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Centre of R&D in Tropical Biocomposite and Bioresource Management

TOWARDS BIO PRODUCTS INNOVATION

EVENT ✓
HIGHLIGHTS ✓
ACTIVITIES ✓
NEW MEMBERS ✓
POSTGRADUATE STUDIES ✓

Micro and Nanocrystalline Cellulose Fibres Reinforced Jatropha Oil-based Polyurethane Composite Films

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Programme : Doctor of Philosophy

Field of Study : Biocomspoite Technology

n this study, composite films from Jatropha oil-based polyurethane (JOPU) reinforced with microcrystalline cellulose (MCC) and nanocrystalline cellulose (NCC) fibres were made. JOPU was produced using in-house synthesized of Jathropha oil polyol and 4, 4' -diphenyl-methane diisocyanate (MDI). Dimethylformamide (DMF) was used as solvent to disperse MCC and NCC fibres prior incorporate with JOPU. Different fibre loadings ranging from 2.5 to 10 wt. % for MCC, whilst from 0.10 to 1.50 wt. % for NCC were used. Basic characterizations were carried-out for both MCC and NCC fibres. The effects of both MCC and NCC fibres in JOPU matrix were examined using FTIR spectrocopy, surface morphology, film transparency and color, thermal stabilty, dynamic mechanical properties, water contact angle and water uptake properties. The comparison between JOPU/MCC and JOPU/NCC films properties were also discussed.

Based on the XRD analysis, the crystallinity index (CI) was decreased from 85.3% for MCC to 78.0% after isolated to NCC. The average size of NCC was 180.82 nm length and 11.29 nm diameter which confirmed that the nanocellulose fibres were successfully produced. Meanwhile, MCC fibres attained length of 112.3 µm and diameter of 21.4 µm. TGA analysis shows that NCC has lower thermal stability than MCC.

Composite films of JOPU/MCC were successfully produced by incorporating 2.5 to 10 wt. % of MCC fibres in JOPU matrix. The addition of MCC seems has increased the density of films and reduced the film transparency. The colour of films seem not affected. The surface morphology of films also seem affected by showing blemish and rough surface. FTIR spectroscopy shows typical polyurethane spectra for all JOPU/MCC films. The thermal stability of JOPU/MCC films also found lower than neat JOPU film. The Tg for JOPU was 5.05 °C and decreased to the range of 3.72 to -2.31 °C for JOPU/MCC films. However, at room temperature the thermo-mechanical and tensile performance of JOPU/MCC films rise tremendously. However, elongation at break appears to be dramatically decline. Increment pattern was recorded for both water contact angle and water uptake properties as the content of MCC increased.

Composite films of JOPU/NCC were also successfully produced by incorporating 0.1 to 1.5 wt. % of NCC in JOPU matrix. Unlike JOPU/MCC films, the addition of NCC seems not affect the density of the film due to little amount of NCC. However, slight effect on film transparency was observed. Conversely, the colour scheme of films seem much affected. The presence of NCC mostly did not affect the surface morphology of films. In term of FTIR, JOPU/NCC films show similar pattern with JOPU/MCC films. The thermal stability of JOPU/NCC films possessed slightly lower than JOPU/MCC films. The Tg range of JOPU/NCC films was from 2.14 to -0.97 °C. The storage modulus, tensile strength and tensile modulus of JOPU/NCC films recorded to improve with addition of NCC and

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Bio-based products are the applications of plant-derived resources as an alternative to non-renewable products. This sustainable approach considers the entire product life cycle from its agricultural origin to its overall renewability. Bio-based innovation in the production and content of commonly used items assures consumers of improved environmental well-being without compromising product performance. Petroleum based products are made from non-renewable resources, such as crude oil and do not focus on their life cycle post-consumer use. It seems that in the long terms both oil and its products prices will be determined by the supply of crude oil and the demand for products. Bio-based economy aims at reducing the dependence from fossil fuels and finite materials without overexploiting natural resources. According to the definition of the European Commission "Bioeconomy encompasses those parts of economy that use renewable biological resources from land and sea to produce food, biomaterials, bioenergy and bioproducts". Behind bioeconomy there is much science related to industrial biotechnology and a deep change in Economics and Politics, as well as societal issues. The most pressing challenge for all bio-based industries is to improve the economics of production through upscaling and industrialisation in order to bring competitive solutions to the market. This is as much an innovation challenge as an investment challenge.

"Radical innovation" to bring R&D towards deployment and market pull is needed to deliver bio-based products superior or at least comparable to non-bio based products in terms of price, performance, availability and environmental benefits. Continue research and innovation on technologies and processes which are not yet developed or proven at demonstration/ commercial scale is another challenge. It is needed to remove the sector barriers and create new value chains from farms, forests, agro-food and pulp industry to consumers in a cradle to cradle approach. Diverse technical, strategic and commercial challenges have to be addressed in parallel in order to ensure a smooth transition and a lasting success.

INTROP as a research institution that aims to play an important role in spurring sustainable growth and boosting bio-based products competitiveness by providing advanced research and development in this field. These efforts will enable the transition to a sustainable bio-based economy for the country in the next decade.

Plant Oil-Based Polymer: Jatropha Curcas

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INTRODUCTION

Plant oils are derived from many crops and basically classified into edible or non-edible oil groups (Figure 1). Plant oils are triglycerides and contain various fatty acids, which differ in chain length, composition, distribution, and location (Sun, 2013). They comprise saturated and unsaturated oil which result variation in physical and chemical properties. Resin matrices and adhesives can be derived from these triglycerides by applying similar approaches of producing petroleum-based resin and adhesives. This can be done by introducing polymerizable groups to many active sites of triglycerides, such as double bonds, allylic carbons, and ester groups (Sun, 2013).

PLANT OIL RESOURCES

Edible oil	Non-edible oil
Oil Palm	Jatropha
Soy bean	Karanja
Corn	Hochst
Linseed	Castor
Rapeseed	Polanga
Sunflower seed	Tung
Coconut	Chinese tallow
Peanut	Rubberwood seed
Sesame	Tobbacco
Olive	Polanga
Almond	Sea mango
Cocoa butter	Soapnut
Walnut	Neem

Figure 1. General classification of plant oil and resources
(Adapted from Atabani et al., 2013)

Generally, three main techniques that been used to produce resin from plant oil. First technique is to reduce the triglycerides into monoglycerides. Polymerizable groups, such as maleate half esters, can be attached to the monoglycerides, allowing them to polymerize through free-radical polymerization. The second technique is to functionalize the unsaturated sites and reduce the triglycerides to monoglycerides, which can form monomers by reacting with maleic anhydride, allowing polymerization by free-radical polymerization. The third technique is by attaching polymerizable chemical groups, such as maleinates and acrylic acid, or by converting the unsaturated sites to epoxies or hydroxyl functionalities, making the triglycerides capable of polymerizing via ring- opening, free-radical, or polycondensation reactions (Wool and Sun, 2005). The third technique is wide and commonly used due to much cost effective, practical and simple step than the other two techniques. Such reactions produce bio-based polymers that have properties and costs comparable to those of petrochemical-based adhesives and resins.

Jatropha Curcas

In Malaysia, jatropha has been selected as one of national commodities after oil palm and rubber tree. The Malaysian Rubber Board is a government body that been appointed to look on development related to jatropha in Malaysia. Unlike oil palm, which is planted for oil and lignocellulose biomass and rubber tree for latex and timber, jatropha is planted mainly for biodiesel production. With suitable climatic conditions (i.e. temperature, rain fall), soil condition and adequate area for commercial plantation, it is possible to cultivate jatropha in most part of the country (Mofijur et al., 2012). Besides, jatropha can be cultivated on underutilize land of which is usually left abandoned due to not suitable for food crop cultivation. BATC Development Berhad has been actively engaged in jatropha plantation and bio-fuel industry since 2007 in Malaysia. About 600,000 acres planted areas, 3.3 million areas land-banks and more than 300 nurseries and collection centres were reported in Malaysia (Bionas, 2011). In worldwide, according to International Jatropha Organization, around 330,000 km2 of land cultivated with jatropha producing 160 metric tonnes of seed and 95% of its total production will be cultivated in Asia by year 2017 (Taib, 2017).

Jatropha curcas or locally known as "Jarak Pagar" is a shrub tree with height of 5 to 7 m tall under family of Euphorbiaceous, which is widely grown in South America, South-West Asia, India and Africa (Mofijur et al., 2012). The fruits of jatropha can be harvested after 3 to 5 years of planting and the life expectancy is 50 years.

The fruit is a kernel which contains three seeds each and can produce about 2 to 4 kg/seed/tree/year for plant that planted in good conditon soil, whilst about 1 kg/seed/tree/year in poor soil (Saalah et al, 2015). Figure 2.8 shows jatropha trees, fruits, seeds and oil. It has been reported that Jatropha curcas produces about 2000 litres of oil in one hectare annually (Akbar et al., 2009). Jatropha oil, contains about 79% of unsaturated fatty acid mainly oleic acid (43.1%) and linoleic acid (34.1%) (Sarin et al., 2007).

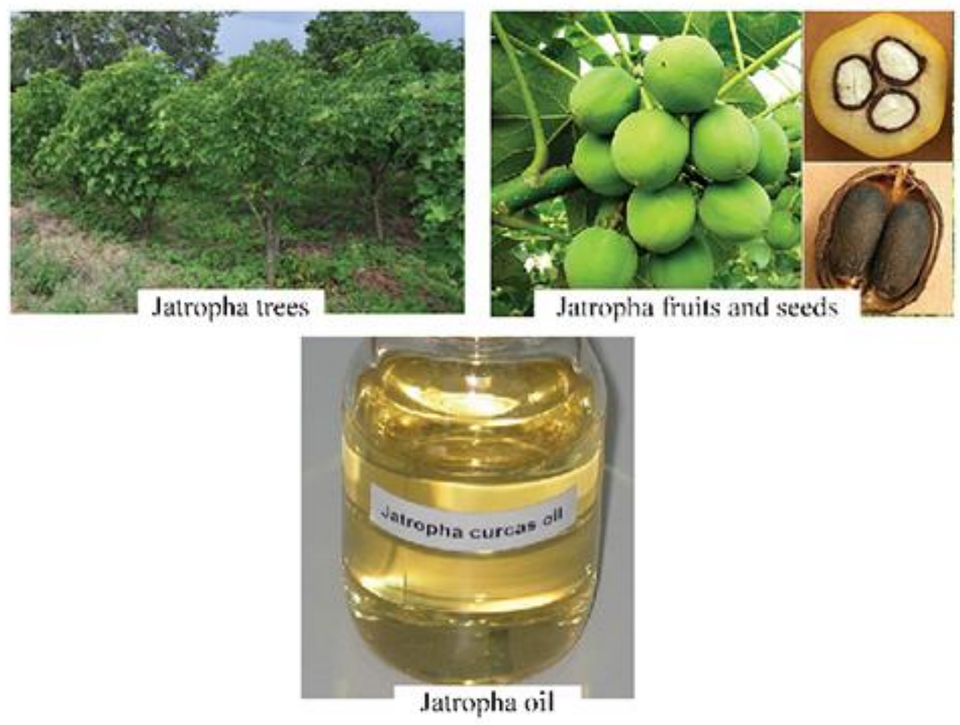

Figure 2. Jatropha trees, fruits, seeds and oil

Jatropha oil was classified as non-edible due to phorbol ester contain, which is toxic for human consumption (Kumar and Sharma, 2008). The oil content of jatropha seed was reported at 63.13 %, which is higher than palm kernel, linseed and soybean with oil content value of 44.6 %, 33.3 % and 18.4 %, respectively (Akbar et al., 2009). The yield, however, highly depends on the extraction method as well as the feedstock quality. Jatropha oil can be used to fabricate adhesive and coatings with promising properties in the polymer industries (Aung et al., 2014). Table 1 shows the compositions of fatty acids contains in jatropha oil compared with selected major plant-based oil.

Fatty acids	Jatropha oil	Palm oil	Sunflower oil	Soy bean oil
Oleic 18:1	44.7	39.2	21.1	23.4
Linoleic 18:2	32.8	10.1	66.2	53.2
Palmitic 16:0	14.2	44.0	-	11
Stearic 18:0	7.0	4.5	4.5	4.0
Palmitoleic 16:1	0.7	-	-	-
Linolenic 18:3	0.2	0.4	-	7.8
Arachidic 20:0	0.2	-	0.3	-
Margaric 17:0	0.1	-	-	-
Myristic 17:0	0.1	1.1	-	0.1
Caproic 6:0	-	-	-	-
Caprylic 8:0	-	-	-	-
Lauric 12:0	-	0.2	-	-
Capric 10:0	-	-	-	-
Saturated	21.6	49.9	11.3	15.1
Mono unsaturated	45.4	39.2	21.1	23.4
Poly unsaturated	33.0	10.5	66.2	61.0

Source: Saalah, 2015

The structure of triglycerides in plant oil itself varies from molecule to molecule. For instance, Salimon and Ahmed (2012) reported that jatropha oil contains more than 11 different structures of triglyceride, mainly OLL (22.54 %), PLL (25.41 %), OOL (23.06 %), OOO (8.02 %), POL+SLL (8.19 %), LLL (5.02 %), POP (2.14 %), and PPP (2.90 %), (L stands for linoleic, O for oleic, and P and S for palmitic and stearic acids). Figure 3 shows a general jatropha oil structure consisting of a glycerol backbone attached to oleic, linolenic and stearic acids.

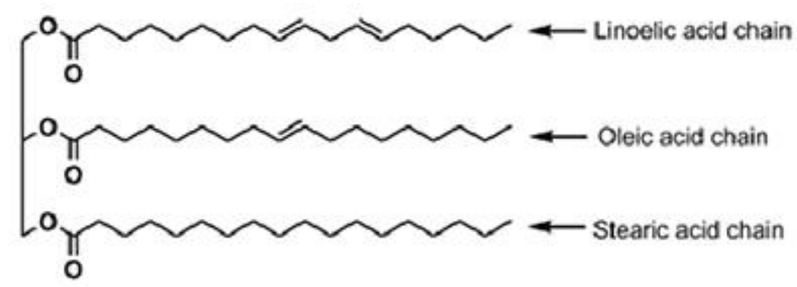

Figure 3. General structure of tryglyceride of jatropha oil
(Source: Saravari and Praditvatanakit, 2013)

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As conclusion, previous studies show that a diverse set of applications exists for syntactic foams ranging from deep sea vehicles to space vehicles. It is found that the modulus of syntactic foams can be higher than that of the matrix resin, which enables their load bearing structural applications. Applications of syntactic foam are grow rapidly as the research studies continues to explore.

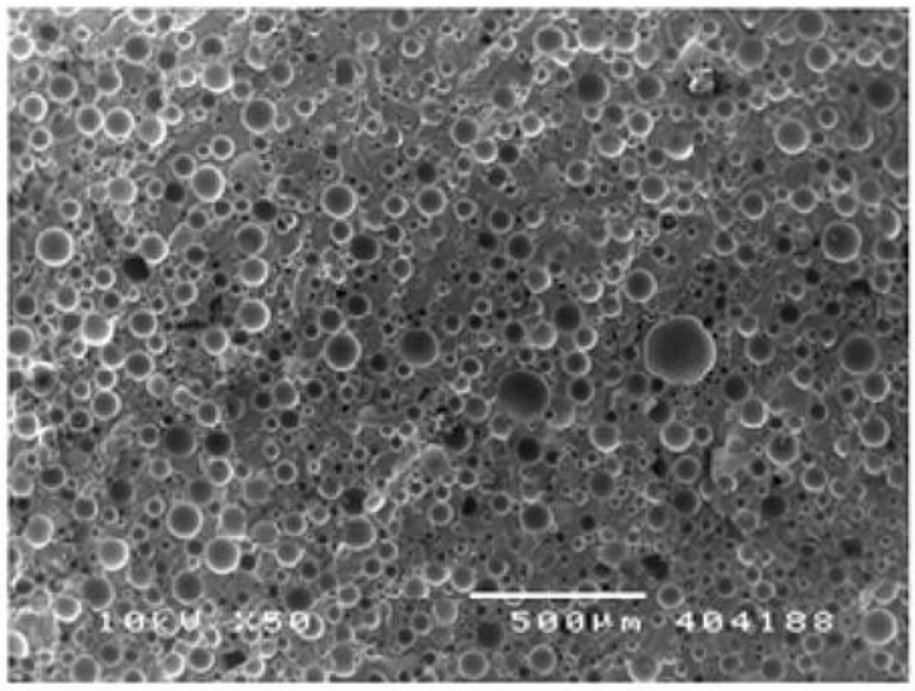

Figure 1: Microspheres syntactic foams

Figure 2: Diversity of wall thickness in a constant microsphere's size (increasing wall thickness from left to right [9].Figure 1: Microspheres syntactic foams

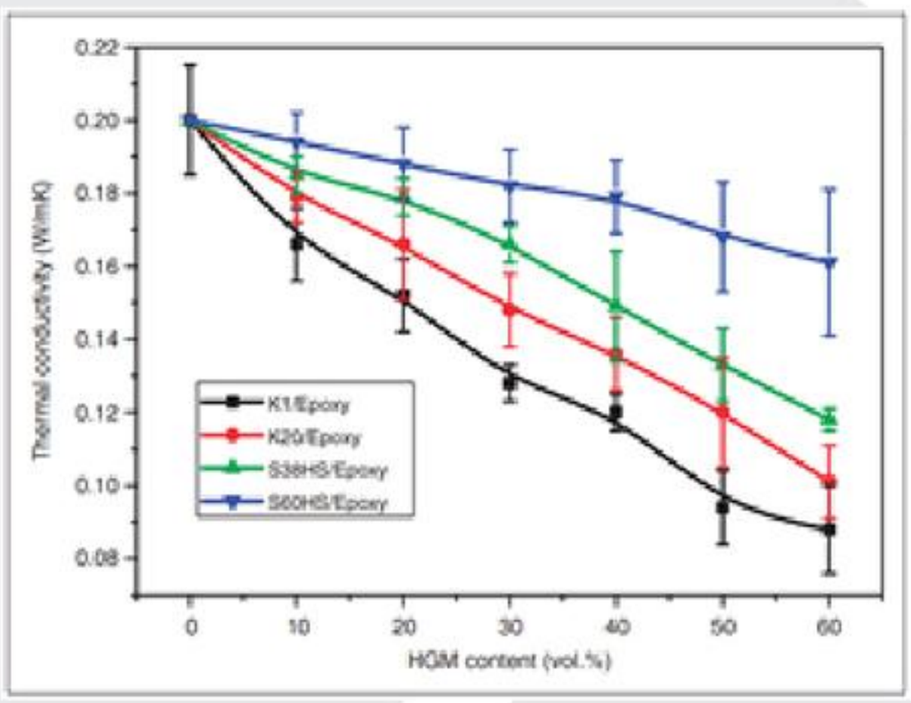

Figure 3: Thermal conductivity of the composite as a function of HGM content at average temperature of 40oC [10].

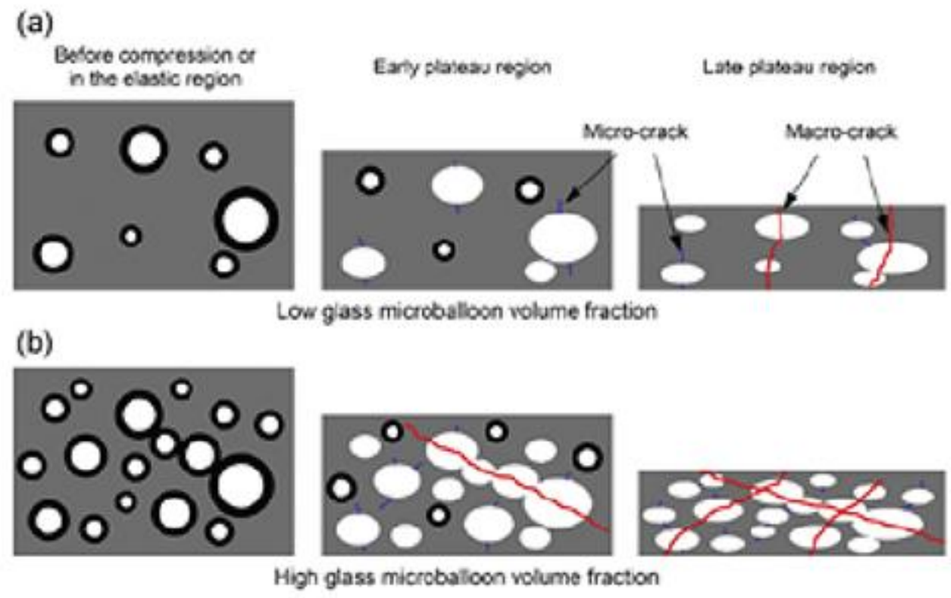

Figure 4: Schematic of the microstructural change in syntactic foams at the elastic and plateau regions during uniaxial compression: (a) low and (b) high glass microspheres volume fractions [14].

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Ultra Low Weight Composites - Microsphere Syntactic Foam

Dr. Lee Ching Hao

INTRODUCTION

Composite material is not a novelty term for many people nowadays. Tailorable properties to fit specific purpose or working environment is one of the most attractive feature of composite material. Wherefore, polymer matrix composites can be designed as low density but high-performance materials. Reduction of structural weight has been demanded in transportation industries. Vehicles or public transports with lower weight could increase fuel efficiency as well as load capacity; likewise, low weight aerospace materials resulted in higher flight distance, higher passenger capacity, and lower carbon footprint. Syntactic foam was established with many promising properties like high thermal stability, high compressive strength-to-weight ratio, low dielectric constant and high impact properties. It is one type of composite materials and fabricated by hollow particle fillers insertion in matrix [1-4]. Initial applications of syntactic foam were designed for marine structures due to its outstanding buoyancy properties and later applied on aircraft, sport equipment, furniture [5].

Some frequent used polymer matrix includes epoxy, phenol and vinyl ester. Epoxy syntactic foams are the most widely studied syntactic foam. On the other, hollow particles played important role for the properties of syntactic foams and sometimes referred microballoon [6] or microspheres [7]. Hollow glass microsphere (HGM) is the most famous fillers in syntactic foams because of its lower density with high compression strength [8]. Other famous microsphere has been used in syntactic foams are made by carbon, fly ash cenospheres, ceramics and polymers. The figure of microspheres syntactic foams is shown in figure 1. The hollow particles can be characterized based on their wall thickness (w) and it can have related to a parameter named radius ratio, η, with equation as below

$$\eta = \frac{r_i}{r_o} \qquad (1)$$

Where ri and ro are the internal and outer radii of hollow particles, respectively. Diversity of wall thickness in a constant microsphere's size are shown in figure 2. The parameter η is then related to the microspheres which using the equation as below,

$$\eta = \left(1 - \frac{\rho_{ms}}{\rho_g}\right)^{\frac{1}{3}} \qquad (2)$$

Where ρ_g and ρ_{ms} is the density of microsphere's material and density of microsphere, respectively. It is reported that smaller wall thickness for microsphere diameter has lower density value as well as poorer strength properties. Inclusion of thin wall thickness microsphere reduced the strength and modulus of composite because part of the stronger phase is replaced by a weaker phase [9]. Besides, Zhu (2012) has studied four types of HGM, having different density, inserted in epoxy syntactic foams. The results shown a deteriorated thermal conductivity trend for higher HGM content or lower HGM density in (Figure 3), which showing that the performance of the syntactic foam is mainly contributed by properties of HGM [10]. This findings was agreed in many previous studies [11, 12]. On the other hand, Panteghini (2015) reported the dependence of the effective compressive strength on microsphere volume contents can be predicted very well by using modelling of the relation between the matrix defectiveness and the filler mechanical response [13].

Crushing of HGM is an important failure mechanism for compression performance. Therefore, study on compression failure mechanism of syntactic foam was done by Huang (2015) [14]. In the syntactic foam with low volume fraction of microspheres, the distance between microspheres is far and most of the micro-cracks are near to the top and bottom of the microsphere when being pressed. After that, the micro-cracks propagate almost in the longitudinal direction (Figure 4a) where stress loading is applied. By joining the neighbouring voids (crushed microspheres), the micro-cracks become a macroscopic longitudinal crack in the foam, which can be seen on the specimen surface. On the other hand, higher microsphere fillers content in the syntactic foam (Figure 4b) creates more voids in the matrix because more microspheres are crushed in compression. The stresses in the matrix concentrate not only near the top and bottom of the microspheres but also in the connection between the microspheres. Therefore, there are more micro-cracks forming in the matrix in all possible directions. As the foam is deformed, the macro-crack propagates crack in the preferred diagonal direction on the surface.

Bio products innovations: on the way

Dr. Mohammad Asim Khan

INTRODUCTION

In recent years, an increased debate and interest in green product innovation was clearly observed. Green product innovation is increasingly being portrayed as an opportunity; while some also considers it as a win-win logic of being 'green and competitive'. Examples of success stories are the Body Shop's range of cosmetic products and Toyota's hybrid car. Nevertheless, the debate on what is sustainable or what compose a green product is still on-going (Lin, Tan et al. 2013). However, Hall and Vredenburg (Hall and Vredenburg 2003) argue that sustainable product innovation in these companies are either public policy induced or is market-driven.

MARKETING OF BIOPRODUCTS

According to many researchers (Carrillo-Hermosilla, Del Río et al. 2010, Horbach, Rammer et al. 2012), environmentally sustainable product innovation depends on consumers willing and able to acquire such innovations, environmental-friendly legislation, government incentives, and educational campaigns that disseminate sustainable culture among society. When market realizes that organizational practices minimize negative environmental impact, companies tend to obtain benefits related to cost and differentiation. In a similar research says, environmental certification positively influences adoption of green innovation. Environmentally sustainable practices add value to a brand as they generate positive awareness towards the brand, as well as increased perceive quality and trust that may positively impact customer satisfaction (De Medeiros, Ribeiro et al. 2014).

NATURAL FIBRE BASED BIO PRODUCTS

Natural fiber-based polymer composites offer various noteworthy advantages over conventional synthetic ones in terms of biodegradability, eco-friendliness, cost, availability, low density, and so forth (Majeed, Jawaid et al. 2013). Natural fiber reinforced polymer composites are gaining more and more recognition and further acceptance in food packaging, in automobile, railway coach and aero-plane interiors, as well as in storage devices, in building and structural applications. A number of bio-based natural polymers are being explored and studied for diverse applications (Siakeng, Jawaid et al.) shown in figure 1.

Figure 1- Natural fibre based some products

Extensive research and development activities have resulted in considerable interest in exploring new materials based on biodegradable polymers. As is well known, the application of polymer composites can be greatly affected by the composition of the blending deferent types of polymers with natural fibres and can vary based on the end use requirements.

APPLICATIONS OF BIOPRODUCTS

As the demand for eco-friendly and renewable materials continues to rise. Biopolymer based composites are receiving increasing attention and biopolymer blends based materials have found major green applications (Nampoothiri, Nair et al. 2010, Armentano, Bitinis et al. 2013). Even though these biopolymers products are emerging as alternatives to existing non-renewable fossil fuel-based plastics, the current low-level production and high price limit their extensive applications. However, the demand for bioproducts have been amplified during the past decade due to their improved applications and environmental concerns (Faruk, Bledzki et al. 2014). Bioproducts have been widely used in various areas such as packaging, medical, upholstery, textile and automotive interiors, due to its light weight, good biocompatibility, biodegradability and some mechanical properties (Saba, Jawaid et al. 2017). The simplest and most eco-friendly way to improve the mechanical and thermal properties of biopolymers is the addition of natural fibers or filler materials. Both synthetic and natural fibers, as well as nanoparticles are used as reinforcement in

biopolymer-based composites to improve their overall properties (Sawpan, Pickering et al. 2011, Nassiopoulos and Njuguna 2015). The application of bioproducts has been extended to other commodity areas, especially in the composite industry, ever since its production cost has been lowered by new technologies (Rose and Palkovits 2011). Natural fiber/PLA composites are being widely used in a wide range of applications such as packaging, medicines, textiles, automobiles, industrial, infrastructure, building, furniture, and other commercial markets as listed before. Various automobile parts, for example, dashboards, door panels, package trays, headliners and some interior parts, are being developed using these natural fiber-based biopolymers (Jia, Gong et al. 2014). Industrial markets for bioproducts are likely to increase considerably in the future. Some of the uses of PLA are showcased in Figure 2.

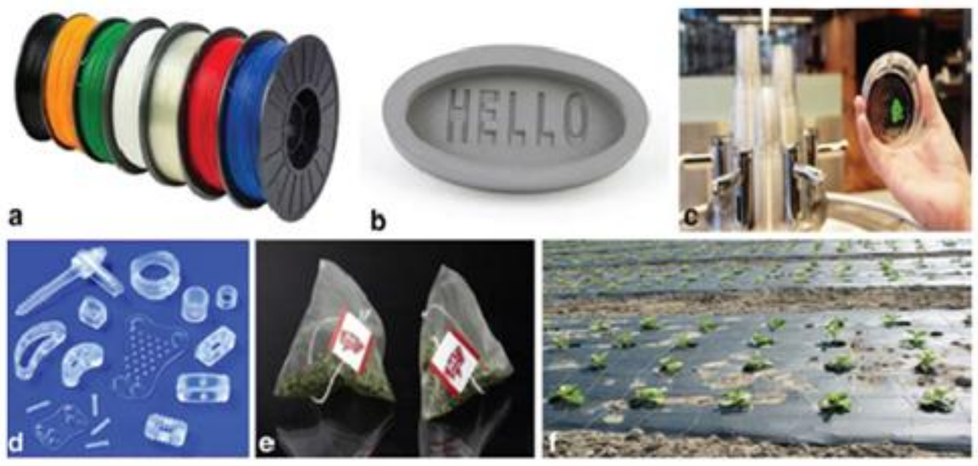

Figure 2- Different types of bioproducts (Siakeng, Jawaid et al.)

PROSPECTS OF BIOPRODUCTS

Increasing demands for renewable and recyclable materials, the alarming energy crisis, environmental regulations, and public concerns about plastic dumps and pollution have spurred efforts to develop biodegradable materials. natural fibers and biopolymers offer a potential alternative to the conventional fibers and synthetic polymers, which are difficult to recycle and not sustainable.

Future development trends in bioproducts are as follows: first, low-cost production, which can win general acceptance. Considering market demands, mass production of biocomposites and increasing development of cheaper biopolymers, the cost will probably decrease. Second, current and future research should examine the fabrication and improvement of biopolymers-based composites with different types, ratios, and forms of natural fibers for multifunctional applications. Finally, a proper database should be prepared on fibers and biocomposites due to the complex and diverse nature of natural fibers.

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also noticed that the decreasing trend of the impact strength was obtained as the talc loading increased from 3 to 15 wt.%. Hence, this evidenced that with the incorporation of talc to the LDPE/KCF biocomposites, it does not improve the toughness of the biocomposites, but it does enhance the brittleness of the biocomposites.

On the other hand, the different observation has been acquired when the biocomposites were incorporated with calcium carbonate. From Figure 2, it is obviously seen that the impact strengths for the biocomposites with the incorporation of calcium carbonate are greater than the biocomposite without calcium carbonate. The impact strengths have also increased as the calcium carbonate loading increased from 3 to 15 wt.%. Therefore, this proved that with the incorporation of calcium carbonate to the LDPE/KCF biocomposites, it provided more toughness and less brittleness to the biocomposites.

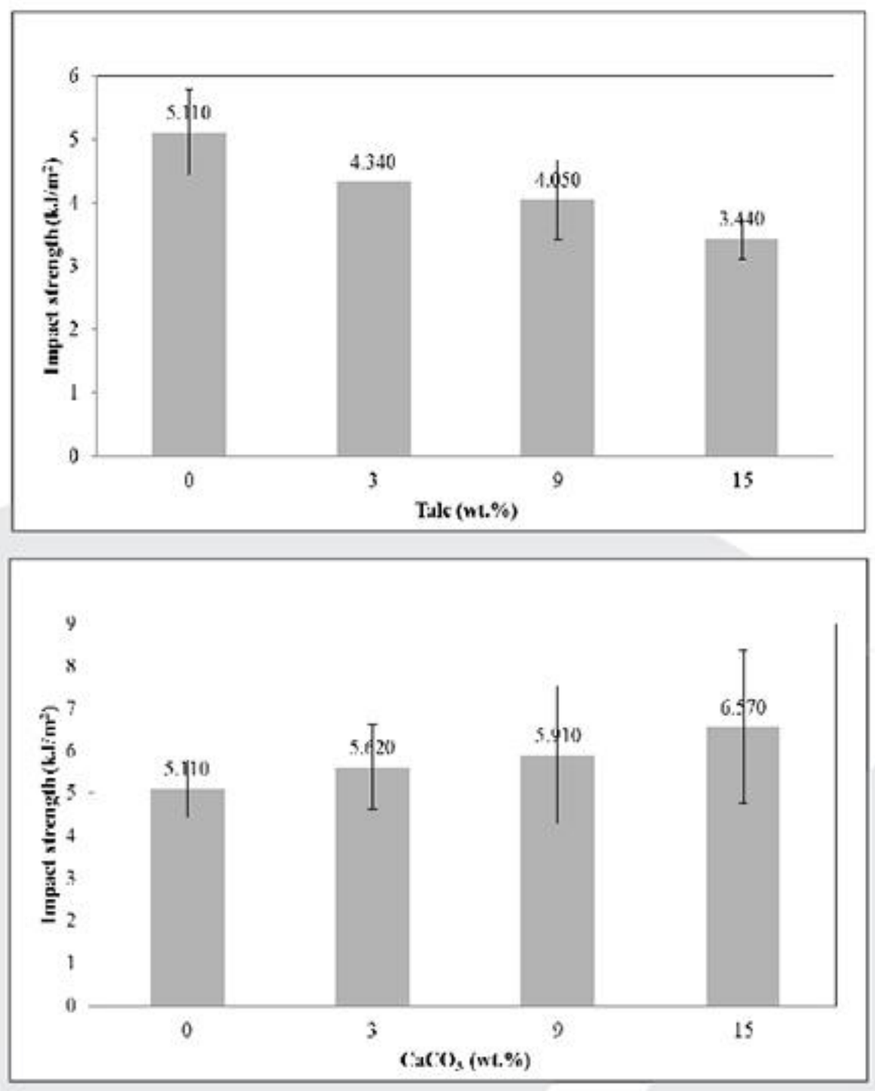

Figure 2. Impact strength of the LDPE/KCF biocomposites with different percentages of talc (above) and calcium carbonate (below)

CONCLUSION

From the attained results, it showed that the stiffness of the biocomposites can be improved with the incorporation of hydrophobic mineral such as talc as secondary filler. Instead, calcium carbonate can be considered as the good hydrophilic mineral filler for improving the toughness of the LDPE/KCF biocomposites compared to talc. The improvement in the stiffness and toughness are probably due to the ability of the minerals to withstand and absorb exerted load and energy, respectively.

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Exploitation of Mineralized Fillers for Increasing Mechanical Properties of Polymer Biocomposites by

Ahmad Adlie Shamsuri

INTRODUCTION

Talc is a hydrous magnesium silicate with the chemical formula of $Mg_3Si_4O_{10}(OH)_2$ which is one of the hydrophobic minerals (Yekeler et al. 2004). The hydrophobic nature of the basal surfaces is due to the atoms exposed on the surface are linked together by siloxane (Si-O-Si) bonds, thus they could not form strong hydrogen bonding with water (Şener and Özyılmaz 2010). Calcium carbonate with the chemical formula of $CaCO_3$ is a hydrophilic mineral (Wang et al. 2010), low-cost and non-toxic substance that has been widely used as functional filler in polymer composites for improving their physicochemical properties. The effects of talc and calcium carbonate minerals on the stiffness and toughness properties of the LDPE/KCF biocomposites were studied.

MATERIALS AND METHOD

LDPE (coating grade) was purchased from the Lotte Chemical Titan (M) Sdn. Bhd., Malaysia. KCF (420 µm) was attained from the National Kenaf and Tobacco Board, Malaysia. Talc (10 µm) was procured from the Sigma-Aldrich (M) Sdn. Bhd., Malaysia. Calcium carbonate (10 µm) was acquired from Merck (M) Sdn. Bhd., Malaysia. All materials were used as received without further modification. Brabender internal mixer machine was used to prepare the biocomposites. The mixing was done at a temperature of 150°C, and the rotor speed was fixed at 60 rpm. First of all, 24g of LDPE was inserted into the mixing chamber, and allowed to melt for 3 minutes. After that, 16g of KCF was added into the chamber, and permitted to mix for 6 minutes. Finally, talc or calcium carbonate was incorporated into the composite, and allowed to blend for 6 minutes. The contents of the talc and calcium carbonate were varied as 0, 3, 9 and 15 wt.%.

RESULTS AND DISCUSSION

Figure 1 demonstrated the tensile strength results of the LDPE/KCF biocomposites with different loadings of talc and calcium carbonate, respectively. From the graph in Figure 1, it showed that with the incorporation of talc from 3 to 15 wt.%, the tensile strength of the biocomposites has increased. Nonetheless, the tensile strength of the biocomposite without talc is lower than the biocomposites containing talc. This implied that the LDPE/KCF biocomposites with the incorporation of talc have high stiffness feature where they can withstand high loads before failure.

A different phenomenon occurred to the LDPE/KCF biocomposites containing calcium carbonate. It is clearly seen that the tensile strength of the biocomposite without calcium carbonate is higher than the biocomposites containing calcium carbonate. The incorporation of calcium carbonate to the biocomposites system has not offered improvement in their tensile strength. Thus, the results evidenced that the LDPE/KCF biocomposites with the incorporation of calcium carbonate are less stiff compared to the biocomposites containing talc and without calcium carbonate.

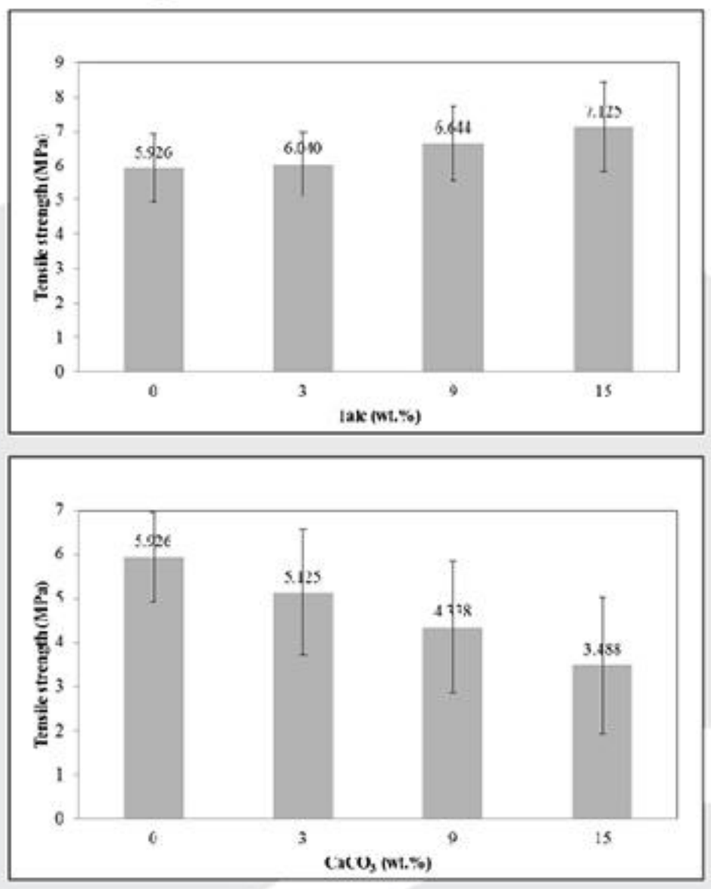

Figure 1. Tensile strength of the LDPE/KCF biocomposites with different loadings of talc (above) and calcium carbonate (below)

Figure 2 exhibited the results of the impact strength of the LDPE/KCF biocomposites with different percentages of talc and calcium carbonate. From these data, it is clearly perceived that the impact strength results are inversely proportional to the tensile strength results. It

Professor on Duty – Organised by E2TD in Collaboration with Universiti Putra Malaysia (UPM) and Universiti Kebangsaan Malaysia (UKM)



Ir. Assoc. Prof. Ts. Dr. Mohamed Thariq bin Haji Hameed Sultan, Ir. Prof. Dr. Mandeep Singh Jit Singh, Dr. Ain Umaira Md Shah

On last October, a programme called 'BIJAK MATEMATIK' organized by SEKOLAH MENENGAH KEBANGSAAN (SMK) TAMAN MALURI, KUALA LUMPUR in collaboration with Engineering Education Technical Division (E2TD), The Institution of Engineers Malaysia (IEM) had been successfully conducted. A group of 32 universities students from Universiti Putra Malaysia (UPM) and Universiti Kebangsaan Malaysia (UKM) was selected as facilitators to assist the form 5 students in Mathematics for their coming Sijil Pelajaran Malaysia (SPM) Examination.

Facilitators were divided into several small groups of four students in each classroom. The role of a facilitator is to assist the students in answering the questions practically. Students were given a set of questions from paper 1 and paper 2, which they need to answer all the questions. Facilitators explained and discussed the methods used to solve each question. More attention were given to the weak students by giving explanations whereby the students will managed to understand and be able to answer the questions. This approach gave an opportunity to the weak students to have direct one to one assistance and explanations for respective topics and questions. Some advices on the time management to answer all questions within the allocated time was also given to the students.

From this programme, students can learn new techniques in answering questions effectively. By dividing the students into smaller groups with a facilitator at the age of only 4 to 5 years gap, makes the students more comfortable and easy to ask questions. Answering more types of questions also gives the students more exposure to identify various concepts of questions in examinations, thus gives them more confident during the real examination.

This programme indirectly gives the chances to the students to get more information about the IPTA/IPTS in Malaysia as a preparation for them to further studies at the next level. Students can ask directly from the facilitators on the route and lifestyle to succeed in university. Not only focusing in Mathematics, the facilitators also shared their experiences as a former SPM candidates and gives some advices and motivations to the students.

As to support the campaign from Ministry of Higher Education, which IPT students are encouraged to conduct activities with the community, this programme was seen as a good approach that will benefits both parties, the IPT students and secondary school students. The IPT students as facilitators can enhance their communication skills, which they need to deal with younger students and school teachers in an effective way as everyone can understand the content and benefits from the programme. The IPT students also can improve their thinking skills in problem solving and answering questions from the students.

The skills of leadership was also improved among the facilitators. As a leader in a group, they have to ensure that all members understand and involve actively in the discussion. In monitoring the progress of each student in the group, facilitators have to use their soft skills to ensure everyone was given the attention and no one was left behind.

As conclusion, IPT students had gain new valuable experiences and become more confident to communicate in public with different ranges of audience. This is a good initiative from the government to develop and improve the skills and potentials of IPT students in self-development. It can be seen the benefits gain by the society not only in the area of education but also in technology transfer and technical skills.

Students from UPM (undergraduate students from Department of Aerospace Engineering) actively assist the students during the 'Bijak Matematik' programme.

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**Please be informed that this article has also been publish in IEM Bulletin*

8 LAB SAFETY TIPS

1. Plan ahead – know the steps in experiment – learn properly how to use the equipment – Never use lab equipment that you are not approved or trained by your supervisor to operate.

2. Think safety first - Laboratory safety should be first priority. Lab managers must develop effective training programs, best-practices, and safety audits to minimize risk

3. Know Emergency response - Make sure you are aware of where your lab's exits and fire alarms are located

4. Follow all the safety procedure - Make sure you always follow the proper procedures for disposing lab waste.

5. Report dangerous activities and situation - all injuries, accidents, and broken equipment or glass right away, even if the incident seems small or unimportant.

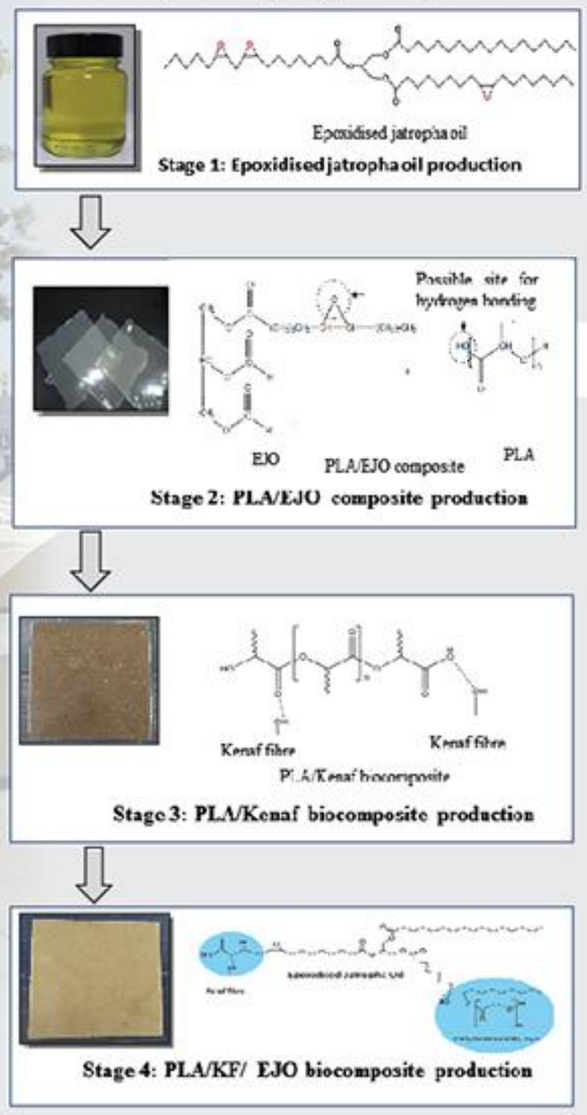
6. Properly identify hazardous materials - Before you start an experiment, make sure you are fully aware of the hazards of the materials you'll be using. -chemicals should always be clearly labeled with the name of the substance, its concentration, the date it was received, and the name of the person responsible for it.

7. Ensure you are fully aware of your facility's/ building's evacuation procedures.

8. Keep work area clean

Summary Thesis for Intropica

Poly (lactic acid) (PLA) has been highlighted to be a useful material in substituting the petroleum based polymer due to its promising mechanical properties and biodegradability. However, its brittleness properties and higher price as compared with the common commodity plastics have limited its application. Thus, the addition of epoxidised jatropha oil (EJO), a type of biodegradable plasticiser from natural products was employed to the PLA in response to concern about the environment as well as modifying the brittleness of PLA. Kenaf, one source of environmentally friendly and abundantly cheap natural fibers has been used in this study as reinforcement in PLA. Despite the advantages of using kenaf as a natural fibre, their limitations include, poor moisture resistance, poor wettability by the hydrophobic matrix and insufficient adhesion between fibre and polymeric matrix which can lead to poor properties. Therefore, one way to improve the fibre/ matrix interfacial bonding is through the incorporation of fibre surface modification or treatment. The aim of this study is to investigate the effect of EJO as plasticiser on mechanical, physical, thermal and morphology properties of PLA. Furthermore, the effect of NaOH treatment on the properties of PLA/Kenaf composites as well as PLA/Kenaf/EJO composites were studied. Five different weight percentages of EJO ranging from 1 wt.% to 5 9 were melt blended in the Brabender internal mixer prior to compression moulding of blend in a hot press and compared to a neat PLA matrix sample. The mechanical properties of PLA/EJO composites were characterised in terms of tensile strength, tensile modulus, flexural strength, flexural modulus and impact strength. Results showed that the tensile strength, tensile modulus, flexural strength and flexural modulus decreased with increasing content of EJO in the blend. On the other hand, with the further addition of EJO to the PLA composites, the elongation at break properties increased significantly by 8.1% to 78.4%. The FTIR study indicated that miscibility and interaction of PLA and EJO exist as a small shift towards a higher temperature appeared in the absorption peak of PLA/EJO blend. Moreover, the study findings showed that the water absorption of plasticized PLA decreased significantly by 1.3% to 1.0% with increasing EJO concentration up to 5 wt.%. While for thermal properties, the Differential Scanning Calorimetry (DSC) measurement revealed that the addition of EJO resulted in a decrease of glass transition temperature up to 62.2°C which aids PLA chain mobility in the blend as predicted. In addition, the Thermogravimetric Analysis (TGA) showed that the presence of EJO in the blends reduce the rate of decomposition of PLA by increment of onset temperature up to 388.2°C and enhanced the thermal stability of the blend. The improvement in mechanical, physical and thermal properties of PLA/EJO composites indicating better polymer-plasticiser interaction which is proved by Scanning Electron Micrograph (SEM) analysis. Afterward, five different weight percentages of kenaf fibre loading ranging from 10 wt.% to 50 wt.% were employed in the PLA blends in order to study the optimum fibre loading value in the blend. As a result, 40 wt.% of kenaf fibre loading found to be the optimum value for PLA/kenaf biocomposites. The surface modification treatment with 6% NaOH on kenaf fibre enhanced the properties of biocomposites as compared to the untreated kenaf fibre. The incorporation of EJO as a plasticiser to modify the brittleness of PLA demonstrated that the plasticised PLA/Kenaf bicomposites with good mechanical and thermal properties could be developed. It can be concluded that the addition of plasticiser and the treatment of fibre improved the properties of PLA/Kenaf/EJO biocomposites. Out of the analyses subjected, PLA (57 wt/%) / Kenaf (40 wt.%) /EJO (3 wt.%) reported as the best formulation of biocomposite from this study. Hence, the study findings will pave the way towards a greater usage of vegetable oil as well as natural fibre for the commercialisation and mankind benefits which can replace petroleum-derived products in the long run. Specific applications for the studied materials involved interior parts of the car, environmental packaging, tray and box.



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