UPM
UNIVERSITI PUTRA MALAYSIA
BERILMU BERBAKTI

Issue 19·July-Dec 2019
ISSN No. 1985-4951

INTROPica

INSTITUTE OF TROPICAL FORESTRY AND FOREST PRODUCTS

Centre of R&D in Tropical Biocomposite and Bioresource Management

Safety, Health and Environment in the Biocomposite Industry

Manufacturing safety is important to prevent or lessen the risk of workplace injury, illness and death. Injuries to employees may also create significant worker's compensation and medical treatment costs. The organization has to take time to investigate the injury and to manage the costs of the injury including finding and training a replacement for the injured worker.

In any industry, precautions must be taken to ensure the safety of employees. In the biocomposite manufacturing and relevant industries, hazards relate primarily to the toxicity of the materials used and the improper use of Personal Protective Equipment (PPE). Chemicals used like resins, especially in wood composited manufacturing, is an essential component of composite structures. The most commonly used resins are polyesters epoxies and vinyl esters, in addition to more exotic resins such as Phenolics, Bismaleimide and Polyimide. Each of these resins pose a health risk to the worker. All persons working with resins need to be aware of the health and exposure risks associated with each type of material they are working with; focusing primarily on the skin, lungs, and eyes. It is mandatory to wear the proper PPE at all times when working with any resin system. The main concern with fiber reinforcements is the irritation caused by direct contact with the skin. Fibers that lodge into skin pores can be exceptional irritants. it is important to wear the appropriate PPE and educate workers in the proper use of the materials.

Composite machinery being used every day without issue can lead to complacency or cut corners when it comes to safety. But an improperly installed safeguard can be just as dangerous to employees, if not more, because an incident can happen at any time during normal operation. While servicing composite machinery and other components in the manufacturing industry, the correct procedures must be executed to ensure accidental start-up and energy discharge do not happen. Technicians are especially vulnerable when working deep within machinery, so there must be absolute certainty that warning signs, lockout safeguards, and employee warnings are distributed.

It is important to train technicians working with composite materials in the health effects of improper exposure to fibers and chemical compounds. Health risks of working with composites are significant. Other factors such as housekeeping, employee involvement, manager training, and more also contribute to a safe work environment.

DESIGN FOR SAFETY IN THE DEVELOPMENT OF BIOCOMPOSITE PRODUCTS

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ABSTRACT

Design for safety in the development of biocomposite products is presented in this article. The design for safety general guidelines proposed by some experts is implemented. Four design for sustainability guidelines were used in the development of three biocomposite products, i.e. safety helmet, PUTRAFrame and multi-purpose table. The guidelines of design for safety were successfully applied in these products.

KEYWORDS: Safety; Biocomposites; Conceptual design; Ergonomic design; Biodegradable

INTRODUCTION

Product designers design biocomposite products following design of traditional composite product design procedures. To the author's knowledge, no publication that publishes exclusive design procedures on biocomposite products is available yet. Design for safety is one of the elements of design for manufacturability (DFM). Designer considers issues related to manufacturing at the outset of product development process. (Sapuan, 2017). It is a concurrent engineering approach in product development. Safety is one of the primary considerations in the product development process. Figure 1 shows three important aspects of design for safety (Dieter and Schmidt, 2009).

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Figure 1: Three important aspects of design for safety

DESIGN FOR SAFETY IN BOCOMPOSITE PRODUCT DEVELOPMENT

This article presents design for safety in biocomposite product development. This article discusses four rules of design for safety given by Bralla (1996) (See Figure 2).

DESIGN FOR SAFETY GUIDELINES FOR BIOCOMPOSITES

1. **Ergonomic design**
2. ***The use of painting and surface finishing materials complying with OSHA regulations***
3. **Designing the product so it is easier to use safely than unsafely**
4. ***Thoroughly testing prototypes to reveal any hazards overlooked in the initial design***

Figure 2: Design for safety guidelines for biocomposites

ERGONOMIC DESIGN: SHARP EDGE AND CORNERS

There is strong correlation between good ergonomic design and safe design. One of good ergonomic design elements is to avoid sharp edges and corners. PUTRAFrame is one of the products developed at INTROP, Universiti Putra Malaysia (UPM). Designers design PUTRAFrame with the concept of minimalist, sleek, ergonomic and versatile. PUTRAFrame has no sharp edge and corner to ensure ergonomic design (Figure 3). PUTRA Frame retains the original natural colour of kenaf fibre reinforced high density polyethylene (HDPE) composites. It is brown in color resulted from kenaf core fibres used in the formulation of the pallets.

Figure 3: PUTRAFrame: Sharp edges and corners are avoided

It is not only for safety reason, as far as fabrication process is concerned, sharp edges and corners/radii are not desirable because as a rule they should be made as generous as possible as sharp edges can concentrate stress during composite fabrication process (Murphy, 1994).

››› PAINTING AND FINISHING FOLLOWING OCCUPATIONAL SAFETY AND HEALTH (OSH) REGULATIONS

UPM researchers also developed biocomposite multi-purpose table and safety helmets. Unlike PUTRAFrame, these products involved painting and finishing processes (Figure 3). In one of the studies, finishing processes used in biocomposite products include gel coat, and sprays. Four types of sprays were used; plastic primer, putty primer, clear spray, and black colour spray. Sand paper was used to remove gel coat excess. The finished surface was tested for surface roughness, and scanning electron microscopy to detect any surface defects (Nurul Nathirah, 2019). Painting of biocomposite products is important to achieve aesthetically pleasing finish (Figure 5). It has been ensured that all these activities were conforming to OSH regulations (Legal Research Board, 2019).

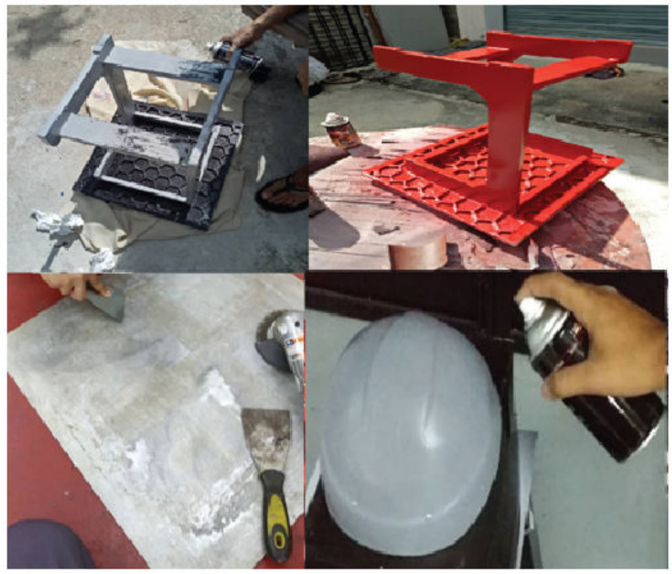

Figure 4: Painting and finishing processes of biocomposite products

Figure 5: Biocomposite tables painted in different colours

››› DESIGNING THE PRODUCT SO IT IS EASIER TO USE SAFELY THAN UNSAFELY

It is customary with the design of biocomposite products to consider the design in safe way. Design involved material selection. Selecting material, which is biodegradable facilitates safer use of products. Some non-biodegradable materials may be unsafe for marine creatures (Sapuan, 2019). It is safer to use biocomposites than glass or carbon fibre composites in automotive interiors during crash. Biocomposites did not form sharp-edge fracture, thus providing safety to passengers.

(https://www.businesswire.com/news/home/20171002005936/en/).

THOROUGHLY TESTING PROTOTYPES TO REVEAL ANY HAZARDS OVERLOOKED IN THE INITIAL DESIGN

Multiple preproduction versions of biocomposite products were fabricated for testing and refinement. In this case the products are safety helmets for palm oil plantation workers. These versions are called early (alpha) prototypes. Alpha prototypes were fabricated with production-intent parts (Figure 6 a,b). They are the parts having exactly same product geometry and material properties intended for the final production process of the products. However it is not necessarily fabricated using the actual processes to be used in production (Ulrich and Eppinger, 2004). In this case, alpha prototypes of safety helmets were fabricated using hand lay-up process but in the actual production, resin transfer moulding (RTM) or compression moulding process may be used. Figure 6.c shows testing of alpha prototype of biocomposite helmet. Through a series of testing, effective product refinements can be achieved. One of the reasons for the testing and refinement is to reveal any hazards overlooked in the initial design.

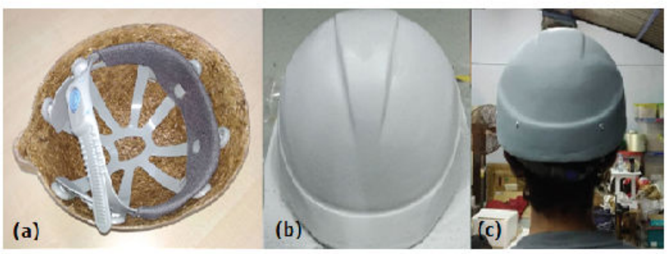

Figure 6: Alpha prototype of biocomposite helmet and its testing

ACKNOWLEDGEMENTS

The author thanks staffs of Laboratory of Biocomposite Technology, INTROP, UPM for their inputs in the preparation of this article.

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ENVIRONMENTAL LEVERAGE EFFECT FROM KENAF FIBRE REINFORCED BIOPOLYMER COMPOSITES

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ABSTRACT

During the covid-19 pandemic period, high practice of personal hygiene is recommended. Disposable plastic products are applied in order to avoid the contamination of viruses. Unfortunately, this had brough back the nightmare of plastic pollution. In this short review, the introduction of kenaf fibre reinforced biopolymer composites as an environmental leverage shall be discussed. The improved performance from the kenaf fibre reinforcement has widen the applications of biopolymer composite. In this short review, it acts as an awareness that the usage or replacement of kenaf fibre reinforced biopolymer composites have actually helped to mitigate severe environmental condition we are facing now.

INTRODUCTION

As the world suffered from covid-19 pandemic, personal hygiene is priority in daily activities. The use of single-use mask, single-use glove has increased dramatically in past few months and expecting high usage volume for the remaining months in 2020. About 85% of Malaysia citizens wearing face masks when in public area in a survey conducted on 25th of May 2020 [1]. Besides, high practice of personal hygiene has brought back the nightmare of plastic pollutions as use of single-use plastic was encouraged in standard operating procedure (SOP) of many countries. A chef scientist at Ocean Conservancy, environmental nonprofit based organization, has claimed his worried that this pandemic pushes their environmental effects back to 10 years back [2].

Hence, scientists are not only keen to develop vaccine but also urge to find suitable plastic product replacements. Biopolymers like PLA, PHA, and PBAT had introduced in the market for a decade. However, direct applications are not preferred by manufacturers due to higher raw biopolymer cost and lower performances of biopolymer-made-products [3]. Hence, scientists had reinforced fillers including natural fibres, into biopolymer composite with an attempt of better strength or specific properties enhancement. Díez-Pascual, 2019, has reviewed and summarized some previous characterization studies on biopolymer composites and its cost [4]. In this short review, only kenaf fibre reinforced biopolymer composite shall be discussed. How kenaf fibre reinforced biopolymer composite can help in environmental leverage.

KENAF FIBRE

Kenaf fibre is one of the famous used natural fibres with the purpose of strength of enhancement for polymer composites. Kenaf is the traditional crop in Thailand, certain areas of Africa, India, and Bangladesh, and to a certain level in Southeast Europe. It has been grown for over 4000 years in Africa, and its parts have been used for animal diet, food, handicraft manufacture, and fuel by inherent communities. It can glow at a wide range of weather and Malaysia is one of the plantation countries. Malaysia has allocated more than 2,000 hectares for kenaf cultivation and expecting USD 854 million revenue by 2025 [5]. Kenaf plantation brings variety of economic and environmental benefits. All the components of kenaf plant, fibre, seeds and leaves, are provide specific applications. Kenaf single fibre provides 11.9 and 60 GPa of tensile strength and modulus, respectively.

Kenaf is one of the fast-growing annual crops. It cultivates twice per year with 15-20 tonnes of dry weight per hectare, including 20% of fibre contents [6]. On the other hand, high photosynthesis rate of kenaf plant, is the first criteria as an environmental leverage. It has a photosynthesis rate of 23.4 mgCO2/dm2/h and it's about 2.7 times compared to conventional tree (8.7 mgCO2/dm2/h) [7]. Figure 1 shows carbon dioxide absorption by kenaf plant and PLA biopolymer, in order to moderates global warming issue.

Kenaf plant can grow in 3 months for 3-meter height and 3-5 cm diameter. Its stem constructed by 30 wt% of bast fibre and 70 wt% of core fibres. Bast fibre is retted from phloem bundles and provide strength to the stem. Bast fibre provides highest strength reinforcement compared to other natural fibres.

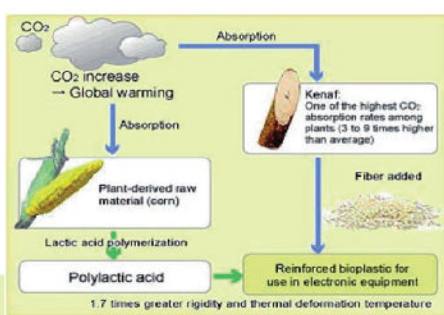

Figure 1: carbon dioxide absorption by kenaf plant and PLA biopolymer, in order to moderates global warming issue [6].

APPLICATION OF KENAF FIBRE REINFORCED POLYMER COMPOSITES AS ENVIRONMENTAL LEVERAGE.

There are plenty of studies on high performance kenaf fibre reinforced biopolymer composites have been published. Lee, 2018, have investigate the effect of kenaf fibre insertion into Floreon biopolymer composite and the results reviewed a better product's flexibility and dimensional integrity [8]. Other than this, rough surface of kenaf fibre increase the adhesive bonding with matrix and facilitate better stress transfer as a result from non-cellulosic component removal on fibre surface. It has high potentials to apply as active packaging material to reduce the usage of conventional plastics that harm environment [9]. Besides, Ranakoti et al, 2018, have pointed out the increasing tread of natural fibre composites development in past 10 years and numerous of natural fibre application in various industries especially medical field, this is because medical components required high hygiene practice, e.g. single-use products [10]. Application of natural fibre in single-use products will no stressed the pollution condition we currently facing [11]. Mukherjee and Kao,2011, have addressed the sustainability issue of biopolymer in their comprehensive review [12]. Kenaf fibre is one of the famous used natural fibres in PLA composites and one highlighted discussed work show 286% of tensile strength improvement. This magnificent outcome provides a huge motivation to researcher on developing kenaf fibre reinforced biopolymer composites. On the other hand, kenaf fibre composite-made car-bumper-beam have been fabricated. The analysis showed high fuel efficiency, higher impact capacity and creating non-toxic smoke during fire incident that could save human's life as well as environmental friendly [13]. As better performances observed from kenaf fibre reinforced biopolymer composites, it has high favourite to substitutes conventional non-biodegradable materials but remaining similar properties. This promotion is then made it as an environmental leverage since biodegradability of the biocomposite decompose itself after a period of time. Threaten to marine life, saturation of solid waste and global warming caused by non-degradable plastic, could be solved out by applying or substituting kenaf fibre reinforced biopolymer composites.

CONCLUSIONS

High practice of personal hygiene is recommended throughout the time of the Covid-19 pandemic. Disposable plastic products are used to avoid virus contamination by previous user. Unfortunately, this contamination prevention has brought back the nightmare of plastic pollution. The implementation of kenaf fibre reinforced biopolymer composites as an environmental lever is agreed and applied by previous studies. The improved performances of the kenaf fibre reinforcement has widened its applications. In this short review, it acts as a guidance to mitigate environmental issue created by plastic pollutions, with the use of replacement of kenaf fibre reinforced biopolymer composites.

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COMPOSITE INDUSTRY TOWARD ENVIRONMENTALLY FRIENDLY BINDERLESS COMPOSITES AND BIO-RESIN BASED COMPOSITES

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BACKGROUND

Worldwide deforestation have created issue of wood scarcity and demand of renewable materials are increasing exponentially due to the demerits of synthetic materials. New environmental regulations have tried to impose some new parameters to composites manufacturers to avoid synthetic polymers or materials [1]. In this condition, natural fibres, non-forest materials (twigs, lower density wood) tannin from trees and agriculture residue from field and agro-industries are in high priority to the researches and industries [2]. In development of biodegradable materials such as plastics bags packaging products fiberboards and particleboards, synthetic adhesive and polymers are commonly used for daily usage [3].

In composite boards, adhesive is an essential component of wood composite manufacturing and formaldehyde based adhesives are the most common adhesives, widely used in the industrial scale due to its desirable performance and low cost [4,5]. Although, formaldehyde has been categorized as carcinogenic and restricted to use in many developed countries, it is still in practice due to non-availability of suitable alternative [6]. The research and engineering interest has been shifted from the above-mentioned materials to new biobased resins due to environmental concerns [7] and eventually to self-bonding boards, free of synthetic adhesives [2,8]. A complete or partial replacement of formaldehyde based adhesives with starch and protein is also under intensive investigation [9,10]. However, the technique to fabricate fiberboards without adhesives has promising hope in prospect the economic as well as environmental. The initiative for binderless fiberboards was started around three decades before, when industrial waste bagasse was used to prepare composite through self-bonding technique [10] and a patent for the binderless fiberboards fabrication for a pilot scale production [11].

Plastic bags are serious issue and play vital role in destruction of environment, it does not pollute the earth but also marine lives. The annual production of petroleum-based plastics was recorded as more than 300 million tons until 2015 [12]. During the manufacturing of plastic bags, the emission of carbon and many other dangerous gases causes environmental concerns [13]. Generally, polyethylene plastic films, such as low-density polyethylene (LDPE) and high-density polyethylene (HDPE), are being used to produce a variety of polyethylene plastic films, and the drawback of this plastic is its non-degradability. Over 1000 million tons of plastic were predisposed of as unwanted elements, and they might take several hundreds of years to decay. The percentage of plastics in municipal solid waste continues to grow rapidly. When plastic wastes are dumped in landfills, they interact with water and form hazardous chemicals, and the quality of drinking water may also be affected [12]. Hence, efforts are taken to reduce the use of synthetic plastics and to promote bioplastics. Biodegradable plastics are made from starch, cellulose, chitosan, and protein extracted from renewable biomass [14]. The development of most bioplastic is assumed to reduce fossil fuel usage, and plastic waste, as well as carbon dioxide emissions. The biodegradability characteristics of these plastics create a positive impact in society, and awareness of biodegradable packaging also attracts researchers and industries [15]

MANUFACTURING PROCESS AND FUTURE PROSPECT

BINDERLESS FIBREBOARDS

Binderless fiberboards are manufactured through two methods; wet-process and dry-process. In wet-process, the water-distributed cellulosic fibers are pressed at high temperature with or without adhesive. Thus, the hydrogen bonding and lignin plasticizing are the only bonding forces, formed during heating and drying processes of wet-process [16]. In wet process, lower mechanical strength and poor water resistance are the main disadvantage, along with the waste of water in the process. In dry process, cellulosic fibers are dried first followed by addition of resins and finally pressed at curing temperature [16]. The industry follows mainly dry-process manufacturing procedure with an addition of synthetic resins. The raw material rich in lignin and hemicelluloses are preferred for binderless fiberboards preparation. The pretreatments such as steaming, chemical or enzyme pretreatments modifies the fiber composition which is believed to play an important role in self-bonding. Thus, the binderless boards manufacturing involves two major processes: pretreatment followed by hot-pressing.

BIO-PLASTICS

The bioplastic prepared from the corn and rice starches have better biodegradability than the existing plastic materials [17]. Addition of citric acid improves the shelf-life of the material and improves the mechanical properties. The average thickness of the bioplastics is 0.25 mm (250 microns). The average moisture content is 13.2%. The solubility in water is 11.9%. The biodegradability of the sample is 48.7%, and it is achieved in 15 days. The maximum tensile strength of the bioplastics is found to be 12.5 MPa. The water contact angle of 70o was obtained. From the above test results, it can be concluded that bioplastics can be used as packing materials and can be used as an alternative to LDPE and HDPE plastic bags. Due to the obtained properties of bioplastic, it would be interesting to prepare polybags using this bioplastic with assumed lower cost. Investigation of the hybridization of proposed starch materials with other biomaterials, and with different plasticizers, would be an interesting scope for this research

BIOCOMPOSITES

Coir Fibre(CF)/Pineapple leaf fibre(PALF)/PLA biocomposites were prepared by melt blending in an internal mixer at 180 C temperature and 50 rpm speed for 10 min [18]. The different weight percentages of CF and PALF in the PLA hybrid composites have been studied. The mixed materials were compressed in a hot press at 180oC for 10 min. After compression moulding, the samples were quenched using a water-cooled press and stored at room temperature before biodegradability test.

The biodegradability of a lignocellulosic composite largely depends on its polymer matrix, and the rate of biodegradation depends on many environmental factors, such as moisture, light (radiation), temperature, and microbes. Biodegradation was evaluated by soil burial and accelerated weathering tests. Changes in physical and morphological properties were observed in the biocomposites after weathering. It was found that the degradation rate of PLA was lower than that of CF/PALF/PLA biocomposites after 250 h of accelerated weathering shown in fig. 1. The effect of weathering on the morphology of the biocomposites was characterized by the formation of cracks and fractures, increased surface roughness, and colour and weight change as a result of degradation. Biocomposites degrade after weathering through photo-radiation, thermal degradation, oxidation, and hydrolysis.

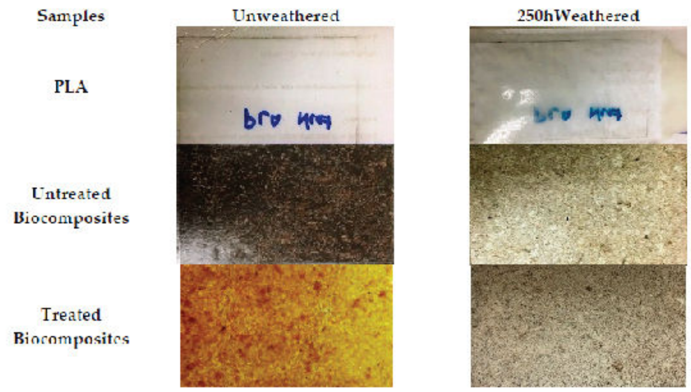

Figure 1. Unweathered and accelerated weathered untreated and treated biocomposites [18]

Water enhances the rate of degradation through the swelling of fibre, which leads to further light dispersion. The soil burial tests imply good biodegradability of the CF/PALF/PLA biocomposites. All the biocomposites showed weight loss and gradual degradation with burial time. The percentage weight loss in all the biocomposites was linearly related with the number of days of soil burial. The alkali treatment led to reduced hydrophilicity in fibres and, hence, less moisture absorption by the biocomposites from the soil, ultimately leading to slower degradation of the biocomposites with surface-modified CF and PALF. From this study, we can conclude that untreated CF/PALF/PLA biocomposites would be a more favorable choice owing to their better biodegradability and are suitable for the suggested biodegradable food packaging applications

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SAFETY, HEALTH AND ENVIRONMENT AT WORKPLACE: FOR POSSIBLE IMPLEMENTATION IN BIOCOMPOSITE LABORATORY

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INTRODUCTION

More than 5000 workers are employed in the laboratories in UPM. Laboratory workers such as Science Officer (SO), Assistant of Sciences Officer (ASO) and Lab Assistant (LA) are the important person who conducts the laboratories. Laboratory workers are exposed to the numerous hazard including chemical, biological include viruses, bacteria, insect, animals, physical, safety, ergonomic and psychosocial.

The Occupational Safety and Health Management Office, UPM (PPKKP), established at UPM on August 1, 2009 was to carry out its main function ensuring compliance with the Occupational Safety and Health Act 1994 (Act 514) and the Atomic Energy Licensing Act 1984 (Act 304) and related laws and regulations, including conducting occupational safety and health inspections at the workplace / Responsible Centre (PTJ), conducts accident research and accident studies, hazardous events, occupational toxicity and occupational diseases, designs, provides and implements appropriate occupational safety and health training programs in matters pertaining to occupational safety and health management at the university and issue instructions about it. PPKKP is the existence of two highly committed and responsible sections, namely the Administration and Quality Section and the Operations and Services Section assisted by the First Response Team Unit. All institute and faculties used PPKKP as a guideline and references. For reminder and practices PPKKP will do inspection and audit yearly to each faculties and institute.

CREATE A SAFETY WORKPLACE

Laboratory safety is the rules that are used in every lab to keep everyone including researchers and students safe. Proper lab rules are important to keep people getting hurt. To make the workplace comply all the rules, first we must make sure our workplace is safe to work. There are many steps to safe and healthy workplace such as develop a system for organizing safety and health efforts, know your responsibilities, know the laws and regulations for the work you do, address specific workplace hazards and have regular safety meetings and find out the best solutions to safety and health problems. As a worker it is our responsibility to know and follow all lawful employer safety and health rules and regulations and wear or used required protective equipment while working. Workers should report hazardous to the employer and report any job-related injury or illness to the employer, and seek treatment promptly. Workers should comply with all applicable OSHA and safety standards.

LABORATORY SAFETY

Safety awareness in the lab starts with familiarising yourself with all equipment and correct procedures before commencing work. Rules and regulations will vary from each lab, but some of the basic safety awareness measures include: to any unsafe equipment so action can be taken as soon as possible. Institute must lead and coordinated departmental safety effort. It will involve the implementation of a chemical hygiene plan for safe chemical handling, storage, and disposal of chemical. Eye wash and showers must be in operating condition, and fume hoods with proper sashes are essential. Researchers, students and visitors in the lab must wear goggles, and consumption of food or drinks must not be permitted. A clean laboratory is more likely to encourage careful work.

SAFETY IN THE MECHANICAL WORKSHOP LABORATORY

All persons using workshops should apply good housekeeping practices; wear appropriate clothing and footwear or use personal protective equipment (PPE). A tidy workplace makes it easier to spot and avoid hazards, and does not interfere with normal work operations.

Always wear safety gear while working in the workshop. Hand gloves, safety shoes, helmets and eyeglasses are mandatory for workshops jobs like plumbing, machine fitting, welding or carpentry. Safety shoes with steel toe caps are required

When working with machine tools, keep your fingers well away from the tool. Do not handle chips coming from the work piece as they are hot and have sharp cutting edges, example wood chipper machine, band saw and ring knife flaker. When using any wrench provided to tighten a tool bit or work piece, never leave the wrench in the chuck. Check travel and clearance between the tool post and chuck to prevent contact.

No one is permitted to work in lab areas alone. This is to provide protection and assistance in case personal injury should occur. Supervisor or SO/ASO/LA MUST be notified whenever a student intends to work in an unsupervised area. Please arise any problems while operating a piece of equipment, shut down the equipment and report the problem to the instructor.

Officers must keep the working area neat and well organized; keep the floor clean of oil spills and metal chips. Clean off your machine when finished and return all tooling to the storage bins, trays, etc. The area must be swept clean before leaving your machine. Report any personal injury to the officer in charge for treatment. Report any hazard you notice to the officer in charge. Figure 1 shows student use PPE while doing their lab work.

Figure 1: Stem & Fibre Processing Unit, BIOCOMPOSITE Laboratory

Obey the safety regulations posted on the safety boards. This is required by law under the Occupational Health and Safety Act Revised Statutes 1980.

SAFETY IN THE CHEMICAL LABORATORY

These basic chemistry lab safety rules are relevant to many scientists as chemistry labs are one of the most common types, dealing with the safe performance of usual activities and tasks in the average chemistry lab or minimize hazards as much as possible. Since almost every lab uses chemicals of some sort, chemical safety rules are compulsory. Following these policies helps scientists avoid hazards in order to prevent injury to yourself and others around you, as well as damage to the environment outside of the lab.

1. Please make sure you are familiar with the safety guidelines, hazard warnings and manuals of the experiment you are performing on a given day before you start any work
2. Before you start an experiment, make sure you are fully aware of the hazards of the materials you will be using by reading the label on the chemical bottles twice. Every chemical should be treated as though it were dangerous.
3. Do not allow any solvent to come into contact with your skin. Always exercise extreme caution by wearing proper gloves, laboratory coat, footwear and safety glasses.
4. All chemicals should always be clearly labelled with the name of the substance, its concentration, the date it was received and expired, and the name of the person responsible for it. Figure 2 shows harmful chemical hazard sign and Globally Harmonized System (GHS) symbol.
5. Chemicals should be stored away from heat and direct sunlight. Chemical storage cabinets may be used for long-term storage of limited amounts of chemicals. When storing chemicals on open shelves, always use sturdy shelves that are secured to the wall.
6. Never take more chemicals from a bottle than you need for your work. Always pour chemicals from large containers to smaller ones.
7. Chemicals should never be mixed, measured, or heated in front of your face or in sink drains. Flammable and volatile chemicals should only be used in a fume hood.
8. Experiments should not be performed without supervisor or officer in attendance and must not be left unattended while in progress.
9. If a chemical spill occurs, clean it up right away. If the spill is large or is of a hazardous material, inform the officers immediately. Please make sure safety showers, eyewash stations and doorways are not obstructed.
10. Do not return unused chemicals back into their stock container.
11. Chemicals or other materials should never be taken out of the laboratory except when required to do so for analysis.
12. Ensure that all chemical waste and broken glassware are disposed properly in suitable containers. All glassware, equipment, tools, etc. must be clean before you leave the lab.

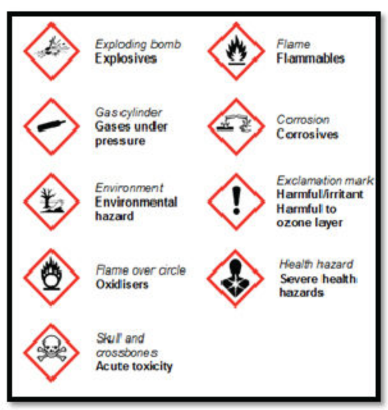

Figure 2: GHS symbols and their meaning (Source:www.discountsafetysignsaustralia.com.au/label-chemicals-correctly-this-festive-season-urges-safe-work-australia/)

SAFETY IN THE THERMAL ANALYSIS LABORATORY

In INTROP, we have thermal analysis equipment under Product Testing Laboratory, Lab. of Biocomposite Technology (BIOCOMPOSITE) consisting of Thermal Gravimetric Analyzer (TGA), Dynamic Mechanical Analyzer (DMA), Differential Scanning Calorimeter (DSC) and Thermal Mechanical Analyzer (TMA). One of the important things that we should take safety precautions in thermal analysis is when handling the liquid nitrogen used for DMA and TMA machines. Figure 3 shows dangerous goods sign – Class 2 non-flammable non-toxic gas

Figure 3: https://www.globalspill.com.au/product/dg-diamond-sign-division-2-2-nonflammable-toxic-gas/#:~:text=Non%2Dflammable%2C%20non%2Dtoxic,dioxide%2C%20compressed%20air%20and%20helium.

Liquid nitrogen (LN2) is a colourless and odourless liquid with a boiling point of −195.79°C and is widely used as a coolant for easier machining or fracturing as it is a very cool substance.

Because of its extremely low temperature, careless handling of liquid nitrogen and any objects cooled by it may result in cold burns. Here are the precautions when handling liquid nitrogen.

Figure 4: Liquid Nitrogen Tanks in Product Testing Lab, BIOCOMPOSITE Laboratory

1. Wear safety glasses or a face shield when transferring liquid nitrogen and handle the liquid slowly to minimize boiling and splashing.
2. Wear gloves when touching any object cooled by liquid nitrogen. Gloves should be loose fitting, so they are able to be quickly removed if liquid were to pour inside them.
3. A laboratory coat or overalls should be worn at all times. Avoid open pockets and turn-ups where liquid could collect.
4. Shoes with a reinforced toe cap are recommended for handling liquid nitrogen tank. Open toed shoes should not be worn under any circumstances.
5. Use only approved unsealed/special insulated containers. Materials such as carbon steel, plastic and rubber become brittle at these temperatures.
6. Never seal it in any container as this may result in it bursting or an explosion.
7. Never dip a hollow tube into liquid nitrogen; it may spurt liquid.
8. Never modify safety devices such as cylinder valve or regulator of the tank.
9. Never use in a small poorly ventilated room, and never dispose of liquid nitrogen by pouring it on the floor. It could displace enough oxygen to cause suffocation. Nitrogen gas is colourless and odourless. The cloud that forms when you pour liquid nitrogen is condensed water vapor from the air, not nitrogen gas.
10. Do not store liquid nitrogen for long periods in an uncovered container.

CONCLUSIONS

Safety rules and regulations are created to protect laboratory personnel such as researchers and lab officers from unsafe work practices and prevent injury when handling equipment and hazardous materials. Hazards in the workplace can be avoided when research work are well planned, lab personnel are provided guidance, and work is carried out carefully and responsibly. The most important thing to create a safe and healthy work laboratory environment is to identify the risks and hazards in your own workplace and establish the necessary measures that can be used to manage the risks. Consistently following and implementing the safety rules will help encourage a safety culture within the workplace.

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POTENTIAL OF BIOBASED COMPOSITES IN ELECTROMAGNETIC RADIATION SHIELDING APPLICATION

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INTRODUCTION

EMI is refer to Electromagnetic interference. To dig more into EMI, we must know the basic of radio frequency (RF). All the frequencies used for communication, radar, and satellites is call as RF with up to maximum frequency of 300 GHz. The knowledge of RF is regarded as black art and something mysterious since it cannot be touched and be seen. Interestingly, even we cannot see radio waves, most people will, at college or at school. Its presence can be proved by classical experiment with magnetic fields and iron filing and use an electroscope to demonstrate the presence of electrostatic charge. With this fact, it should be at least be possible to convince such fields are very common in any electrical environment and not a magical. RF have been implemented and conceived twenty or thirty years ago and now widely used in various application to fulfil demand from communications, broadcasting, production processing, navigation, medical therapy and radar fields. Recently, there is an increasing use in application of wearable devices, smartphone, anti-theft system in shop, remotely control system and many other novel applications. However, some energy may be unintentionally released from any source of fields into free space which will lead interference with other equipment or receivers. Such interference has been experienced by most people in their lives. The most common one is “ocean breeze sound” and crumple effect on screen when u received a phone call nearby television. This is because, electromagnetic waves propagated in free space which have the electric and magnetic fields perpendicular to each other and to the direction of propagation. This phenomenon is illustrated as in figure 1.

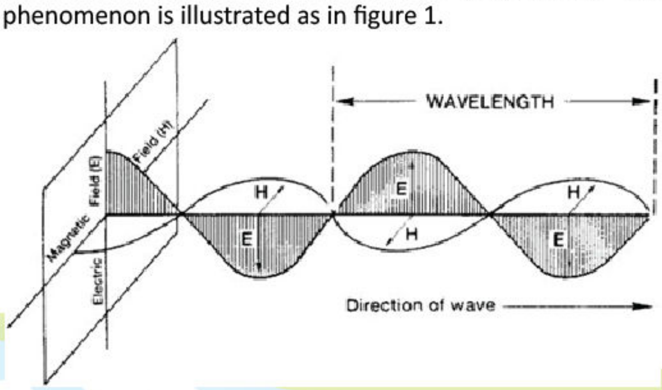

Figure 1: Electromagnetic waves propagated mechanism. (adopted from [1])

RF radiation come from many sources and one of them is from broadcasting. Broadcasting used medium frequency (MF) and high frequency (HF) which exceeding 2MW. MF are usually used for national broadcasting and HF for long distance broadcasting. So usually this MF and HF transmitter requires quite a lot of survey time to monitor radiation within safety range. Another example is from communication source. However, there is an infinite of communication equipment such as mobile phone, air and ship communication system. In fact, communications used higher frequency from HF to very high frequency (VHF) and ultra-high frequency (UHF) as we used phone and other communication equipment to communicate around world. Air traffic control communication system is one which used UHF and VHF and its antennas are face away from tower which to reduce the exposure to those doing work on the tower. Figure 2 illustrate example of broadcasting and communication equipment associated with magnetic wave propagation. It is worth to mention that, increase in frequency subsequently increase the RF radiation as well.

Broadcasting

Air traffic controller

Figure 2: Source of RF radiation

The fast growing of innovation made electronics more convenient to humanity. Smart watch like Apple watch, Mi band and smart phone like Iphone and Samsung really change we do things through our daily life. However, as we consistently use these devices, potential effect of Electromagnetic (EM) radiation to human as have gained huge attention. Table 1 summarised the direct effect of EM radiation potential hazard and Table 2 summarised exposure to EM radiation with clinical comment reported around the world.

Table 1: Potential hazard of EM radiation toward human and environment

	Thermal Effect	Shock And Burn	Health
Human	Hazard associated with heating of human body due to absorption of RF energy	Hazard associated with direct physical contact with conductive object such as scrap metal which located in electromagnetic field	Hazard associated with biological tissue where risk of leukaemia is high among children as EM field act directly without any significant heating being involved.
	Flammable	Transportation	Medical Equipment
Environment	Potential explosion where flammable vapours are stored on storage tank that can conduct electricity and presence of spark gap.	Potential of crush as critical equipment is interfered with and the aircraft may be in jeopardy.	Potential of medical equipment failure. With increase use of mobile phone risk extend to interference with critical medical equipment in hospital

Table 2: Reported cases of exposure to EM radiation (adopted from [1])

Source	Frequency	Duration of exposure	Clinical/biological symptoms	Authors
Radar	3 GHz	5 hours	Heat, headache, vertigo	Baranski et al., 1976
Radar	9-10 GHz	80 sec	Creatine kinease,	Forman et al., 1982
Microwave oven	2.45 GHz	5 sec	Neuropathy	Fleck H et al., 1983

Application of carbon and bio based composites for EMI shielding material

Today, metal coating, metal film and metal foam are applied as conventional EM interference (EMI) shielding materials to prevent all potential hazards. Besides that, metal is preferable is due to its better electrical conductivity compare to others non-metal materials. As electrical conductivity increases EMI shielding effectiveness (EMI SE) is increase as well. Conventional EMI materials is shown in Figure 3. However, metal cannot fulfil today advance innovation on electricals devices especially wearable devices which required elasticity and high strength, both at the same time. In order to fill this gap, composites of carbon-based nanomaterials and polymer which is eco-friendly have received much attentions as EMI shielding materials [2]–[4]

Conventional EMI materials   Carbon based nanocomposite

Figure 3: Conventional and carbon-based nanocomposite EMI materials (adopted from[4] and [5])

The most common particles used as carbon-based filler are carbon nanotube (CNT), graphene, carbon nanofibers and carbon black (CB). All these types of filler are illustrated as in Figure 4. These carbon nanoparticles are classified according to their structure and dimension.

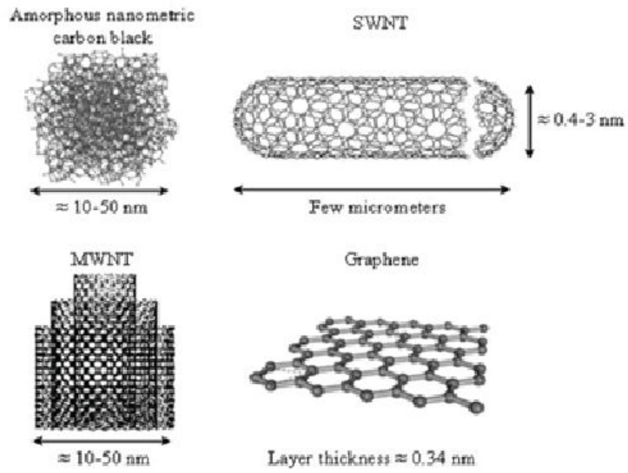

Figure 4. Types of carbon filler (adopted from [4]

The way on how these nanocarbon comspoites incorporated with polymer matrix bring huge increase electrical conductivity and thus increase EMI SE. It is expected any agglomeration happen during incorporation process, decreasing bonding between carbon particle and polymer as well as decreasing electrical conductivity. In-situ polymerization is one of the major preparation techniques. In this method carbon-based nanofillers are mixed with the monomer, polymerization taking place with or without addition of a curing agent [6]. Re-agglomeration would be avoided and better chemically bonded is achieved. It is worth mentioning that, preparation of carbon based nanocomposite using this method show significant improvement in term of strength and thermal properties [7]. Apart from incorporation method, surface modification of carbon nanoparticle is highly influence on EMI SE. Overall, surface modification improve interaction between filler and polymer matrix [4]. Electrical conductivity of the material is highly dependent on the structure of the created conductive network in nanocomposite. Therefore, the better the surface modification, the better structure of created network thus increasing EMI SE. The improved of electrical conductivity was achieved when carbon nanoparticle was selectively localized in polymer matrix and show a better EMI SE compared to in situ polymerization[8]. Beside a good selection of conductive filler and suitable incorporation technique, selection of polymer matrix also brings a significant effect on EMI SE. Incorporation of conductive filler into polymer matrix is called as composite materials. Sadly, as been discussed earlier, conventional EMI material does not suitable to be use for rapid need of today technology as it is high in density (heavy), high in cost processing, poor resistance to corrosion and only suitable for material which demand reflection EMI shielding mechanism. Good news is conductive nanocomposite materials have been widely studied to be an alternative. Advantages such as low density while keeping high conductivity with low cost of processing is the main reason why this nanocomposite materials become a good alternative [4]. Meanwhile polymer derived from bio resources is one of the great candidates. One of the good examples is jatropha oil based waterborne polyurethane (WBPU). In fact, WBPU has been used extensively as the result of their advantages such as far-reaching substrate applicability, abrasion resistance, flexibility and elasticity [5]. In addition, WBPU has minimum toxicity and does not use volatile organic compound compared to solvent borne based polyurethane (PU) which make PU more ideal safe to use in coating application [9] especially for wearable devices. This combination between WBPU and conductive filler such as graphene or carbon nanotube seem to be ultimate key in solving disadvantages of conventional EMI materials. The derivation of jatropha oil-based polyurethane is shown in Figure 5. The synthesis details of jatropha oil based waterborne polyurethane was reported by [10]

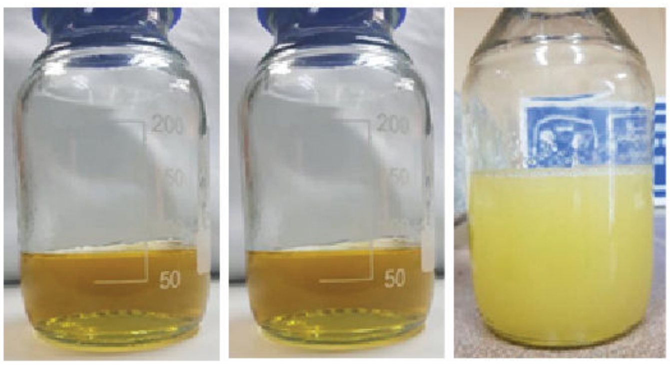

Figure 5: Derivation stages of Jatropha oil based waterborne polyurethane

Then come this big question, how does this conductive nanocomposite work in EMI shielding? Basically, there are 3 types of shielding mechanism which are absorption, reflection and combination of both as illustrated in Figure 6. For absorption, EM waves is absorb and dissipated inside nanocomposite materials while reflection is where all the EM waves is reflected at the surface of the nanocomposite materials. It has been observed that EMI SE of nanocomposite materials are higher is based on two following reason. Firstly, the selected filler must be very conductive and its able t construct the connected conductive network at extremely low content. Another reason is the ability of the filler to form dense layer in composite significantly attenuate EM waves [11]–[13]. Many are not aware that this EM waves leakage happened daily in our daily life and we are expected to be expose for almost 24 hours. Thanks to different scientific committees care on safety standards and associated risk, made all the electronic devices safe to be used. Issue related to EM waves leakage in healthcare application rise so much concern. Such wearable device involve is pacemaker and wireless body area network (BAN). Pacemaker is implant in our heart to regulate electrical shock wile wireless BAN is a wearable technology used wireless communication function for effectively collect of various vital health data of human body and send them wirelessly to hospital. As for daily life, we face this EM waves leakage in smart watch which can detect hearth rate, smartphone, wireless internet connection router. All application of EMI shielding is presented in Table 3.

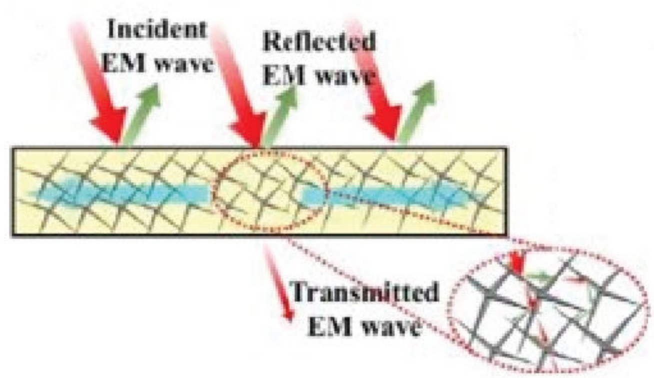

Figure 6: Schematic representation of the shielding mechanism (adopted from [14])

Table 3: Summarized of EMI shielding in various application

Application	Devices	References
Healthcare	Pacemaker	[1]
	Body area network	[15]
lifestyle	Smart watch	[15]
	Wireless charging docket	[16]
	Wireless internet connection	[16]
	Smart phone	[17]
	Smart television	[17]

CONCLUSION

EM is characterised under RF and all the frequencies used for communication, radar, and satellites is used RF with up to maximum frequency of 300 GHz to covey the information. Naturally, EM is propagated in free space which have the electric and magnetic fields perpendicular to each other and to the direction of propagation. Thus, if there is an electrical frequency, there will be a free EM propagated in free space. As been discussed, this free EM was harmful to both human and environmental. It also been discussed that, in real case study that as low as 5 sec of exposure of 2.4GHz frequency leads to neuropathy. In today trend of technology, wearable devices are use a lot by people for various application in daily life. As these devices is often use in daily life, some measure needs to be taken to reduce the EMI and thus lowering the potential hazard. Convention EMI materials are not relevant as for today technology due to not acquired good elasticity and high strength and the same time. Therefore, carbon-based nanocomposite has attracted much attention to solve this problem. Way of incorporation and surface modification was highly affected EMI SE. However, selection of polymer is crucial when it come to apply this EMI shielding in which area of application. Wearable devices required thin film with high elasticity and WBPU is one of the great examples. Overall, there are 3 types of shielding mechanism and each mechanism is unique and depend on types of application. Thanks to this EM shielding, our life is much more safer as we often use wearable devices.

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SAFETY AND HEALTH MEASURES IN BIOCOMPOSITE LABORATORIES

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ABSTRACT

This paper presents the guidelines of important facts and basic concepts that can be used as a guide to prevent accidents and injuries in biocomposite laboratories. It is designed to be easy to understand and practical. The objective of these guidelines is to be used to prevent accidents and injuries in biocomposite laboratories in particular while increasing the safety and health of students/customers.

INTRODUCTION

Having a strong set of laboratory safety rules and guidelines which can be strictly adhere by students/customers is an important component to avoid the accidents and injuries in laboratory. Overall workplace injury cases increased from 12,810 cases in 2018 to 13,779 cases in 2019 (Table 1). The number of workplace fatal injury cases decreased from 41 cases in 2018 to 39 cases in 2019, resulting in a lower fatal injury rate of 1.1 per 100,000 workers. The number of workplace major injuries increased 5.5% from 596 in 2018 to 629 in 2019. Likewise, the number of workplace minor injuries increased 7.7% from 12,173 in 2018 to 13,111 in 2019. The confirmed cases of occupational disease decreased from 563 cases in 2018 to 517 cases in 2019 while the number of dangerous occurrences decreased from 23 incidents in 2018 to 21 incidents in 2019 [1].

Table 1: Number of workplace injuries, dangerous occurrences and occupational diseases,

	2018	2019
Workplace Injuries	**12,810**	**13,779**
Fatal Injuries	41	39
Major Injuries	596	629
Minor Injuries	12,173	13,111
Dangerous Occurrences	**23**	**21**
Occupational Diseases (OD)	**563**	**517**

Safety procedures usually involve chemical hygiene plan and waste disposal procedures and significant physical and health hazards associated with the specific type of research and instruction in specific procedures that researchers should use in order to prevent and limit exposure to the health hazards in that workplace [2].

OCCUPATIONAL SAFETY AND HEALTH ACT (OSHA) 1994

The Occupational Safety and Health Act (OSHA) 1994 was enacted to provide for the safety, health and welfare of workers and to protect against the risk of accidents involving workers' environmental activities. In OSHA 1994, section IV (Employer) and Part VI (employee) [3]. The objectives of the acts are:

a) To secure the safety, health and welfare of persons at work against risks to safety or health arising out of the activities of persons at work.
b) To protect persons at place of work other than persons at work against risks to safety or health arising out of the activities of persons at work.
c) To promote an occupational environment for persons at work which is adapted to their physiological and psychological needs.
d) To provide the means whereby the associated occupational safety and health may be progressively replaced by a system of regulations and approved industry codes of practice operating in combination with the provisions of this Act designed to maintain or improve the standards of safety and health.

SAFETY

Students / customers need to make sure the strategic plan is in place before carrying out the tasks and work in the lab. This is because students / customers are exposed to risks while in the lab. Among the risks involved are students / customers exposed to are chemicals, the use of high-temperature laboratory tools, hydraulic stops that can cause cluttered hands and feet if not alert and careful use of tools and machinery in the laboratory. For your information, the Biocomposite Technology Lab has been fitted with fan exhaust to inhale chemicals or odour as students / customers conduct experiments in the lab.

In the event of an emergency or injuries among the students while performing work in the laboratory, supervisor will take follow-up actions such as obtaining an injury report, assisting the student in follow-up treatment as well as contacting the most relevant contact including *Pusat Kesihatan Univeristi (PKU)* and the Office of Occupational Management and Occupational Health (OSH) UPM.

LABORATORY SAFETY KNOWLEDGE

Laboratory safety knowledge is constantly emphasized by the Officer in charge of the lab as well as the Biocomposite Technology lab showing the safety aspects inside and outside the lab to provide guidance to students / customers. This gives the student / customer awareness to be careful about carrying out assignments and work in Biocomposite Laboratory.

Knowledge of the use of laboratory tools is also provided in each of the laboratory tools as guidelines for instrumentation and safety. The knowledge to use the personal protective equipment (PPE) in accordance with the requirements of the equipment or machinery available at the Biocomposite Laboratory also been provided.

GENERAL LABORATORY SAFETY RULES AND GUIDELINES

Following are the rules and guidelines that relate to almost laboratory. Compliance to safety rules and guidelines while in the lab is very important to adhere as students / customers are at high risk when using tools or machines in the Biocomposite Laboratory.
The rules and guidelines are detailed out below [4]:

1. Be sure to read all fire alarm and safety signs and follow the instructions in the event of an accident or emergency.
2. Ensure you are fully aware of your facility's/building's evacuation procedures.
3. Make sure you know where your lab's safety equipment which includes first aid kit(s), fire extinguishers, eye wash stations, and safety showers that is located and how to properly use it.
4. Know emergency phone numbers to use to call for help in case of an emergency.
5. If there is a fire drill, be sure to turn off all electrical equipment and close all containers.
6. Do not, drink, or eat while working in the lab.
7. Never use lab equipment that you are not approved or trained by your supervisor to operate.
8. If an instrument or piece of equipment fails during use, or isn't operating properly, report the issue to a technician right away. Never try to repair an equipment problem on your own.
9. Do not work alone in the lab.
10. Never leave an ongoing experiment unattended.
11. Make sure you always follow the proper procedures for disposing lab waste.
12. Report all injuries, accidents, and broken equipment or glass right away, even if the incident seems small or unimportant.
13. If you have been injured, yell out immediately and as loud as you can to ensure you get help.
14. In the event of a chemical splashing into your eye(s) or on your skin, immediately flush the affected area(s) with running water for at least 20 minutes.
15. If you notice any unsafe conditions in the lab, let your supervisor know as soon as possible.

CONCLUSIONS

Safety and health measures are very important for all students/customers while using laboratory equipment in Biocomposite Laboratory. This is because by following these safety guidelines, the risk of accidents and injuries among the students/customers in the laboratory can be mitigated and minimized.

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COVID-19 - THE NEW NORMAL IN LABORATORIES AT INSTITUTE OF TROPICAL FORESTRY AND FOREST PRODUCTS (INTROP), UNIVERSITI PUTRA MALAYSIA

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The Novel Coronavirus found in 2019 also known as the COVID-19 has been declared as a pandemic throughout the world. The virus pretty much affects the whole world in many ways mostly due to the implementation of movement restriction order (MRO). Malaysia has no exception and has announced MRO on 17 March 2020. All sectors including industrial, academic, sports and recreational were put into a halt. Everyone was not ready and has no idea how the MRO could affect their daily lives and working routine. Daily movement routine is restricted, and you can't come to works, except for the essential services listed by the government. The tagline such as #stayathome was used to remind all citizens how serious the situations are. The safety measure such as closing the border, mobilization of full enforcement capacity which involve police, military, civil defense, local authorities etc., routine media update on current pandemic situation in the world and Malaysia and also routine advertisement info on information for self-care to protect COVID-19 infections have making the communities become aware and educate with essential information on COVID-19

At one point during this crisis, the government has declared MRO with slight moderation. Universities could welcome back their staff and postgraduate students to re-establish research works and the laboratories being put into operational again. Stringent standard operating procedure (SOP) could be used as staff and students need to prepare themselves with the new normal. There are several factors of the new normal in laboratories and two (2) of the most important is related to human and environment. The Health Ministry of Malaysia has come out with guidelines such as Avoid 3C and Practice 3W. The 3C were for all to avoid Crowded Place, Confined Space and Close Conversation and then Practice 3W which are Wash your hand frequently, Wear mask if you have symptoms and Warn for close contacts, sneezing and coughing ethics, regular disinfections, stay at home and receive treatment if you have symptoms such as shortness of breath, fever, dry cough or fatigue.Universiti Putra Malaysia (UPM) and all research laboratories were closed during MRO and now is set to be re-open again. Before we start to receive students, we at Institute of Tropical Forestry and Forest Products (INTROP) has developed a plan that includes all the factors that could initiate the spreads of the virus at the lab. During the planning phase, the lab management begin with imagining how the new normal would looks like at the end of the implementations and started to work backward by adding all the necessary factors. The factors include movement control, accessibility between lab, personal protection equipment (PPE), social distancing and cleanliness. On top of that, lab management has been actively collecting info from the Health Ministry and UPM Management so that we did not miss important details and keeping tab with all the requirement outlined. The planning also includes the establishment of staff schedule due to the requirement of only 30% staff could be presence at a time. This could see a large amount of staff will have to work from home (WFH) thus a proper guidelines and monitoring should be established. After the planning phase, the first important thing is to make sure the laboratory is safe and ready for working condition upon returning. Sanitizing the whole building or at the exact location that received most contact with human is required. This could avoid any unknown virus contact that might presence before this and most important is to make sure everybody is coming to the lab with free mind and feel safe. Secondly, we must list all consumables and personal protection equipment (PPE) that is compulsory to be used during the lab activities. This is to make sure the supply for PPE is ready the moment student and customer start to engage with lab activities and sample submission. Besides that, wearing a mask is compulsory for all and for those who are not wearing could be prohibited from

Figure 1: Wear a mask whenever you are in a crowded places inside the building

Figure 2: All movement inside the building must be registered in a logbook

entering the building. Figure 1 shows a staff is wearing a mask during his work in the laboratory. Next, we shall log all movement from all attendees inside the building during working hours. This is because the nature of the laboratories is to conduct research works and services from inside and outside customers. A lot of movement inside and outside of the laboratory will be going on and if there is a positive infection inside the building, the person under investigation (PUI) will be trace down his/her movement inside the building base on the movement log. All close contact person will be listed and reported, and the location visited by PUI must be sanitized. This could be extended towards shutting off the lab operational to prevent further outbreak inside the building. Figure 2 shows a person registering their particulars first before being allowed to enter the building. Finally, the lab consistently commits to educate on social distancing and self-cleanliness. All that is entering the building have to record their body temperature and maintain their distance at least 1 meter from each other as shown in Figure 4. Several locations that has been identified to be congested with people has been mark with necessary floor label to maintain their distance and the location for queue. Figure 5 shows a floor label to locate a safe distance between persons in the lab. All chairs or table inside the meeting room or other room that occupy mass amount of person were also marked as shown in Figure 5. Figure 6 shows the used of hand sanitizer that was placed at all entrance spot and to be used before and after entering the laboratories. Besides that, we encourage all to wash their hand using soap and water frequently too. By all these precaution steps and cooperation of all parties involve, we hope we will win our war with COVID-19 soonest possible even though the vaccine yet to be available. #togetherwefightCOVID-19 #Wemustwin!!.

Figure 3: Each person is compulsory to record their body temperature before entering INTROP

Figure 4: Floor label to maintainsocial distancing

Figure 5: Label on the table to maintain social distancing

Figure 6: The use of hand sanitizerbefore and after entering the building is compulsory

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POTENTIAL HEALTH RISKS AND PRECAUTIONS DURING BIOCOMPOSITE PRODUCT PREPARATIONS

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INTRODUCTION

In recent years, development of composite materials especially bio-based composites including biofiber, biopolymers and biocomposite products has gained intention from researchers throughout the world (Jaafar, Zainol, & Rizal, 2018; Shahroze et al., 2019). This shifted paradigm have been significantly increased in various industries due to their promising physical, mechanical, thermal and chemical performance in many applications. In specific, the elevated demand quantity on the composite materials either by using fiber of synthetic or natural materials is contribute due to their high strength and lightweight properties for specific applications that available in markets (Ashraf et al., 2019; Ilyas et al., 2020; Johari et al., 2019).

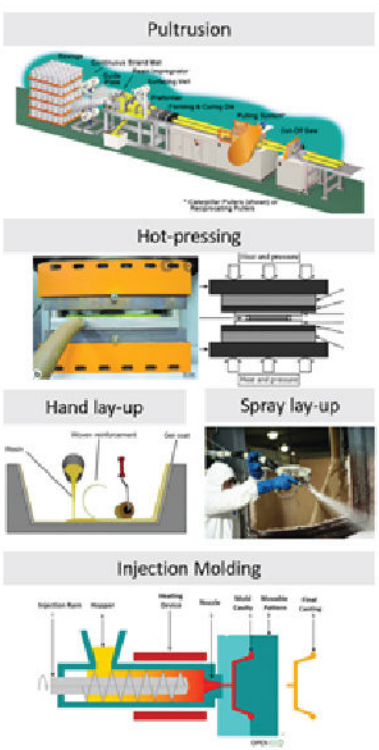

Figure 1. Various types of composite manufacturing processes. (REFERENCE, TEXT IS TOO SMALL- BETTER TO PRESENT INDIVIDUAL)

Generally, the fibers in composite are classified into two categories which are biofiber and conventional fiber. For natural fiber, it is produced from natural resources such as plant, animal, and geological processes. They are very easy to obtain, extensively available material in nature (Jaafar, Rizal, & Zainol, 2018). Meanwhile, man-made fiber or conventional fiber are synthetically produced from mining process of crude oil and coal (Itam, Ishak, Yusof, Salwi, & Zainoodin, 2018). Either natural or synthetic fiber, both of them require a specific manufacturing techniques to produce a product such as pultrusion, hotpress, hand-layup, spray-layup and injection molding processes (Bismarck, Mishra, & Lampke, 2005). Figure 1 shows the manufacturing process of composite materials.

However, these fibers are necessary to be handled appropriately in order to ensure the safety and health of the operator in good manner. Currently, there are no occupational exposure limits during managing workplace exposure to fibers in composite laminate preparation. Due this reason, composite material present new problems to estimating and governing potential health risks toward the operators (Maynard & Kuempel, 2005; Shvedova et al., 2005). The aims of this study was to inspect various processes involved in the processing of composite materials and to govern whether emission of these materials occurred.

According to the Mazzuckelli et al. (2007), preparation of composite material exposed to the operator via inhalation and cause breathing problem subsequently health diseases. This happened due to fiber size somehow is very small size which easily can enter human respiratory system. Moreover, the volatile of resins such unsaturated polyester (UPE) contains carcinogenic components which induce cancer diseases. Potential hazards were identified on a manufacturing process basis in the composite material preparation. These hazards exposed to operator including:

1. Transferring volatile synthetic resin such as polyester and vinylester outside a laboratory hood to a small beaker for weighing inside the hood.
2. Exposing during mechanical mixing of hardener and resin inside a 5-gal mixing vessel without local exhaust ventilation.
3. Sawing and cutting composite laminate use table saw Chopping fiber into smaller size without local exhaust ventilation.

EFFECT ON HUMAN HEALTH

A study led by Cullinan et al. (2013) reported that fatal and respiratory disease might occur when operators were layering up glass fibers with styrene resins at their worksite. The continuous exposure from glass fiber and styrene resin likely to cause them *Obliterative bronchiolitis* disease, which may lead to fatal. Moreover, the process of fabrication composite laminate can irritate skin and eye since the tiny fiber are used to fabricate a product. When a person experiencing too much contact with tiny fibers, it could cause inflammation of the skin, which induces dermatitis, or red rash on skin. In the context of volatile organic compounds (VOCs) resin, it might permit chemical toxic volatile in the air during layering up the polymeric resin on the fiber (Jie , Ying, Xiaofang & Zhenming, 2012). The continuous exposure to VOCs can cause irritation of the eyes, nose and throat, skin problems, nausea and dizziness. Furthermore, the VOCs aids to create smog. These issues were happened when a necessary actions are not taken during the process of manufacturing the composite laminate.

Figure 2. Health effect when exposure to hazardous substance of composite without using PPE.(REFERENCE)

PRECAUTIONS NEEDED TO BE TAKEN

As discussed in previous paragraph, the improper handling of fabrication composite can be causing a serious health issues to operators. Hence, in order to commence the manufacturing process of a composite product, these approaches are proposed to eliminate and reduce the worsening effect toward health. One of the steps can be taken is replace some of the manual equipment with new automated machines to increase the production as well as minimize the human exposure toward hazardous materials (Micheal, James & Mehdi, 2016). Apart from that, create a proper guidelines during the handling process of composite such as wearing personal protective equipment and emergency response when accidents happen (Eylem, Abdullah & Alamir, 2018). Moreover, provide a facilities such as local exhaust ventilation and ventilation system for air circulation (Rohdin et al 2009). Lastly, provide a regular maintenance schedule for equipment and tools to ensure the operator safety and minimize any occurring health issue (Bhupesh & Makarand, 2011). Figure 3 shows the steps and approaches can be taken to reduce the safety and health problems.

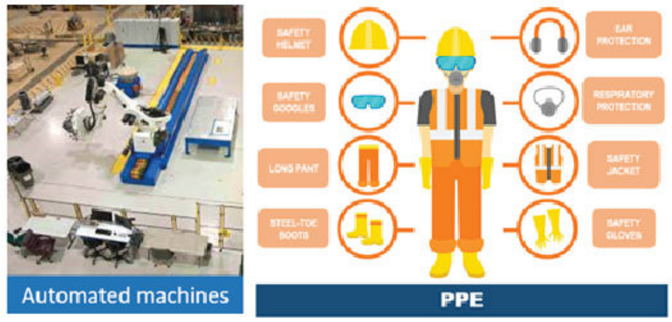

Figure 3. Precaution steps to reduce health and safety risks during fabrication of composite.(REFERENCE)
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DEEP EUTECTIC SOLVENTS: POTENTIAL ENVIRONMENTALLY FRIENDLY ADDITIVES FOR BIOCOMPOSITE MATERIALS

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INTRODUCTION

Deep eutectic solvents (DESs) are eutectic mixtures that consist of ionic species. They are combination of more than one compounds that possess lower melting temperature than their actual compounds [1]. The most popular DES is choline chloride/urea. It was prepared by mixing choline chloride (Figure 1) and urea (Figure 2) with stirring at temperature around 80°C [2]. No solvent is required, no side product forms, and no need for purification of the DES. The solvent has a melting temperature of 12°C, which exists in liquid form at room temperature (Figure 3). Figure 4 shows the chemical reaction between choline chloride and urea to produce DES. 1 mole of choline chloride and 2 moles of urea are required to obtain DES with low melting temperature.

Figure 1. Choline chloride powder (melting temperature = 302°C).

Figure 2. Urea powder (melting temperature = 133°C).

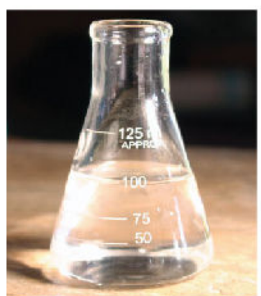

Figure 3. Choline chloride /urea DES (melting temperature = 12°C).

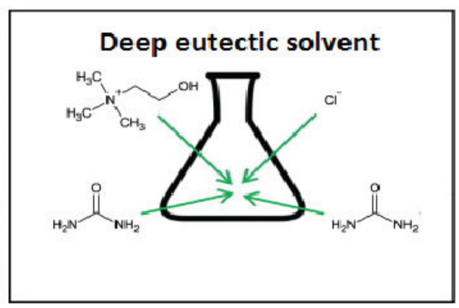

Figure 5. Components in choline chloride/urea DES.

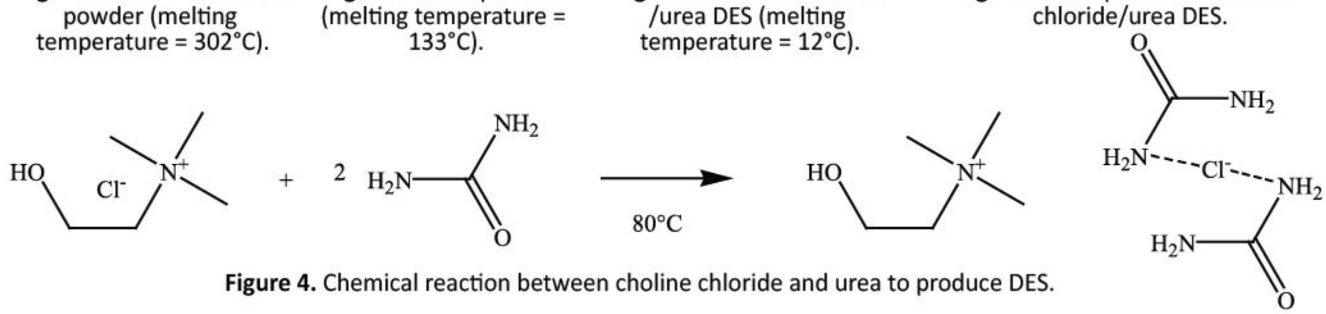

Figure 4. Chemical reaction between choline chloride and urea to produce DES.

The differences between DESs and typical ionic liquids (ILs) are: 1) DESs are mixture of compounds, whereas ILs are ionic compounds. 2) DESs precursor (choline) is biodegradable and non-toxic, while ILs precursor (imidazole) is non-environmentally friendly and toxic. 3) DESs have high ionic conductivity, whereas ILs have moderate to high ionic conductivity. 4) DESs cost is very low, while cost of ILs is very high. 5) DESs viscosity can be adjusted, whereas ILs are highly viscous. 6) DESs synthesis is very simple and no purification required, while ILs synthesis is complicated and purification required. 7) DESs are not moisture sensitive and easy to store, whereas ILs are moisture sensitive and critical to store [3].

DESs are potentially to be used as additives in polymer composites system especially in biocomposite materials. This is due to the fact that the presence of natural fibre in biocomposites could interact with the DESs via hydrogen bonding when choline chloride was used as organic salt or urea was used as complexing agent [4]. This can increase the flexibility of the biocomposites containing DESs. On the other hand, the use of DESs could also combine with surfactant to enhance the compatibility between synthetic polymer matrix and natural fibre filler in the biocomposites system [5]. Moreover, the DES especially choline chloride/urea is biodegradable and environmentally friendly mixture which could intensify the biodegradability of biocomposites. Besides, the presence of urea in the DES can assist the growth of planted plants [6], therefore the waste from biocomposite products containing choline chloride/urea can also be used as fertilizer.

CONCLUSIONS

Combination between organic salt and complexing agent could generate deep eutectic solvents. The advantages of deep eutectic solvents such as low-cost, simple preparation, and environmentally friendly are the main factors of these mixtures suggested as additives for biocomposite materials. Additionally, the use of deep eutectic solvents in the biocomposites system could also increase the flexibility and/or compatibility of the materials.

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COMPOSITE PANELS FROM ENVIRONMENTALLY FRIENDLY UNDER-UTILIZED WOOD AND AGRICULTURAL FIBER RESOURCES

By SALIM HIZIROGLU

INTRODUCTION

Production of wood composites such as particleboard, medium density fiberboard (MDF) and oriented strand board (OSB) continues to steadily increase in many countries. New wood-based composites are also progressively developed and successfully introduced as raw material for numerous structural and non-structural applications. Both particleboard and MDF are extensively used in furniture industry as substrate for thin overlays [6]. Using low quality small diameters trees which are not suitable for lumber manufacture is one of the main advantages of such panels. Within the scope of sustainable use of our forest resources underutilized wood species and agricultural fiber resources from various plants including rice straw, jute, coconut fiber, oil palm, bagasse, kenaf and bamboo are also getting popular to be used as raw material to produce different types of value-added composite panels [2,3,5,6]. As it is well known overall production process of such composite panels are quite similar to each other. In most cases, the chip or low quality logs are reduced into particles, fibers, or strand by using hammermill, disk refiner or flaker before the particles are dried to an approximate moisture content of 2-4%. Usually particles are classified as fine and coarse on different size of screens in a typical particleboard manufacture. Figure 1 illustrates various types of raw materials including particles, fibers and strands used for manufacture of experimental panels products. In the next step the material is blended with interior or exterior adhesive depending on the panel type. For example urea formaldehyde is the most widely used resin for manufacture of particleboard and MDF being interior panels while phenol formaldehyde is used for OSB having resistance under the outdoor conditions for building purposes. Wax and some other chemicals are also added into the resin to enhance overall properties of the final product. Blending is followed by the forming line where the raw material is configured into three layer loose mat having fine materials on the face and coarse material in the core layer of the panels. In the case of any type of fiberboard including MDF, thermally treated chips are converted into fibers using different techniques and equipment such as pressurized refiners. Multi opening presses are commonly used for most manufacturing processes of the composite panels. Heat and pressure are applied to the mat to cure the adhesive and give the desired strength properties to the final products. Figure 2 shows unpressed mats and finished panels. Last twenty years or so continuous press line is also getting more popular with respect its better efficiency and higher productivity. As mentioned above formaldehyde base adhesives are widely used in composite panel production. However these binders create significant health problems for both short and long-term exposure due to formaldehyde emission.

Therefore, formaldehyde emission has been the major concern associated with urea and phenol formaldehyde bonded wood composite panels [1,6]. From the perspective of green approach starch and soy based adhesives are getting attention in the industry. Starch from various plant materials such as corn, cassava, potato, and rice were studied to be used in wood composite panels as binders in past studies [2,5]. In one of these attempts modified starch combined with very small amount of formaldehyde based adhesive was used to produce experimental particleboard panels having an underutilized species, Eastern redcedar as raw material. The samples made in this work had modulus of elasticity values of 2,241.92 MPa, 2,344.32 MPa, modulus of rupture values of 11.17 MPa, 12.14 MPa and internal bond strength values of 0.57 MPa, 0.62 MPa for the panels with 0.70 g/cm3 and 0.80 g/cm3 density levels, respectively [5]. It was found that these panels satisfied properties stated in the American National Standard Institute [4]. However the dimensional stability of the samples need to be

Figure 1. Various types of raw materials used for experimental composite panel manufacture [5,6].

Figure 2. Unpressed mats and finished panel products [5,6].

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ENVIRONMENTALLY FRIENDLY MEAT TRAY PROTOTYPE BY USING 3D PRINTING

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INTRODUCTION AND BACKGROUNDS

As the fight against plastic pollution rages on, the need to find environmentally friendly manufacturing materials has become a topic of grave importance (Siakeng et al., 2018). Positive economic and environmental aspects of natural fibres reinforced polymer composites have resulted in significant worldwide consideration for use in various applications (Mohammed et al., 2015). The main advantages of natural fibres over synthetic fibres include lightweight, reasonable mechanical properties, high sustainability, and lower carbon emission (Stoof et al., 2017). However, they are usually combined with fossil fuel-based polymers and plastics which burdens the environment ultimately. On the other hand, bio-based polymers such as polylactic acid are less hazardous and naturally sourced worldwide. While many studies are available on natural fibre reinforced synthetic polymers and synthetic fibre reinforced bio-based polymer composite systems, limited studies have focused on the combined use of natural fibres reinforced bio-based polymers/plastic composite materials and little implementation has occurred (Tolinski, 2011). The utilization of biobased materials polymer in current development of natural fibre based composites by using innovative technology for Health and safety emerging attention of Researchers and Industrial people for rapid expansion in the global market (Rosu and Visakh, 2016; Faruk et al., 2012).

3D printing, also known as additive manufacturing is a technology for manufacturing a solid object from a 3D digital model, typically by laying down multiple successive layers (at sub-mm level) of a materials (Justo et al., 2018). 3D printing is a process of making three dimensional solid objects from a digital file. 3D printer follows the G-code instructions to lay down successive layers of liquid to build model from a series of cross sections. By using this method, it allows you to save a lot of material and low cost. 3D Printing manufacturing technologies have the advantage such as produce fast, flexible end products directly from digital information, fabricate designs and features unmatched as compared to traditional method (Türk et al., 2017; Wang et al., 2017). The downside of this technologies are that the products obtained do not have the same mechanical properties with those obtained by traditional manufacturing processes such as casting and compression molding, which are currently the best-suited techniques for processing natural fibre based polymer composites (Le Duigou et al., 2016). In recent times, researchers have found ways to print composite materials, such as carbon fibre and glass fibres which improve the structure and durability of 3D printed products. On the other hand, a study regarding composites with natural fibres for additive manufacturing is very limited. While the process of 3D printing composites is not mainstream yet, many developers have started to use it to print many thing from aircraft parts, car to the walls of future buildings (Ngo et al., 2018).

Nowadays plastic is used as a packaging tool mainly because of its cheap, lightweight and durable as shown in Figure 1. Malaysia is facing problem of plastic disposal because of most of packaging tray used in Hypermarket and Supermarket made of plastic which is not degradable and create environmental hazards. Therefore, lot of researchers are looking alternative materials which is biodegradable and compostable as per International Standard to fulfil Government initiatives of single use Plastic. We have found a solution by replacing plastics with resins produced by nature such as biopolymers to replace existing meat tray used in Hyper and Supermarket in Malaysia. We analyzed the available designs used for Meat Tray packaging in Hyper and Supermarket in Malaysia and after that we designed a 3 D Model for new Meat Tray which can be suitable for 3D Printing by using Biopolymers. We need to do some preliminary study based on product design before making a product from a biopolymer as per specification for food packaging tray.

Figure 1: The Existing Meat Trays in Hypermarket, Malaysia

In product design many factors need to be considered such as material strength, prototype fabrication and weight. Design analysis is very important for producing a product because it reduces the cost, time and design error.

DESIGNING OF 3D MEAT TRAY

3D Design can be done by computer aided drawing (CAD) by 3D modelling design (Figure 2) using a CAD tool like CATIA V5-6R2012 software and CAD design 3D printed models results to reduce design errors which can be corrected before printing. The design of the tray is made according to the actual size. The design is created through the formulation of the various trays available in the market. It is also designed based on the material to be used for 3D Printing Tray. Figure 3 is thesketch detail of top, side, and front views according to the actual size of meat tray by CAD tools.

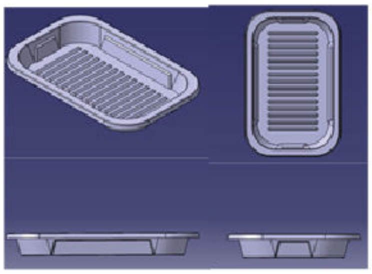

Figure 2: Design Tray in Catia Software

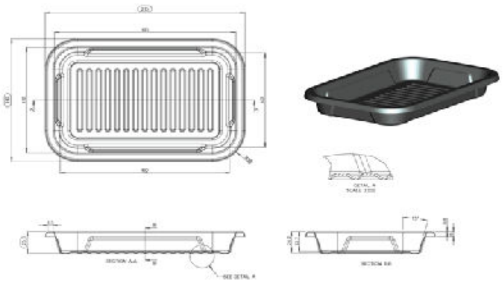

Figure 3: dimension of meat tray (215 x140 mm)

3D PRINTER

The process adopted by us is FDM technology can be used for by materials such as PLA (polylactic acid), ABS (acrylonitrile butadiene styrene), HIPS (high impact polystyrene), etc. The first filament developed from this materials heat until melting point and it is deposited layer by layer. Combination of many layers of such type gives us a final 3D model, the process could take up to minutes or hours as shown in Figure 5.

After 3D printing, these support structures must be carefully removed (Figure 6). Apart from that, the finishing of the 3D part should also be considered. With this, post-processing 3D printed part is usually required.

Figure 5: 3D Printers started printing

Figure 6: Remove support structure from 3D part

CONCLUSIONS

Polymers such as acrylonitrile-butadiene-styrene (ABS) copolymers, polyamide (PA), polycarbonate (PC) and polylactic acid (PLA) can be used for 3D printing of Meat Tray. Meat tray also possible to design by reinforcing natural fibres in biopolymers and manufacture filament of optimize diameter 3D printed composites and its mechanical and thermal properties further enhanced by adding nanomaterials. However, it faces challenges such as limited materials and regulatory issues.

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