick were hand moulded into a custom made wooden brick mould of 212mm x 95mm x 70mm dimension. The brick mould was coated with formica layer and lubricating oil applied to the surface to avoid the mixture sticking on to the wall of the brick mould. This sticking effect prevents the brick from being gently removed from the mould after casting. During moulding, the brick was compacted using hammer to enhance the cohesiveness of the raw material, hence resulting into less pore space or holes.

The wet brick were dried in the laboratory scale drying oven at approximately 115°C for 48 hours. After drying before putting into the furnace for firing, the length and weight of each brick were measured, and then the brick was put into furnace with temperature stir step increase from 150°C to optimum of 900°C for 8 hours and then left at this constant optimum temperature for 12 hours and finally cooled down to the ambient room temperature for 7 hours.

Table 1: Amount of water and mass of raw materials required per brick

Ratio of clay: rice straw Mixture (wt %)	Clay (g)	Rice Straw (g)	Total Mass of Raw Material (g)	Water Added (mL)
100:0 (control)	2000	0	2000	550
98.5:1.5	1970	30	2000	553
97.5:2.5	1950	50	2000	600
95:5	1900	100	2000	650
90:10	1800	200	2000	800

RESULT AND DISCUSSION

Characteristics of clay

The PH value of clay was found to be 3.87 and the moisture content was found to be 0.67% which is a very low value and this was caused due to the dryness of the clay sample obtained from the local brick manufacturer from Kuang, Malaysia, while the moisture content of rice straw was 9.7% .

Plasticity is another important parameter that describes the ability of material to undergo irrevocable deformation at constant volume without crumbling or crushing [6], in this study clay sample showed a plastic limit of 32.37% and liquid limit of 36%, hence, the plasticity index is 3.63%. The occurrence of plasticity in clay may be due to the presence of clay minerals that give rise to its cohesive nature, thus, causing it to act as a cement or paste [7].

Physical and mechanical properties of rice straw amended brick

Water Absorption

One important property in determining the strength of clay brick is the water absorption, the extend of cohesiveness and firmness of the brick is measured by the level of water absorption and it has been reported also depends on type of clay and method of production used [8]. From Figure 1 and Table 3, it can be analyze that water absorption of bricks increased

with addition of rice straw, the observed increase in water absorption was due to poor application of compacting pressure due to the hand-moulding using manual compaction and the formation of voids due to the burning of organic matter in the rice straw.

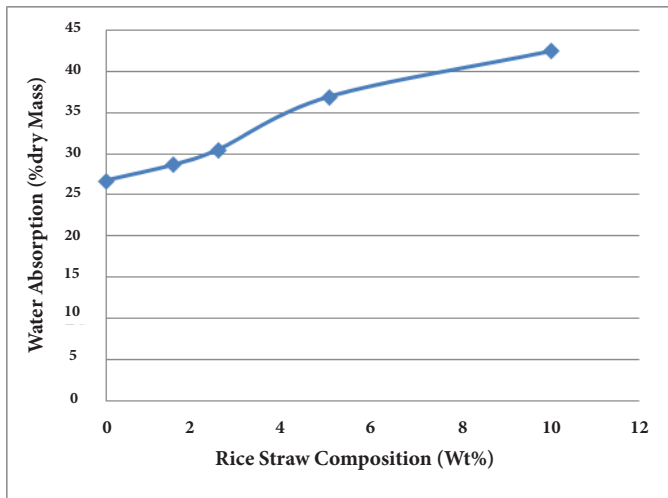


Figure 1: Effect of Rice Straw composition on Water Absorption

Compressive Strength

All construction or building materials without any exception must resist stress due to the load of building, therefore the strength of material is equivalent to the stress at which it failed or crumbled. In contrast to water absorption, the compressive strength of the brick material decreased as a result of rice straw addition. From Figure 2, the resulting compressive strength ranges from 8.30 N/mm² for 1.5 wt % rice straw amended brick to 3.95 N/mm² for 10 wt % rice straw amended brick. In fact, 5% rice straw addition caused a 32% reduction in compressive strength compared to the reference specimen (with clay: rice straw ratio of 100:0) which is 8.68 N/mm.

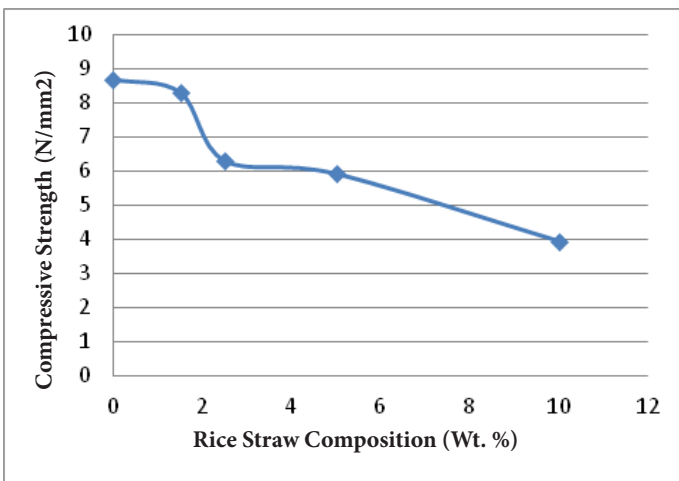


Figure 2: Effect of Rice Straw composition on Compressive Strength

Furthermore, by making comparison to the British standard BS 3921:1985 for compressive strength of brick, as shown in Table 2, the value obtained for compressive strength of 1.5, 2.5 and 5 wt. % were well above the standard compressive strength for the “Damp-proof course” and “All others” classes of brick, hence they can be utilize for normal brick application, however, the compressive strength for the 10 wt. % rice straw brick exceeded the limit

Table 2: Classification of Rice straw-Amended Clay bricks by compressive strength according to BS 3921:1985

Rice Straw Composition (Wt %)	Compressive Strength (N/mm ²)				Value obtained
	Engineering		Damp-proof course		
0					8.68
1.5	A	B	1	2	8.30
2.5					6.30
5	>70	>50	>5	>5	5.92
10					3.95

Linear Shrinkage and Weight loss

Shrinkage during firing is unavoidable. In this study firing shrinkage increased with higher addition of sludge, similar finding was reported by Alleman [9]. Table 3 highlights the effect of rice straw addition on the properties of brick, the highest shrinkage occur for the 10 wt. % rice straw addition while the lowest is for the control specimen (0% rice straw composition). Fortunately, the firing shrinkage value obtained in this study for all the rice straw amended brick samples and the control specimen were quite below the acceptable shrinkage limit of between 6% and 8% [10].

The results from the analysis on weight loss highlighted that as the proportion of rice straw increase from 1.5 wt. % to 10 wt. % the percentage weight loss increased and was caused due to the burning of the organic matter present in the rice straw as a result of excessive firing at the high temperature of 900°C. This findings was also confirmed from previous study conducted by other researcher utilizing other type of sludge that contained significant amount of organic contents [11]. Hence from an economical point of view the reduction in weight of the final brick production can resulted into a prosperous financial saving in terms of brick transportation cost.

Table 3: Effect of Sludge Addition on the properties of brick

Proportion of rice Straw added (wt. %)	Shrinkage on firing (%)	Weight loss due to firing (%)	Water absorption (wt. %)	Compressive Strength (Nmm ²)
0	0.48	4.4	26.78	8.68
1.5	2.38	10.73	28.67	8.30
2.5	4.76	11.53	30.50	6.30
5	5.58	12.28	36.96	5.92
10	6.04	24.85	42.53	3.95

Appearance of the Rice Straw-Amended Clay Brick

Most of the rice straw supplemented brick simple were subjected to development of minor crack on the surface. The problem of cracking is an indication of an undesirable gas (such as steam and CO₂) evolution from the decomposition of organic matters present in the chemical constituents of the rice straw during firing.

From the esthetic point of view, the surface finishing of the brick body was quite less appealing due to the appearance of many pore spaces and effect of manual hand-moulding, thereby it can't be use as facing brick.

Conclusion

The results presented and discussed in this project showed that rice straw from agricultural activities can be used constitutively as a supplementary raw material in clay manufacturing at various proportion. This project study involved the utilization of rice straw in the proportions of 1.5 wt. %, 2.5 wt. %, 5 wt. % and 10 wt. % and then analysis of some important brick properties such as compressive strength, water absorption, linear shrinkage and weight loss. The result obtained from the analysis shows that the brick amended with 1.5 wt. %, 2.5 wt. %, and 5 wt. % of rice straw can be utilised as brick material according to British Standard (BS 3921:1985).

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Study of Cocoa Pod Husk / Polyvinyl Alcohol (PVA) as A New Biodegradable Composite Film

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ABSTRACT

This paper present the possibility for the use of cocoa pod husk in composite with poly(vinyl alcohol) (PVA). In this study, we preparad a new green composite film from cocoa pod husk (CPH) and poly(vinyl) alcohol (PVA) and to characterize the morphology and mechanical properties of the composite film. The effect of fiber loading, plasticizer (glycerol) and effect of alkaline treatment were investigated. Poly (vinyl acohol) (PVA) with 5, 10, 15wt% cocoa pod husk (CPH) powder were prepared by aqueous mixing. The mixture was casted as composite film prior characterizations. The effect of plasticizer (glycerol) was investigated in the study and it was found that the film showed some good mechanical properties with addition of glycerol and increasing fiber loading. The effect of alkaline treatment on fiber was investigated.

Keywords: *Cocoa pod husk; Poly (vinyl) alcohol; Biodegradable polymer; alkaline treatment; Composite*

INTRODUCTION

Nowadays, thermoplastic composites produced from synthetic polymers filled with renewable natural resources start to gain the attention from world as they are considered as one of the environmental friendly biomaterials. Most of the researches focus on the use or the potential of inexpensive polymeric raw materials such as cellulose, starch, cellulosic resources and other. It is predicted and expected the resulting products are eco friendly and cost effective. Those biodegradable materials can be completely degraded into our ecosystem [1-2]. Moreover, the application of biodegradable polymers and renewable agro wastes as packaging materials is one of the alternatives to solve the problem of solid waste from inert polymers. There are several of synthetic aliphatic polyesters and natural resources are being used as biodegradable materials [3-4]. According to [5-6], most of the organic materials have the natural tendency to decompose or degrade. In our current century, the needs of degradable disposable containers or packaging materials are high. More and more researches and investigations are now being applied to produce plastic materials high biodegradability by involves abundant agro wastes, plant carbon hydrates, vegetables oils and etc. in their countries respectively.

Polyvinyl alcohol (PVA)-starch blend plastics are one of the most popular of the biodegradable plastics, and are widely used in packaging and agricultural mulch films [7-8]. However, according to [7,9], an amylose-PVA composite (PVA-starch blend) was biodegraded slower which was ~75% weight loss required 300 days in a degradation test with activated sludge [3]. PVA is non-toxic, water soluble, highly polar and synthetic polymer which has been used vastly in biomaterial technology. It has excellent film forming, emulsifying and adhesion properties. Degree of hydrolysis can affect properties of PVA and its film quality [10].

Cocoa pod husk (CPH) is a by product of the cocoa harvesting industry whereby it forms about 80% of the cocoa fruit and it is a waste product which can be utilized fully [11]. Besides, it can be used as filler in biodegradable mulch films as the high cellulose fiber content of CPH will provide reinforcing effect in the mulch films [12]. Besides that, the use of CPH as fertilizer can increase the soil macronutrients content because of high Na, P, K, Mg and Ca concentrations of CPH when it degrade in the soil [13]. Natural fibers with good biocompatibility, which can act as green filler in composites have gained interest to replace synthetic fiber. Natural fibers in composites are low cost, good thermal and low density. Combination of natural fiber and biopolymers where both are derived

from natural has the potential to provide materials with enhanced mechanical properties. At present time, many studies have investigated the biodegradable polymers filled with natural fibres [14].

In this study, we present the preparation of a new green composite film from cocoa pod husk (CPH) and poly (vinyl) alcohol (PVA) and to characterize the composite film. The effect of chemical modification, fiber loading and effect of plasticizer (glycerol) were investigated. Tensile properties and functional groups of this new composite film were studied. Biodegradability of the films was studied via soil burial test.

EXPERIMENTAL

Materials

Poly (vinyl alcohol) (PVA) and glycerol used were supplied by Innovative Pultrusion Sdn.Bhd, Negeri Sembilan. Cocoa pod husk (CPH) was collected from a rural cocoa farm located in Kluang, Johor Darul Takzim, Malaysia. The collected CPH was dried under sun for one week after collected from the farm. Sun-dried CPH is crushed into smaller pieces of cocoa pod husk for easier processing via strong plastic crusher. Then, crushed CPH was oven-dried in Memmert model oven at 80°C for 24 hours to remove all the moisture and kills living bacteria or microorganism in the cocoa pod husk. Oven-dried CPH was pulverized and sieved into 250 µm.

Alkalisiation of Cocoa Pod Husk Powder

The CPH powder was treated with alkaline solution to remove the impurities, waxy substances and lignin covering the surface of the fibers. CPH powder was mixed with 5 wt% aqueous solution of sodium hydroxide (NaOH) and stirred for 24 hours, rinsed, and washed with distilled water until the water becomes neutral. After washed and filtered, chemically treated CPH powder was oven-dried at 105°C for further use.

Preparation of Composite

The calculated amounts of CPH aggregate suspension was added to 10 wt% PVA solutions and stirred at room temperature with magnetic stirrer. The mixtures were homogenized in water bath via magnetic stirrer at 70-80°C for ~45-60 minutes. Glycerol was used as plasticizer in the experiments. Glycerol was added and the mixtures were stirred at 80°C until got a homogenous mixture. Mixture was distributed into glass plate. Each solution was dried at ~45°C for 24 hours to form the desired films. According to [4], complete drying was avoided because the composite film required some moisture to remain flexible and to avoid any cracking on the film surface. The formed films were then peeled off carefully from the glass plates and placed into sealed containers to avoid any moisture exchange.

Characterizations

Moisture content of the CPH powder and composite film were determined by drying the film in an oven at 60°C for 24 hours. American Standards Testing and Machine (ASTM), D638 was used to carry out mechanical testing on each sample. ASTM D638 was used to determine the tensile properties of unreinforced and reinforced plastics in dumbbell shape of specimens. The samples were cut according to the specification size to be tested on the mechanical properties. Tensile strength (TS) and elongation at break (%E) were evaluated for each sample using the INSTRON 3365 testing machine. Fourier transform infrared studies of the samples were performed with a Perkin Elmer spectrometer. The samples were prepared in transparent film for analysis by FTIR spectroscopy. Soil burial test for the composite film deterioration in soil was conducted by referred to the similar test on composite film in previous studies [2,15,16].

The small pieces of film (2 x 2 cm) was cut and completely covered by the test soil from all sides. The soils were exposed to atmospheric conditions for 7 and 15 days. After the soil test period, the samples were removed, washed with distilled water and dried to their constant weight in oven. The weight of the samples before and after soil burial test was recorded.

RESULTS AND DISCUSSIONS

Moisture content

Table 1 shows the moisture content of the composite films after oven dry for 24 hours. It found that the moisture content of composite film increase significantly after the addition of glycerol. The composite film made from 10wt% PVA solution without any fibres achieved 6.60% moisture content, however moisture content of composite film increased after the addition of plasticizer. Glycerol has strong hydrophilic character, it is expected the film with glycerol has higher moisture content with those without addition of glycerol.

Table 1 Moisture Content of NaOH Treated CPH/PVA Composite Film

CPH Loading	Moisture	Content (%)
	Content (%)	With Glycerol
0%	6.60	26.37
5%	3.40	12.31
10%	5.94	11.86
15%	8.11	11.72

Tensile properties

Tensile properties were measured for the CPH/PVA composite film containing 5, 10, and 15 wt% of CPH powder. The results of tensile properties (elongation rate, tensile strength) are shown in Figure 1 and 2. Figure 1 shows the effect of fibre medication on the percentage of elongation on composite film. The overall composite films made from NaOH modified CPH achieved higher percentage of elongation. The composite film prepared from 5wt% NaOH-modified CPH powder plasticized with glycerol exhibited the greater percentage of ~864%, which may be due to better cross linking between modified CPH powder and glycerol. Figure 2 shows the tensile strength of alkaline treated CPH/PVA film with and without addition of plasticizer. From Figure 2, tensile strength was decreasing gradually with the increasing fibre loading. It might due to the inability of fibre and the irregularity shape of fibre to support stress which moved from the polymer to fibre. Besides, the decrease of tensile strength also might due to the bubble formation which results in weak interfacial adhesion. The existence of partially spaces between fibre and polymer will results in weak structure of the composite film [3].

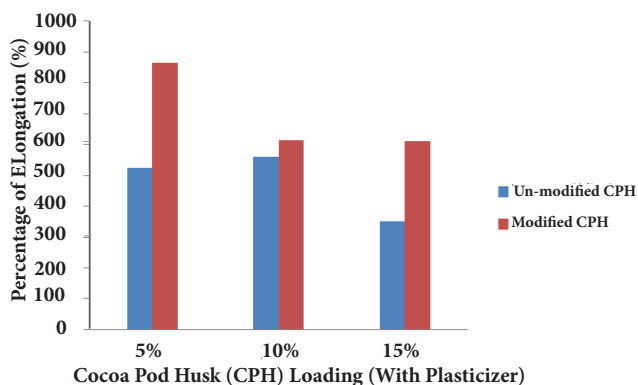


Figure 1: Elongation Percentage of CPH/PVA film (modified & unmodified CPH)

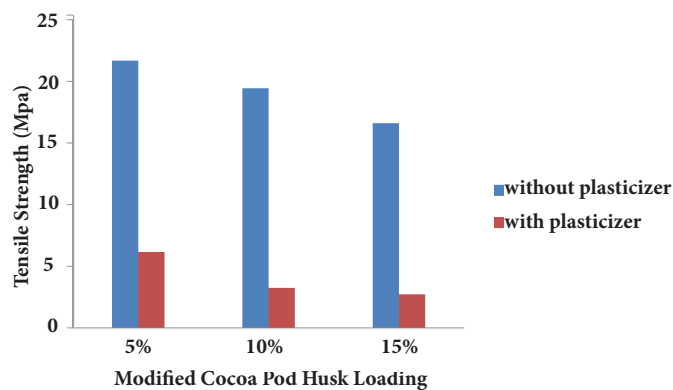


Figure 2: Tensile Strength of Alkaline Treated CPH/PVA film (with & without plasticizer)

FTIR analysis

The FTIR spectrum for 15 wt% NaOH modified CPH/PVA composite film after plasticized with glycerol. The spectrum exhibited a broad peak at around ~3677 -3100 cm⁻¹ which can assigned to hydrogen bonded O-H group or due to -OH stretching. The peaks between ~2700

cm⁻¹ and 2900 cm⁻¹ corresponded to C-H stretching. The absorptions near ~1250 to 1300 cm⁻¹ maybe due to the carboxylic acids and its derivatives which may corresponded to the organic components from cocoa pod husk fibres.

Soil burial test

Biodegradability of the composite was studied by soil burial test. It revealed that the CPH/PVA composite films are biodegradable in nature environment. It achieved the highest ~53.77% reduction after 15 days exposed to environmental condition. The size of composite films had significantly diminished after 7-15 days of exposure in soil as shown in Figure 5 and 6. The films appeared in fragile and brittle after soil burial test. The degradation of composite film was examined by measuring its weight loss which can refers to the erosion of molecules from solid phase [2]. From Figure 4, it is clear that samples with higher fibre loading had the higher weight changes after both 7 and 15 days. This may due to the higher filler loading than the polymer content make it easier to degrade in soil. However, the weight changes were probably underestimated as there was some soil debris strongly adhered to the film surface which unable to rinse off. Meanwhile, Table 2 presented the effect of fibre modification on the degradation rate of composite film. It founds that the film formed by modified CPH fibre has a better weight changes compare with the film without any chemical modification.

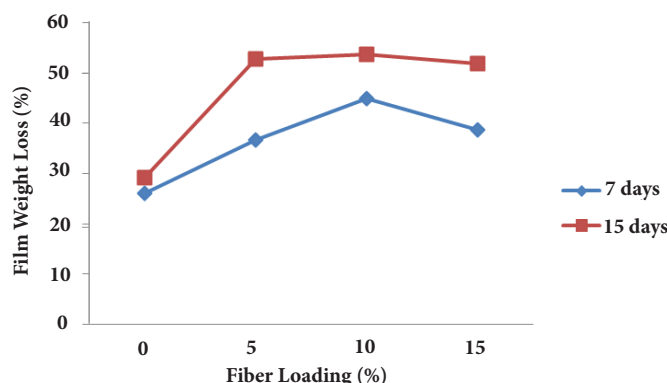


Figure 3: Film Weight Loss (%) of Modified CPH/PVA Films After 7 & 15 Days Soil Burial Test

Table 2 Effect of NaOH Fibre Modification on Biodegradability of Films

CPH Loading(%)	Weight Loss After 15 Days (%)	
	Without Modification	NaOH Modification
5	30.46	52.86
10	35.93	53.77
15	33.62	51.81

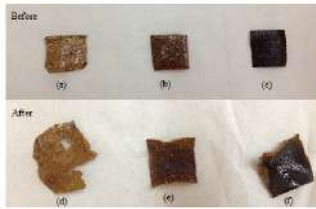


Figure 4: Modified CPH/PVA composite films after soil burial test for 7 days: Before test (a) 5% CPH, with glycerol; (b) 10% CPH, with glycerol; (c) 15% CPH, with glycerol; After test (d) 5% CPH, with glycerol; (e) 5%CPH, with glycerol; (f) 10% CPH, with glycerol

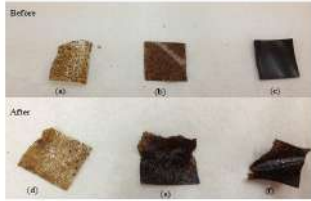


Figure 5: Modified CPH/PVA composite films after soil burial test for 15 days: Before test (a) 5% CPH, with glycerol; (b) 10% CPH, with glycerol; (c) 15% CPH, with glycerol;

After test (d) 5% CPH, with glycerol; (e) 5%CPH, with glycerol; (f) 10% CPH, with glycerol.

CONCLUSIONS

A simple route to study the potential uses of the waste cocoa pod husk from cocoa form was carried out. Composite film prepared from 5 wt% CPH powder plasticized with 10wt% glycerol achieved the excellent elongation percentage. However, the overall tensile strength of the composite films decreased after addition of glycerol. Weight loss after soil burial test revealed that the potential of CPH/PVA composite film to degrade in nature environmental condition. The basic advantage of this product is its good elongation for packaging purpose and its biodegradability which can ensures a safe disposal of waste plastic to our environment.

Acknowledgements

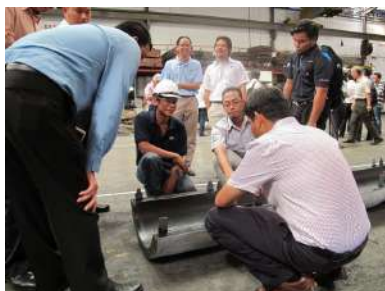
The authors wish to acknowledge the Ministry of Higher Education, Malaysia and Universiti Putra Malaysia (UPM) for providing financial support through Research University Grant Scheme (RUGS) for this research work.

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Training of PETRONAS Young Engineers in Cathodic Protection



"This is how anodes are made"



Dr Tan Swee Hain engaged in a discussion with some of the young engineers.

Senai 20 June 2012

A team of 22 young engineers from PETRONAS Skill Group 15 (Materials, Corrosion & Inspection) visited an Anode Manufacturing factory in Senai, Johor during their Cathodic Protection training programme. The group of young engineers, under the tutelage of their trainer, Dr. Tan Swee Hain, were briefed on the anode manufacturing process and thermal spray coating technology by IMM Coatings Committee Member, En. Junaidy Abdullah. The engineers also got a first-hand look at how sacrificial anodes are manufactured.

Associate Welding Engineer (AWE) and Welding Engineer (WE)

The fourth Associate Welding Engineer (AWE) and Welding Engineer (WE) was held with 14 AWE and 19 WE candidates. The courses were conducted in collaboration with the Japan Welding Engineering Society (JWES) and implemented by the Overseas Human Resources and Industry Development Association (HIDA), a division of the Japanese Ministry of Economy, Trade and Industry.

This project is to improve the Business Environment related to Trade and Investment between Japan and Malaysia, and co-organized by the Institute of Materials, Malaysia and MWJS.

A total of 42 AWE, 34 WE and 8 Senior Welding Engineers have been trained since 2011.



Ir. Mohd. Suradi Yasin, Honorary Treasurer, addressing the participants at the opening ceremony.

Pipeline Integrity Seminar & Networking Cocktail



Kuala Lumpur
20 September 2012

IMM hosted the Pipeline Integrity seminar & networking cocktail for invited guests and members from the oil & gas, petrochemical and energy industries. The seminar on pipeline integrity covers presentations

on new technologies, new developments and case studies. 3 papers, Composite Overwrap Repair System Application in PETRONAS (by Rosman Bin Hj Arifin), Deepwater Insulation (Tony Bacon—Bredero Shaw) and New Pipe Welding Technique [Magnetically Impelled Arc Butt Welding] (Gabriel Stecher—MIAB Pty Ltd) were presented.



Tony Bacon presenting his paper.



Gabriel Stecher, at right, with some guests at the seminar and networking cocktail.

Asian Welding Federation (AWF) Common Welder Certification Scheme (CWCS)

IMM has been a strong advocator of the Asian Welding Federation (AWF) Common Welder Certification Scheme (CWCS) in Malaysia. The CWCS provides the oil and gas industry an assurance of quality work by certified welders who are registered in a database known as the Manpower Optimisation System (MOS).

Through road shows, IMM has been promoting the CWCS in several parts of the country, and was in Lumut, Bintulu and Miri late last year.



L: Attentive participants at the promotion of the AWF CWCS in Bintulu and in Miri(R)

PETRONAS Skilled Group 15 (Materials, Corrosion & Inspection) Coatings Course

Puchong 11 October 2012

25 young engineers from PETRONAS Skilled Group 15 (Materials, Corrosion & Inspection) attended a Coatings Course conducted by their trainer, Dr. Robert Nuttall. As part of the training, the group visited a factory in Puchong, Selangor which produces fluorocarbon-coated bolts & nuts and conducts thermal spray coating application.



Participants from INSTEP taking a closer look at the Fluorocarbon-coated Bolts and Nuts on display.



Participants listening intently to the presenter.

Microbiologically Influenced Corrosion (MIC) Course



Materials Technology Education Sdn. Bhd. (MTE) also conducted a 3 -day course on "Microbiologically Influenced Corrosion (MIC)" in September with Dr. Reza Javaherdashti.

Extending the Service Life of Crude Oil Export Line using PIPEASSURE™ Composite Overwrap Repair System

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ABSTRACT

Corrosion failure of steel pipelines has become highly expensive maintenance in oil & gas industry. Many of the structures affected are those in marine environments, and some are even critical lines. Fibre reinforced composite wrapping is one of the most cost-effective solution for corrosion prevention in high humidity atmosphere. One such case is discussed here which consist of the installation of PIPEASSURE™, a novel epoxy-glass fibre composite wrapping to provide corrosion barrier and strengthening of a 30" carbon steel crude oil export line situated directly across a river. From the data collected during site assessment, the remaining strength of the pipeline was calculated to be less than 1 year using ASME B31.G manual. Subsequently, ISO TS 24817 was used as the basis for engineering design of the live repair for a design life of 5 years. After 3 days of curing, post installation inspection reveals no discontinuities on the repair when holiday test was conducted. Hardness test result was found to be satisfactory and comply with client's acceptance criteria. The successful rehabilitation of the pipeline using PIPEASSURE™ helped the client avoid costly shut down if the pipeline is to be cut and replaced.

Keywords: PipeAssure, corrosion failure, live repair, composite wrapping, integrity

INTRODUCTION

Pipeline is the lifeline of oil & gas industry. Any pipeline or piping failure is definitely a nightmare for oil & gas operators. Such failure might cause massive losses to operating company in terms of people, environment, asset and also reputation. Hence, operator will be on constant alert to avoid facing a loss of containment incident. Maintenance cost for pipelines can be costly however as saying goes 'prevention is better than cure', the cost of failure will definitely dwarf that of maintenance(1). As such, operators must balance between tight maintenance budget with pipeline integrity and ultimately flow assurance.

There are multiple approaches for a successful pipeline repair whether it is leak repair, strengthening or simply corrosion protection. Total replacement via cut-and-replace provides permanent solution; however it requires costly shutdown and loss of production besides having to deal with hot-work. Mechanical steel split sleeve provides best structural reinforcement however its deployment can be very slow due to long lead time for fabrication and expensive installation cost especially in offshore. Among others, composite wrapping provides the best of almost every aspect due being cost effective and fast deployment. In most cases, live repair can be done without having to shut down the line under repair.

PIPEASSURE™ COMPOSITE OVERWRAP REPAIR SYSTEM

PIPEASSURE™ is a novel pre-impregnated composite resin system for pipeline repairs, both onshore and offshore. The system was jointly developed by PETRONAS Research SdnBhd (PRSB) from Malaysia and Commonwealth Scientific and Industrial Research Organisation (CSIRO) based in Melbourne. It consists of "E-Glass fibre" pre-impregnated with a proprietary underwater epoxy resin formulation. The glass fibre content enables cheaper repairs since glass fibre is cheaper than carbon fibre, despite losing out in terms of strength and stiffness of fibre(2). The resin is designed to be hydrophobic, which keeps moisture away from bare metal thus providing effective corrosion protection and pipe reinforcement properties. Controlled manufacturing process gives the system very homogenous fibre to matrix ratio as compared to wet lay-up system. This in turn provides superior mechanical interlocking and adhesion strength, both in lap shear and transverse direction.

Unlike other competing products, PIPEASSURE™ is curable underwater and is capable of withstanding wet environments without loss of adhesion and mechanical properties. The system was designed to perform in accordance to two international standards; ISO TS 24817 and ASME PCC-2 making it suitable for almost all sorts of repair in the oil & gas industry.

Innovative Oilfield Services SdnBhd (IOSSB) signed a commercialisation agreement with PETRONAS Technology Ventures SdnBhd (PTVSB), the technology commercialisation arm of PETRONAS. IOSSB as the licensee was appointed the official applicator for PIPEASSURE™. Till date, IOSSB has successfully completed numerous pipeline and piping rehabilitation works in various oil & gas facilities, both onshore and offshore.

CASE STUDY: 30" CARBON STEEL CRUDE OIL EXPORT LINE REHABILITATION

One such case of PIPEASSURE™ application is discussed in this paper. IOSSB was invited to provide corrosion barrier and strengthening maintenance work on 30" crude oil export line in Miri, East Malaysia. This particular line is very critical to our client's operation since crude oil will be exported from the terminal via this line during single buoy mooring (SBM) loading to tanker. During peak loading, the line transports up to 130,000 barrels of oil per day, making it also critical to client's coffer.

Defect Assessment

The pipeline is located in a swampy region alongside Miri coastal land, right behind the process area of the terminal. A section of the 2 km long pipeline is located directly across the Lutong River. This section will be partially submerged during high tide and at times exposed to impact from logs. Latest inspection report reveals severe external corrosion due to high humidity with multiple pittings and gorges. Some areas of the pipe possess serious integrity issues with wall loss up to 70% from the original wall thickness. This led to the service request by the client to avoid any catastrophic failure. Summary of the defect assessment is as per Table 1 below.

Table 1: Summary of Defect Assessment

Pipe Material	Pipe size (inch)	Nominal Wall Thickness (mm)	Minimum wall thickness (mm)	Maximum defect depth [mm]	Length of repair [m]
API 5L X52	30	12.7	4.0	8.7	4.0

Design Calculation

Based on the site assessment and inspection report, IOSSB recommended PIPEASSURE™ as the solution for this repair due to its superior mechanical properties, cost effectiveness and fast deployment. The idea behind pipeline strengthening is to restore the integrity and pressure containment capacity of the pipe to that of its design. As a start, ASME B31G-2009 was used to determine of remaining strength of the pipeline(3). Based on the rate of corrosion and corrosion allowance, the remaining life was found to be less than a year. The result was used as input for ISO TS 24817 to determine the minimum laminate thickness, t_{min} required for this particular repair as given by Eq. 1 below(4).

$$t_{min} = \frac{D}{2s} \cdot \left(\frac{E_s}{E_c} \right) \cdot (P_{eq} - P_s) \quad \dots\dots\dots(Eq.1)$$

where

D = external diameter [mm]
s = remaining pressure capacity of pipe [MPa]

- E_c = circumferential modulus of PIPEASSURE™ = 15400 [MPa]
- E_s = modulus of substrate [MPa]
- P_{eq} = equivalent internal pressure [MPa]
- P_s = maximum allowable operating pressure, MAWP [MPa]

As a minimum, the repair was engineered for a design life of 5 years since the pipeline is scheduled to be decommissioned and replaced in year 2016. The required number of layers can be easily calculated by dividing t_{min} with the ply thickness of PIPEASSURE™, t which is roughly 0.8mm. Since the wrapping will be done spirally with 50% overlap, one wrap is equivalent to two layers. The required wrap angle and length of each wrap, L_w i.e. length of PIPEASSURE™ material required for one

complete wrap is calculated using Eq. 2 and Eq. 3 respectively(5).

$$\tan\theta = (2\pi) (D/w) \dots\dots\dots(\text{Eq.1})$$

$$L_w = \frac{L}{\cos\theta} + 2\pi (D+4nt) \cos\theta \dots\dots\dots(\text{Eq.2})$$

where

- θ = wrap angle [°]
- w = width of PIPEASSURE™ tape = 300 [mm]
- L = length of repair [mm]

Summary of the design calculation is tabulated in Table 2 below.

Table 2: Summary of Design Calculation

Design pressure [bar]	Design temperature [°C]	Minimum laminate thickness [mm]	No of wraps	Length of wrap [m]	Wrap angle [°]	No of rolls
44.1	43	9.6	6	68.0	86.4	20

Installation Procedure

Since PIPEASSURE™ is a pre-preg system; it can be applied much faster than wet lay-up system which requires time consuming field impregnation prior to application. The frozen roll of PIPEASSURE™ is left to thaw for few hours while preparation work was done. Once soft, the PIPEASSURE™ tape must be prepared for wrapping by first cutting the tape to L_w and tapering the ends. The taper length is double the circumference of the pipe.

The system is designed best to work when applied to bare metal, thus the pipeline section to be wrapped was grit blasted up to SA 2.5. The surface was then cleaned using acetone as per SSPC-SP1 requirement to remove any impurities prior to application of metal recovery compound (MRC). The load transfer material was used to fill up any wall loss and make up the surface profile of the pipe. The fast acting MRC cured in approximately 5 minutes, after which rough surfaces were smoothed out using sand papers. The prepared surface was then coated with base coat of primer. The PR25 primer comes in two components, epoxide base (Part A) and polyamine hardener (Part B). Both parts were mixed with ratio of 100:17 and mixed portion has a pot life of roughly 45 minutes. The primer was then applied on the bare metal surface of the pipe using roller brush.

To begin wrapping, the tapered end of the tape was aligned at the edge of repair zone perpendicular to the pipe's axial direction. A 50% overlap was maintained at all times as the material was spiralled upwards in clockwise direction. Iron roller was used to squeeze out any air bubbles in between layers. Whenever one roll of PIPEASSURE™ was exhausted during a wrap, another roll was used to continue the wrap using butt joint, by overlapping the tape by 2 inches. The first wrap terminates at the opposite edge of the repair zone. Subsequent wraps were applied by repeating the same steps with alternating wraps beginning at opposite edge of the repair zone.

Once all six wraps were completed, final coat of primer was applied thoroughly on top of the PIPEASSURE™ wrappings especially along the edges of the wrap to avoid any water ingress. Finally, cling film was

wrapped along the length of repair to avoid any contamination and to ensure proper curing.

Post Installation Inspection

After 3 days of curing, the site was revisited for post installation inspection, which covers general visual inspection, Holiday test and Shore D hardness test. The wrapping was visually inspected for any delamination or disbondment of layers after removing the cling wrap. Holiday test reveal no discontinuities and result was found to be satisfactory in accordance to NACE RP0188-99 requirements i.e. no void, leak or pinhole. Shore D hardness test was conducted to measure the degree of curing. The measurement was taken at 3 locations along the length of repairs and 4 readings at cardinal clock position at each location. The acceptance criterion for the test is 70 Shore D units. Result as per Table 3 below.

Area	Right Edge	Middle	Left Edge
12 o'clock	74	75	78
3 o'clock	78	72	77
6 o'clock	70	68	71
9 o'clock	78	78	75

CONCLUSION

Overall, the successful rehabilitation of the pipeline has further increased the client's satisfaction and trust on PIPEASSURE™ as composite wrapping of choice. The system may not be the right repair option every time but it is a viable solution for pipeline rehabilitation especially during live repairs when operators can't afford costly shutdown. PIPEASSURE™ technical capabilities such as curable in wet condition and superior adhesion strength gives the system competitive advantage over other competitors in the market. Being a cost effective solution compared to other alternative repair method, PIPEASSURE™ has great prospect to convince operators especially those with tight maintenance budget.

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Composite Polymer Electrolytes Based on MG49 and Cellulose from Kenaf as Reinforcing Filler

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ABSTRACT

The aim of this project is to explore the possibility of using cellulose from biomass such as kenaf in solid polymer electrolyte in order to increase the mechanical performances at the same time maintaining its ionic conductivity. Lithium-conducting composite polymer electrolytes based 49% poly (methyl methacrylate) grafted natural rubber (MG49) were prepared from cellulose which was extracted from kenaf fiber and lithium triflate salt by solution casting. Prior to that kenaf fibers undergo several treatments (alkali, bleaching) in order to yield the white cellulose. White cellulose then treat with silane to decrease hydrophilic nature of CF which was then used as reinforcing filler in the composites polymer electrolytes. High performance composite electrolytes based on cellulose were prepared with various composition of filler (0-10 wt%). Field emission scanning electron microscopy (FESEM) were used for morphology studies of kenaf fiber for each stage of treatments. The films were analyzed by electrochemical impedance spectroscopy (EIS). Ionic conductivity measurement showed that the addition of various wt% of cellulose give a weak decrease of conductivity with respect to unfilled polymer electrolytes. The effect of different cellulose content of composite polymer electrolytes on mechanical properties was evaluated through tensile modulus test. Result showed that the composite electrolytes with 4 wt% cellulose exhibited high mechanical performance.

Keywords: Composite Polymer Electrolytes, Kenaf, Cellulose, Ionic Conductivity, Mechanical Properties

INTRODUCTION

Natural fibers, as reinforcing elements in polymer composites, offer several advantages over conventional reinforcing materials such as glass fibers. Due to their low tool wear, low density, cheaper cost, availability, and biodegradability, cellulose serves as promising candidates for the preparation of biocomposites [1]. A potential characteristic of cellulose fiber (CF) in the composite fibers made CF has broad range applications such as filler in the preparation of polymer electrolyte composite. Solid polymer electrolyte (SPE) was used as ion-carriers in secondary batteries lithium polymer. SPE have grabbed attention many researchers because the potential of SPE as rechargeable batteries, fuel cells, light-emitting fuels, and many other applications in electrochemistry [2]. One of main advantages of SPE was free solvent which have possibility to reduce electrolytes thickness and result in decreases internal resistance of the battery at the same time maintaining conductivity [3]. The main objective in polymer research is to develop polymer systems with high ionic conductivity with the encouraging mechanical properties. The good interactions between CF/MG49 provide better final properties of composite polymer electrolyte.

Moreover, polymer electrolytes must be exhibit, in addition to high conductivity and wide electrochemical stability, high thermal and mechanical performances for safety and performances reasons. Since the original work of Weston and Steel (1982) that use α -Al₂O₃ as inorganic filler in polymer electrolytes, the understanding of impact of filler in the polymer electrolytes have been extensively studied. Recent year, research on the use of cellulosic resources as filler in the SPE has grown rapidly. In addition, these fibers showed better thermal properties that make it suitable to be used as filler in the composite polymer electrolytes [4].

Kenaf (*Hibiscus cannabinus*) is a plant that belongs to the Malvaceae family and grows commercially in many places worldwide. The fibers derived from the outer fibrous bark, which are also known as bast fibers,

have cellulose contents ranging from 30% to 63%, making them a good source for cellulose extraction [5]. Furthermore, the use of kenaf or lignocelluloses fiber as organic filler is a wise step in replacing inorganic filler because it is cheap, easily available, the resources are not limited to, improving the mechanical properties of composites and is not harmful to health.

The aim of this project is to explore the possibility of using cellulose from kenaf in modified natural rubber (NR) based SPE in order to improve the mechanical performances at the same time maintaining its ionic conductivity. Extractions of cellulose from kenaf undergo several treatments which are alkali and bleaching treatment. Treatment CF with silane decrease its hydrophilic to make sure it compatible with matrix which is MG49 that more hydrophobic [1]. So it can interact well in matrix in preparation SPE. Morphology analysis was evaluated to see the effect of different stages of kenaf fiber treatment. The effects of different filler contain on mechanical performances and conductivity was investigated.

EXPERIMENTAL

Materials

Kenaf fiber was provided by Kenaf Fiber Industry Sdn. Bhd. (Malaysia). Sulphuric acid (98%), sodium hydroxide (99%), sodium chlorite (80%) and acetic acid glacial (99.5%) were purchased from SYSTEM-chemAR (Malaysia) and Sigma-Aldrich (Germany). All the chemicals were used without purification. MG49 was commercially obtained. Lithium triflate (LiCF₃SO₃) salt were supplied by Fluka.

Preparation of cellulose from kenaf

Preparation of white cellulose consisting two steps, the first step was alkali treatment and followed by bleaching process according to Kargarzadeh et al. [5]. Prior to that, kenaf fibers were cut into small pieces. Briefly, kenaf fiber was treated with 4%wt NaOH solution in round bottom flask under mechanical stirring at 80°C 3 h. Reflux process was conducted three times and it was then filtered several times using distilled water to remove alkali component. 5% (w/v) of fiber was undergoing bleaching treatment 4 times with 1.7% (w/v) of sodium chlorite solution and acetic buffer at 80°C under mechanical stirring for 4 hours. The extracted cellulose and was allowed to cool and then filtered using excess distilled water and air dried [5]. Finally, the cellulose was soaked in 5% concentration of silane for 1 h, filtered using distilled water and then dried at room temperature.

SPE Film processing

All polymer electrolytes samples were prepared by the solution casting method [2, 6]. MG49 rubber was sliced into grain size and then was dissolved in conical flasks containing THF. After 24 h, the solution was stirred with magnetic stirring for the next 24 h until complete dissolution of MG49 into clear viscous solution. 20 % wt LiCF₃SO₃ salt was stirred in THF solution for 12 h and it was added to the MG49 solutions for the next 24 h with continuous stirring. White cellulose was dissolved in THF after undergoes solvent exchange (cellulose suspension, acetone, THF). THF suspension of cellulose was added to the MG49/salt in conical flask with continuous stirring for 24 h to obtain a homogeneous solution. The electrolyte solutions were cast onto a glass petry dish and the solvent was allowed to slowly evaporate in a fume hood at room temperature. Resulting films were dried under vacuum oven for 24 h at 50°C to remove remaining solvents. The samples were then stored in desiccators for further use [6].

Characterization

The morphology of the fibers after each treatment was investigated using a Zeiss Supra 55VP field emission scanning electron microscope (FESEM) with a magnification of 400x. All samples were sputter-coated with gold before observation to prevent charging.

The ionic conductivity measurements were carried out by EIS using a high frequency resonance analyzer (HFRA) model 1255 with applied frequencies from 1MHz to 0.1 Hz at a perturbation voltage of 1000mV. All experiments were conducted at room temperature [1]. The ionic conductivity [σ] was calculated according to the equation

$$\sigma = [l / (A.Rb)] \dots\dots\dots (Eq.1)[6]$$

The bulk resistance [Rb] was obtained from the intercept on the real impedance axis (Z-axis), the film thickness [l] and the contact area of the thin film [$A = \pi r^2 = \pi (0.80 \text{ cm}^2)^2 = 2.01 \text{ cm}^2$].

Mechanical performance of the films was evaluated with universal testing machine (Instron model 5566, USA) at room temperature according to ASTM D882. A crosshead speed of 50 mm/min, initial grip distance of 40 mm and load cell of 50 N were used to perform this test. The samples were cut into a dumbbell shape and average value of 7 replicates for each sample was taken.

RESULT AND DISCUSSION

Morphology Studies

Figure 1 presents field emission scanning electron microscope (FESEM) of kenaf fiber after different stages of treatment. Raw fiber (Figure 1a) had a rough surface with impurities and contains by cellulose, hemicellulose, pectin, lignin, and other chemical composition. However, after alkali treatment (Figure 1b) the surface become less rough. The important modification that was done by alkaline treatment was the disruption of hydrogen bonding in the network structure. From the observation, almost all impurities have been removed from the fiber surface which induced the separation of fiber bundles into individual fibers [5]. This treatment removes certain hemicelluloses, lignin, wax and oils covering the external surface of the fiber cell wall, depolymerizes cellulose, and exposes the short length crystallites [2,8,1]. As for kenaf fibers after bleaching, more significant physical change on the fibril surface can be observed (Figure 1c). Fiber has decomposed to the individual microfibril which is caused by the removal of most of the remaining lignin fiber. In other words, this treatment reduces fiber diameter and thereby increases aspect ratio[1].

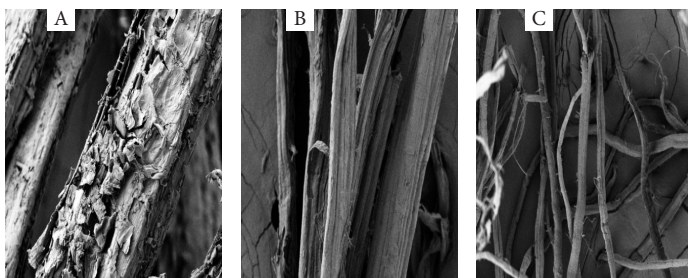


Figure 1: Micrograph FESEM for kenaf fiber a) Raw b) Alkali treatment c) Bleaching

Ionic Conductivity

As can be seen from Table 1, the introduction of cellulose only had a modest influence on the ionic conductivity of the composite. The conductivity of the composite was reduced from 1.2×10^{-7} to 5.4×10^{-8} upon introduction of 2% wt of cellulose fiber. However, the values of ionic conductivity in the composites remain higher with respect to unfilled SPE. A decrease of the ionic conductivity with the addition of tunicin whiskers in PEO based electrolytes was also observed by Azizi et al. [3]. The different in conductivity observed between filled and unfilled composite may be due to the existence of interactions between cellulose and MG49 or lithium salt [7]. Nevertheless, interactions between anions and surface hydroxyl groups of CF via hydrogen bonding lead to decrease the mobility of former [3]. The highest

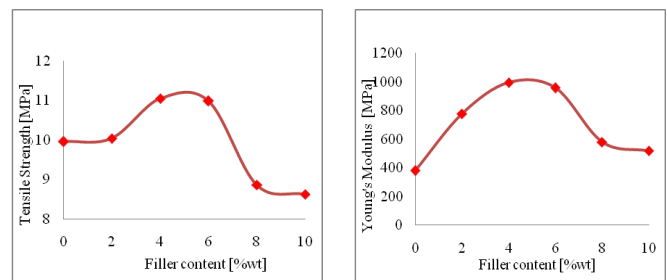
conductivity for filled polymer electrolytes obtained with 2 % wt of CF which is $5.4 \times 10^{-8} \text{ Scm}^{-1}$ compared others. This may due to the increasing of CF content result in increasing crystallization kinetic presence of CF, which undergoes crystallization process and reduce the mobility of lithium ion.

Table 1: Ionic conductivity of SPE MG49-LiCF3SO3/Cellulose

Cellulose content, wt%	Conductivity , σ [Scm ⁻¹]
0	1.2×10^{-7}
2	5.4×10^{-8}
4	4.8×10^{-8}
6	1.4×10^{-8}
8	7.5×10^{-9}
10	9.6×10^{-9}

Mechanical Properties

Tensile strength of SPE was determined and the results are plotted in Figure 2. As shown in Figure 2a, the tensile strength increased with cellulose loading with the optimum fiber loading at 4% due to effective interaction between CF/MG49/salt. This is explained by the increase of uniformity that contributes to the increase in strength, due to the removal of the impurities. The formation of a rigid percolating cellulose fiber network also assumed to be formed through strong hydrogen bonds interactions in cellulose fiber [3]. It is reported that alkaline resulting in better mechanical interlocking, and then increases the amount of cellulose exposed on the fiber surface. Thus the number of possible reaction sites was increase and has effect on the mechanical behavior of natural fibers [1]. From Figure 2b, the Young's Modulus also highest in 4 % cellulose loading and the value (995 MPa) was much higher than unfilled SPE (380 MPa). Generally, optimum tensile properties and Young's modulus are dictated by the volume of reinforcing fiber used for the composites [10]. However, when the percentage of CF further increased up to 6-10% the SPE tensile strength and Young's Modulus tends to stabilize. Rigidity of this network depends on the concentration of filler with respect to the interaction of filler/filler through the hydrogen bonding [9]. Addition of salt was induces the CF flocculation demonstrating the main role of the electrostatic interaction between cellulose and result in a loss homogeneity of the cellulose dispersion. Non uniform distribution of cellulose in the matrix, induces agglomeration hence restrict filler reinforcement within a polymeric matrix [9]. Therefore, the mechanical behavior of SPE will decrease for 6-10% wt of CF.



Conclusion

Composite polymer electrolytes have been prepared using MG49, LICF3SO3 and cellulose from kenaf fiber. Alkali and bleaching treatment of kenaf fiber showed significant physical changes to the fiber. The effect of cellulose loading was investigated by EIS and mechanical test. The presence of cellulose fiber induces weak decrease of polymer electrolytes conductivity due to the interaction between cellulose and MG49 or salt. Cellulose fiber as reinforcing filler for SPE leads to improve the mechanical strength for SPE prepared even small percentage of CF was added.

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Effect of Temperature on the Strength Properties of Adhesively Single-Lap Bonded Joint for Composite Laminates

continued from page 6

the surface of adherends. At temperature above T_g , the joint strength of adhesive bonding strength and stiffness has decreased. The failure modes observed could be classified into three distinct categories: cohesive failure, interfacial failure and mixed failure

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Incorporation Of Rice Straw Into Clay Bricks

continued from page 13

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“Welding and Joining Technology for Non-Welding Personnel”



Ir. Dr. Edwin Jong, elaborating a point during the class on welding.

Kuala Lumpur 3 October 2012

A 1-day “Welding and Joining Technology for Non-Welding Personnel” public programme designed to provide managers, executives, other non welding personnel with an appreciation on managing WPS/WQT, and technical knowledge on welding technology relating to maintenance, inspection, alteration and repair of in service metallic systems in order to avoid unplanned shutdown and reduce expenses. This course would help non welding personnel make sound decisions on the acceptance of WPS/WQT during welding production and me-tallic fabrication work.

IMM Visits Kuching

Kuching 17 October 2012

A IMM team, led by Deputy President, Prof. Dr. Che Husna Azhari, presented a Career Talk during the Open Day "cu@ poliku" of Politeknik Kuching. Members of the team received a huge welcome with thunderous applause greeting them. Prior to the talk, Dr. Clara Ong Guat Leng, Director of Politeknik Kuching conveyed the wish to begin a student chapter in the school.

The possibility of setting up a student chapter in Universiti Malaysia Sarawak (UNIMAS) was also discussed when a career talk was held amongst a large gathering of students a day earlier.

The team also paid courtesy visits to the Sarawak Timber Industry Development Corporation (STIDC) and Sarawak Skills Development Centre (SSDC) to learn and seek collaboration opportunities.



The secretary of IMM Kuching Chapter, Wan Mohd Naguib Abdul Rahman (L) with Tn Hj Baharudin Hj Abdullah of SSDC and other members of IMM.



Prof. Dr. Che Husna (3rd from left) with Dr. Clara Ong (4th from left) and other members of IMM. Inset: The chairman of IMM Kuching Chapter, Nuzul Adzwan Bin Sulaiman.

Asian Welding Federation (AWF) Meetings



L to R: Zamaluddin Ali, Prof. Dr. Mohd. Kamal Harun (President on IMM), Prof. Dr. Che Husna Azhari, Ir. Dr. Edwin Jong and Ir. Mohd. Suradi Yasin at the AWF Governing Council and Task Force meetings

The Asian Welding Federation (AWF) held its 18th Governing Council & 11th Task Force meetings in Bangkok. Members from 11 countries were present to discuss the implementation of the Common Welder Certification Scheme. As an active proponent of the scheme in Malaysia, IMM was drafted as one of the reviewers of OP20 which pertains to Internal Audit and Management.

The 19th AWF Governing Council & 12th AWF Task Force Meetings would be held in Singapore in July 2013, coinciding with the 7th Asia Pacific International Institute of Welding (IIW) International Congress

New Approaches to Sustainable Materials Research at CSIRO Materials Science and Engineering



Kuala Lumpur 6 November 2012

The Institute of Materials, Malaysia (IMM), supported the successful 8th Asian-Australasian Conference on Composite Materials (ACCM8) which was held in Malaysia. A reported 350 delegates from all over the world participated in the 3-day event. IMM's secretariat office, Materials Technology Education Sdn Bhd (MTE) promoted the IMM and its membership and activities during the conference.

Following the ACCM8, the IMM Composites Committee collaborated with CSIRO to organise a talk on New Approaches to Sustainable Materials Research at CSIRO Materials Science and Engineering. The speaker, Dr. Russell Varley, has vast experience in network and engineering polymers focussing on improved performance, durability and sustainability. His expertise include self healing materials.

Dr Russell Varley stressing a point

"Evening Talk" on the Good and Bad Practice in Fabrication and Use of Stainless Steels



Dr. Liane Smith (L) exchanging gifts with Halimah Pit, Chairman of IMM CMD.



Guests sharing experiences and notes after the evening talk.

Kuala Lumpur 6 December 2012

The IMM Corrosion and Materials Degradation (CMD) Committee organised an "Evening Talk" on the Good and Bad Practice in Fabrication and Use of Stainless Steels. Dr. Liane Smith spoke on her experiences of seeing good and bad practice in the fabrication, storage and commissioning of stainless steel pipelines and piping in the oil and gas industry, which called attention to the details which make the difference between success and failure.

The event was fully sponsored by Intetech Ltd (UK).



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Introduction

Many years ago, the Oil & Gas industry discussed the idea of establishing a QA/QC system to check on the quality of paints supplied to the oil & gas industry. There were concerns then regarding the cost reduction initiatives that paint manufacturers may supply "cheaper formula" products labelled as the actual high quality products approved by the oil companies. Scientific testing technologies then were not available for the protective coatings to be "fingerprinted" like metals & alloys which can be checked against its mill certificates obtained via spectrometers and in-house laboratory QC tests. The idea naturally died off. It is believed that the oil & gas industry continues to be plagued with supply of non-conforming protective coatings due to fierce price competition. Materials testing technologies have advanced exponentially over recent years that it may be possible for polymers to be "fingerprinted" in the near future.

IMM Polymer Committee will organise a half-day Forum titled "Towards Fingerprinting of Polymeric Coatings" in conjunction with the IMM Annual General Meeting on Friday 22nd March 2013. This will be the first of a series of such forums as the initiative towards "fingerprinting" technology for polymeric coatings will require many rounds of discussion amongst interested parties.

Institute of Materials, Malaysia

Towards Fingerprinting of Polymeric Coatings

2.30pm - 6.00pm : Friday 22nd March 2013
(Dewan Presiden) Kelab Golf Negara Subang,
Kelana Jaya, Selangor



Objective

The forum is aimed at dispelling the notion that there is no way to identify polymer products in the same way as metallic products like the mill certificate, etc. Polymers should have their own "Mill Certificates & QC test reports" so-to-speak, so that customers and users can be assured that the contents of the polymer product are as per specifications. The first step towards this initiative will focus on the more common product used in the oil & gas industry i.e. the epoxy coatings, as a basis for discussion. Of course, "Fingerprinting" involves more than just the mill certificate e.g. inspection & test reports, production QC reports, raw materials inspection reports, etc. This Forum is aimed at brainstorming the possibilities of using the latest scientific technologies and materials testing technologies during the paint manufacturing & in-house laboratory QC testing process to establish some form of "Fingerprinting" for polymeric coatings. The ultimate objective is to provide assurance that protective coating products have been manufactured according to original product formula specifications.

The forum will kick-off with 4 presentations of 15 to 20 minutes each followed by 45 minutes for open discussion

Components of Epoxy Polymeric Coatings including additives, etc and their identification – this is to provide information to the audience on what the raw material ingredients of an epoxy coating are made of e.g. organic/inorganic components, resin, curing agent, fillers, solvents, and what current methods are used to detect each individual component separately.

Speaker : Professor Dr. Mohd. Kamal Harun (Coatings Researcher - UiTM)

Manufacturing Process of an Epoxy Polymer Coating for Oil & Gas Industries – this is to provide an understanding of the entire paint manufacturing and QC testing process including in-coming raw materials, product formula, mixing & compounding process, in-house laboratory testing methods, and what parts of the process are deemed trade secret and what are not.

Speaker : Mr. Frankie Chua (Managing Director - PLC Laboratory Sdn Bhd)

Spectroscopic Fingerprinting in Polymer Coating that Potentially Useful in Quality Control/Quality Assurance (QC/QA) of Raw Materials and Finished Products in Oil and Gas Industry – this is to provide the audience with information about the new techniques of polymer testing which may offer fingerprinting opportunities. Materials Testing technology has advanced exponentially over recent years that many industry professionals may not have kept themselves up-to-date and are unaware of newer technologies which may assist the industry to improve QA/QC in their industry.

Speaker : Mr. Kenneth Way (Materials Characterisation Specialist - Perkin Elmer Sdn. Bhd.)

User experience on quality issues with Polymeric Coatings in the Oil & Gas Industry – representatives from the Oil & Gas industry will highlight the paint product qualification and approval process and show how good quality epoxy coatings can perform compared to poor quality epoxy coatings. Qualified & approved products are expected to be supplied to the project job sites by the paint manufacturers. Without a fingerprinting system currently, there is no way of assurance that the delivered product is the same as the approved product even though the paint drum can bear the same product name. No "Batch quality certificates" similar to metal mill certificates are supplied to customers currently.

*Speaker : Mr. David Lim (Coatings QA/QC Specialist – ExxonMobil Malaysia) and/or
Encik Zamaluddin Ali (Corrosion Specialist – PETRONAS GTS Dept)*

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