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UNIVERSITI PUTRA MALAYSIA
BERILMU BERBAKTI

5th WOOD & BIOFIBRE INTERNATIONAL CONFERENCE (WOBIC2021)

WOOD & BIOFIBRE - TRANSFORMATION TOWARDS CIRCULAR ECONOMY

ABSTRACT BOOK

23 - 24 NOVEMBER 2021
BANGI RESORT HOTEL,
SELANGOR, MALAYSIA

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MESSAGE FROM THE VICE CHANCELLOR, UNIVERSITI PUTRA MALAYSIA

Assalamualaikum Warahmatullahi Wabarakatuh and Salam Sejahtera,

It is my pleasure to welcome everyone to the 5th Wood and Biofibre International Conference 2021 (WOBIC 2021) organised by the Institute of Tropical Forestry and Forest Products (INTROP), a continuation of WOBIC 2019, which had successfully brought together researchers from within and outside the country.

Congratulations to the Institute of Tropical Forestry and Forest Products (INTROP) for successfully organising this international conference. INTROP is a Centre of Excellence for Higher Education in the fibre and tropical wood niche area. It has been found that the conference is essential to continue sustaining niche research of INTROP and UPM. The University envisages that INTROP UPM would become a prestigious research centre for Tropical Wood and Fibre, which would significantly contribute towards wealth creation, nation-building and universal human advancement through the exploration and dissemination of knowledge and research findings.

My heartiest appreciation goes to the co-organisers and collaborators in the organisation of WOBIC 2021 significantly contributes to the success of this conference. Thanks to the Malaysian Timber Industry Board (MTIB), Malaysian Palm Oil Board (MPOB), National Kenaf and Tobacco Board (LKTN), Forest Research Institute Malaysia (FRIM), and The French Agricultural Research Centre for International Development (CIRAD) for their commitment, ideas, and provision to this conference.

I would like to thank the Universiti Malaysia Pahang (UMP), Universiti Sains Malaysia (USM), Universiti Malaysia Terengganu (UMT), Universiti Teknikal Malaysia Melaka (UTeM), Universiti Teknologi Malaysia (UTM), Universiti Teknologi MARA (UiTM), UCSI University, and Universiti Malaysia Perlis (UniMAP) for their collaboration.

I would also like to take this opportunity to thank our distinguished speakers and participants. I believe that this two-days conference will benefit the participants.

Lastly, I wish you fruitful deliberations at the conference.

Prof. Dr. Mohd Roslan Sulaiman Vice-Chancellor,
Universiti Putra Malaysia

MESSAGE FROM THE DIRECTOR, INSTITUTE OF TROPICAL FORESTRY & FOREST PRODUCTS

Assalamuaikum Warahmatullahi wabarakatuh and Greetings

I am pleased to be given the opportunity to write this message for inclusion in this programme book on the 5th Wood and Biofiber International Conference 2021 (WOBIC2021).

WOBIC2021 carries the theme Wood and Biofibre-transformation towards circular economy. The key concept of the circular economy is to waste and increase the reproducibility of products. We believe, wood and biofibre as a natural material, available in large quantities and is easy to produce, making it the exemplary material to gear up for the circular economy. The success of circular economy is intrinsically bound to environmental innovation in the way societies legislate, produce, and consume. Therefore, one of the innovations by INTROP lead towards generation of circular economy is wood and fiber into various value-added products. The R&D and Commercialization activities using wood fiber for converted into bio-composite production can benefit the circular economy and create a huge and positive impact on the environment.

We are grateful to have a line-up of highly renowned speakers for Keynote and Plenary session who will sharing their expertise and insights ideas in their field of interest. In addition, there will be opportunities for students, researchers, and academia to share their up-to-date research outcomes through oral and poster presentations.

On behalf of the organizing committee, I would like to extend my sincere appreciation to the Universiti Putra Malaysia (UPM), Malaysian Timber Industry Board (MTIB), Malaysian Palm Oil Board (MPOB), National Kenaf and Tobacco Board (LKTN), Forest Research Institute of Malaysia (FRIM), and French Agricultural Research Centre for International Development (CIRAD). I also would like to thank our collaborators Universiti Malaysia Perlis (UniMAP), Universiti Sains Malaysia (USM), Universiti Teknologi Mara (UiTM), Univerisiti Malaysia Pahang (UMP), UCSi University, Universiti Malaysia Terengganu (UMT), Univerisiti Teknikal Melaka (UTeM), Univerisiti Teknologi Malaysia (UTM) for their contributions in this conference. My deepest appreciation to the sponsors and to Organizing Committee for their commitment and cooperation. To all participant, thank you for your support in making this conference a success.

"WITH KNOWLEDGE WE SERVE"

Prof. Ts. Dr. Khalina Abdan
Director, Institute of Tropical Forestry And Forest Products

FOREWORD FROM THE CHAIRMAN OF ORGANIZING COMMITTEE WOBIC 2021

Assalamualaikum and greeting to all

بسم الله الرحمن الرحيم

All praises be to Allah, The Lord of this world and hereafter, and Salawat and Salam to Rasullullah SAW the final messenger. I am most grateful to Allah, the most gracious and most merciful, for His blessings in giving us this precious opportunity to gather in this memorable event. As a chairman, I take great pride in welcoming all the participants of WOBIC 2021, comprising VIP, keynote speakers, plenary speakers and invited speakers, sponsors, representative from co-organizers and collaborators, paper and poster presenters, and organizing/advisory committee. You have contributed tremendously to make this conference a success. The theme of this conference is 'Wood and biofibre – transformation towards circular economy'. Institute of Tropical Forestry and Forest Products (INTROP), Universiti Putra Malaysia (UPM), the organizer of this conference has been granted HICoE by Ministry of Higher Education Malaysia.

I hope this conference will serve as a platform for all experts, researchers and practitioners in the areas of Tropical wood, biofibres and biocomposites to communicate their research through oral presentation and publication, to share and exchange information and knowledge among the students and academic staff and to prepare for publication in high impact journals and chapters in books. This conference also is a step towards achieving our vision in becoming a world-class academic and research institution in the areas of Tropical wood, biofibres and biocomposites in order to produce human capital with first class mentality. I would like to congratulate the member of organizing committee for their commitment and superb drive in organizing this conference. I am very certain that this occasion will be able to provide a platform towards strengthening our relationships in knowledge sharing while at the same time provide the necessary trust in joint research collaborations within the research community. It is my aspiration that this conference will be a foundation for the growth of new ideas towards a better tomorrow. I would like also to acknowledge the cooperation of the management of Institute of Tropical Forestry and Forest Products (INTROP), Universiti Putra Malaysia, and our co-organizers and collaborators who have helped technically, morally and financially in organizing this conference, as well as to the session chairpersons, judges and keynote, plenary. And invited speakers and all the parties involved.

PROFESSOR IR DR MOHD SAPUAN SALIT, FASC

KEYNOTE SPEAKER 1

PROF. DR ALCIDES LOPES LEÃO
São Paulo State University, Brazil

PROFILE

Professor Alcides Lopes Leao is Full Professor, responsible for the area of Biomass, Bioenergy and Biobased Materials. Coordinator of the laboratory RESIDUALL – Laboratory of Solid Residues and Composites. He has published more than 150 papers in Journals, 100 articles in Newspapers and magazines, 35 books chapters, 4 books. Visiting professor at University of Wisconsin, Madison, WI, USA, 1993; Queensland University of Technology, Brisbane, Australia, 2019-2023. Also, Professor of the Professional Master's degree course promoted by Volkswagen AG, Autouni - Sustainable Technologies, Wollfsburg, Germany, totaling 400 class hours, 2005 Coordinator of the Global Bioeconomy Alliance, UNESP, TUM, UQ, UBC and NTU. Professor Alcides was invited lecturer in more than 150 international conferences and lectures in more than 60 countries. he has coordinate more than 50 international and national projects in several research projects under public and private support in many fields. His Hobbies like travelling around the world learning about different culture, people and landscapes; scuba diving: Has dived in more the 100 sites in the 5 Continents

ABSTRACT

Natural Fibers and Its Role in Advanced Materials

Natural fibers have a history of being considered the highest quality fibers for textiles and non-textiles applications. Since then natural fibers have developed its application and processes methods, up to nowadays to the advanced composites, using both thermoplastics and thermosetting resins as matrices. Natural fibers production, processing and export are a commodity with important economic impact in many developing countries, most in the tropical areas, supporting the livelihoods of millions of small-scale farmers and non-qualified workers. Natural fibers play a key role in the bioeconomy strategy, since presents a lower energy consumption when compared to man-made materials. Also it a renewable resource, with neutral carbon footprint. Also its recyclability allows minimizing waste generation, under the umbrella of the circular economy. Natural fibers are renewed by nature and by humans since the pre-historical times for millennia and can represent the only crop alternative in some economic depressed areas (e.g. sisal in the arid regions on Brazil). The natural fibers have a very high specific modulus, even better than steel, resulting that any part based in its composites are lighter in weight, although can bring some defects too. Considering the properties listed, composites based on natural fibers have being considered for many applications and the use of nanocellulose as reinforcement can mitigate most of the drawback found at the natural fibers at macro-scale.

KEYNOTE SPEAKER 2

PROFESSOR VIJAY KUMAR THAKUR
Scotland's Rural College (SRUC) Scotland, UK

PROFILE

Vijay Kumar Thakur is Professor and Founding Head of the Biorefining and Advanced Materials Research Centre at SRUC, Edinburgh, UK. He also holds an Adjunct Professor position in Jiangsu University, Riga Technical University, University of Petroleum & Energy Studies (UPES), and is a Visiting Professor at Shiv Nadar University and Visitor at Cranfield University, UK. Before commencing his tenure at SRUC, Vijay has previously held faculty positions at Cranfield University, Washington State University, US, and Nanyang Technological University, Singapore. He received PhD in Polymer Chemistry (2009) and did his post-doctoral study in Materials Science & Engineering at Iowa State University (US). His group's current research efforts focus on the design, synthesis, characterization, and applications of monomers/ polymers from biorenewable resources; biomaterials; environmental remediation; utilization of waste materials; biofuels and biobased products; recycling; intelligent materials; functional surface coatings; polymer aerogel/hydrogel, photocatalysis, sensing, nanotechnology and nanomaterials. He has published over 300 SCI journal articles, 2 patents, 52 books, and 45 book chapters in his academic career. In 2020, he was ranked 154th in the world's top scientists list in the "Polymers" field that Scopus Database has compiled for Career Long Impact; and Highly Cited Researchers list (2020) by Clarivate's Web of Science. Vijay is an editorial board member of several SCI peer-reviewed international journals and a member of scientific bodies around the globe.

ABSTRACT

Sustainable Materials From Macro to Nanoscale for a Circular Bioeconomy

Researchers have recently focused on the advancement of new materials from biorenewable and sustainable sources because of great concerns about the environment, waste accumulation and destruction, and the inevitable depletion of fossil resources. Biorenewable materials have been extensively used as a matrix or reinforcement in many applications. In the development of innovative methods and materials, cellulose-based materials offer important advantages because of their excellent properties such as ease of fabrication, higher mechanical properties, biodegradability, and many more. In this talk, I will discuss about the chemistry, structures, advanced applications, and recent developments about nanocomposites obtained from biorenewable sources.

PLENARY SPEAKER

PROF. DR. SALIM HIZIROGLU
Oklahoma State University, USA.

PROFILE

Prof Dr. Salim Hiziroglu has Ph.D. degree in Wood Products from Michigan State University, MS degree in Wood Science from the University of California, Berkeley, and BS degree in Forest Products Engineering from Karadeniz Technical University in Turkey. Currently, Dr. Hiziroglu is Professor Emeritus in the Department of Natural Resource Ecology and Management at Oklahoma State University. His research has focused primarily on value-added wood composite panel technology. He had been as a visiting professor at Lulea University, Sweden, Kasetsart University, Thailand, University Sains Malaysia, Shizuoka University, Japan, the University of Tokyo, Japan, National Pingtung University Science and Technology, Pingtung, Taiwan, Karadeniz Technical University, Turkey, Transilvania University of Brasov, Romania and King Saud University, Riyadh, Saudi Arabia. He has 196 refereed journal publications related to wood products and natural based materials in addition to 100 publications in conference proceedings and through Oklahoma Cooperative

ABSTRACT

Value-Added Composites from Under-Utilized Wood and Non-Wood Species

It is an accepted fact that using forest resources including plantations as raw material to produce different types of composite panels puts a significant adverse impact on our environment. Therefore, underutilized wood and non-wood species would have an important potential to balance supply and demand in raw material to be used in composite panel manufacture. This presentation will review some of the concepts and findings of research projects dealing with under-utilized wood and non-wood species including eastern redcedar, bamboo, rice straw, oil palm and betel palm as raw material to manufacture different types of value-added composite panels. Some of the major concerns and findings of various research projects will be presented. Advantages and disadvantages of the raw materials from the perspective of physical and mechanical properties of the experimental panels will also be discussed within the scope of the presentation. Finally, major challenges related to use of above raw materials in panel production will be summarized

DR. JEAN-MARC RODA
CIRAD Regional Director for the SouthEast Asian Island Countries

PROFILE

JM Roda is an economist at Cirad. He was appointed as the Regional Director CIRAD for Southeast Asia in Sept 2021. He was based in Malaysia since 2006. He was the Head of the Center of Excellence on biomass valorisation of Malaysia (UPM CIRAD). He is also Malaysia focal point for the cooperation platform between EU and SE Asia "Sustainability of Agricultural Landscapes in SE Asia". He is an associate scientist at Paris-Sorbonne University. His research and consultancies focus particularly on strategies and agro-economics that shape the demand and the sustainability of natural resources in tropical countries: mainly timber, forests, and plantation commodities. He is also a forest officer specialised in timber industry and business management. He has 2 masters (Biology, and human geography), and he has a PhD in development economics. He started his carrier in 1993 in the Indian timber industry sector. He successively worked in consulting companies in Europe, in the wood procurement competitiveness, in the pulp and paper sector, and came back to the tropics in 1999 for Cirad, working in 34 countries of Africa, Latin America, Asia, and Pacific. In Malaysia, he was seconded by CIRAD to FRIM from 2006 to 2012 and seconded to UPM since 2012 to 2021.

ABSTRACT

Epistemology of Circular Economy, and implications for forestry and wood products

This presentation draws the various concepts of circular economy, its relativity, and the changes of its meanings according to the culture and the political background. It discusses its various scales, from the molecule to the landscape, and how it applies both to materials and energy. Theory, practice, and steps of industrialization in the tropical countries vs the temperate countries will be compared. Finally the specificity intertwining of technological and sociological dimensions for the circular economy of forestry and wood products will be discussed.

DR. ROB ELIAS
Bangor University UK

PROFILE

Dr. Rob Elias is the Director of the BioComposites Centre at Bangor University with a staff of 25 scientists. The Centre was established in 1989 to work with companies to develop new technologies based on sustainable materials such as wood. The Centre has state of the art facilities including pilot scale equipment that enables companies to demonstrate their ideas by developing prototype materials. Rob has a major interest in the development of bio-derived materials that reduce global warming potential. He has an industrial and academic background in natural fibre production. His expertise includes wood-based panel production, biomass extraction/ chemical composition and product development. His current research interests include biorefining, the production of bioplastic products, extraction of value-added molecules from plant materials, utilisation of wastes and agricultural co-products for construction application

ABSTRACT

Pressurised Refining for MDF and the Circular Economy

The presentation will review the process of pressurised refining for the production of fibres used in applications in MDF. The effect of pressure, temperature and mechanical energy in production of different fibre types including wood and agricultural wastes will be explained. The talk will also describe the use of higher pressures in refining to chemical modify and heat treat the fibres and improve durability of MDF. The presentation will also cover future topics of interest such as the circular economy and the increasing need to recycle products. This will be illustrated with an update on MDF Recovery Ltd's approach to recycling and the development of novel insulation materials with 98% recycled content.

PROF. DR. SARANI ZAKARIA
Faculty of Science and Technology
Universiti Kebangsaan Malaysia (UKM), Malaysia

PROFILE

Prof Sarani is an expert in utilising bio-resources lignocellulosic materials especially from plant biomass in converting them into various high value-added products. Her research focuses on the area of pulp and paper technology, wood plastic composites, bioresin, cellulose derivatives and regeneratedcellulosewiththecombinationofnanofunctionalmaterialssuchascellulosenanocrystal,nano fibrillated cellulose, metal oxide, silver nano particle, etc. Projects in regenerated cellulose and cellulose derivatives involved the preparation of cellulose pulp from various method into film (membrane), wet spin fibre, hydrogel, aerogel and hybrid for various application such as in textile, health, agriculture, membrane separation/purification, electronic etc. The projects of bioresin are utilising biomass via liquefaction and solvolysis process (biorefinery for fine chemicals) for making adhesives, foam and boards such as phenolic and polyurethane and hybrid for various applications.

ABSTRACT

Biobased Polyuerthane Foam from Liquified Lignocellulose Materials

Lignocellulosic materials were liquified to produce different polyol properties. Oil palm empty fruit bunch fibre (EFB) and cellulose from oil palm empty fruit bunch (EFBC) were liquefied in cosolvent polyethylene glycol–glycerol to produce polyols. The acid and hydroxyl number were determined. The viscosity, molecular weight, and chemical functionalities of the polyols were analyzed and compared. The optimum liquified temperature for both EFB and EFBC is 175 C. However, the optimum liquefaction time of EFBC (180 min) was longer than the time recorded by EFB (90 min). Liquefaction temperature and time had influenced degradation and recondensation of liquefied biomass products, hence affected the propeties of polyols. Extreme degradation and recondensation during liquefaction had reduced the OH number of polyols. Recondensation significantly affected the molecular weight and viscosity of the EFB polyol, but not those of EFBC polyol. Rigid PUFs synthesized from the optimum EFB and EFBC polyols were denoted as EFB PUF and EFBC PUF, respectively. EFB PUF possessed larger average cell diaeter than that of EFBC PUF. Comparatively, the thermal decomposition and compressive strength of EFB PUF were lower than those of EFBC PUF.

PROFESSOR DR. HAZIZAN MD AKIL
Universiti Sains Malaysia (USM), Malaysia

PROFILE

Professor Dr Hazizan Md Akil was born in Temerloh, Pahang. He received his early education at Sekolah Kebangsaan Bohor Baru, Temerloh, Pahang and his secondary education at Sekolah Menengah Sultan Abu Bakar, Kuantan, and Pahang. In 1993 he obtained his dual Diplomas in Rubber and Plastics Technology (UiTM) and Diploma in Natural Rubber Processing (RRIM). 3 years later, in 1996 he obtained his B.Eng. (Hons) in Polymer Engineering from the University of North London, United Kingdom. Subsequently, he obtained his PhD in Composites Materials (with a focus on Sandwich structure) from the University of Liverpool, UK, in 2002. Upon his return to Malaysia, he joined Universiti Sains Malaysia (USM) as a lecturer in the School of Materials and Mineral Resources Engineering. He was promoted to Associate Professor in 2008 and a full Professor in 2012. Prof Hazizan is currently a Professor at USM's School of Materials and Mineral Resources Engineering. Widely regarded as an authority in the study of polymer composites research with special emphasis on natural fibre reinforced composites and impact mechanics, Prof Hazizan's expertise is evident through a body of work that covers a period of 21 years which includes extensive and in-depth research on low velocity impact response of composites materials and sandwich structure and application of natural fibre, particularly Malaysia-grown kenaf fibre for the production of renewable and green fibre reinforced polymer composites. The kenaf fibre reinforced composites has been commercialized as grating and outdoor applications. Prof Hazizan's work on the manufacturing kenaf fibre yarn and production of long and continuous form of kenaf fibre reinforced composites via Pultrusion method has gained overwhelming attention from the industries and composites engineers. Prof Hazizan has also continued efforts to expand the application of kenaf fibre by producing hybrid kenaf/glass fibre for manufacturing advanced hybrid system using Pultrusion method. Modification of the Pultrusion machine has led to the innovative hybrid kenaf/glass composites with enhanced properties and lightweight. His aptitude for high quality research of international standing has been further supported by his more than 205 international journal publications with a total citation of 2885 times and an h-index of 27. Prof Hazizan has also successfully supervised 15 PhD and 35 MSc students and is currently supervising 8 PhD students. Prof Hazizan has been honored with a total of 15 local and international awards for his achievements including Geneva Exhibition, ITEX, MTE, PENCIPTA and i-ENVEX. Prof Hazizan was also named as one of the Top Research Scientists in Malaysia (TRSM 2014) by Academy of Sciences Malaysia. He has also been awarded as one of the Malaysia's Rising Stars in 2015. He has been regularly invited to present his research findings at various international and national conferences and has strong international collaboration and linkages.

ABSTRACT

Advances, challenges and future outlook on the potential applications of Natural fibre reinforced composites

The development of engineering products made from natural resources is increasing worldwide, due to renewable and environmental issues. Among the many different types of natural resources, kenaf plants have been extensively exploited over the past few years. Therefore, this paper presents an overview of the developments and advancements made in the area of kenaf fiber reinforced composites, in terms of manufacturing methods and overall properties. Several critical issues and suggestions for future work are discussed, which underscore the roles of material scientists and manufacturing engineers, for the bright future of this new "green" material through value addition to enhance its use.

DR. RUSHDAN IBRAHIM
Forest Research Institute of Malaysia (FRIM)

PROFILE

Rushdan bin Ibrahim is a Principal Research Officer at Pulp and Paper Laboratory, Forest Research Institute Malaysia (FRIM). He received his first degree in forestry from the University of Montana, USA; a master degree in Wood Technology from Universiti Putra Malaysia, Selangor; and Ph.D. in Paper Science from the University of Manchester, UK. He is a researcher, innovator, educator, and consultant in pulp and paper. His research interest is in pulp, paper and cellulose derivatives from hardwood, non-wood and recycled paper. He was involved in 35 research projects, and 19 of them are as a project leader. He has produced 17 invention disclosures, and 5 patents has been granted. Furthermore, he has won 15 golds, 19 silvers and 9 bronzes for his innovation. His R&D on pulp and paper from rice straw, oil palm empty fruit bunch and kenaf has been commercialized. He has presented and published over 200 technical papers at international and national conferences and journals. He was a consultant and trainer to over thirty companies and institutions.

ABSTRACT

Commercialization, Innovation, Kenaf, Oil palm empty fruit bunches, Research & Development, Rice straw.

Pulp and paper laboratory, FRIM was established in 1955. The laboratory is equipped with facilities for wood chemical analysis, pulping, bleaching, paper-making, and paper testing. Since its establishment, most of its R&D project s are on tropical hardwood species, but started in 1980's besides tropical hardwood, the R&D projects on non-wood are introduced. These R&D projects on non-wood were supported by Malaysian government and industries, and have generating knowledge, creating wealth, and upgrading societal well-being.

ROSLINA IDRIS
Malaysian Timber Industry Board (MTIB)

PROFILE

Roslina Idris has more than 25 years of experience working with the Malaysian Timber Industry Board (MTIB), an organisation responsible for promotion and development of the timber industry. She is currently serving as a Director at the Licensing & Inspectorate Division of MTIB. She received his first degree in BSc (Hons.) from the University of Malaya. She also has achievements such as contribute to transfer of technology, design enhancement and product development, successfully undertake the responsibilities embedded within MTIB's status of Standards Writing Authority (SWO), implement the human resource development blueprint, named WISDEC Qualification Framework for the timber industry which is being implemented through the Wood Industry Skills Development Centre (WISDEC), completed MTIB's flagship projects - developing business plan, including assessment of financial viability and project feasibility with specific outcomes and performance measures. These includes development of WISDEC Sabah and Galeri Glulam in Johor Bharu, paper developed, entitled Capacity Building in Furniture Production Engineering was chosen to be presented to Joint Economic Committee Malaysia-Italy, actively involved and participated in timber industry master plans, such as deliberation in NATIP and Commodity Policy Review, and its framework., upon lengthy deliberation with Terengganu Authorities and stakeholders, timber sector was agreed to be part of the potential sectors to be further developed in Terengganu. Prior to this, there was no clear policy to encourage downstream timber processing industry and envisaged in revisiting and reviewing Rules and Regulations within the dynamism of timber industry, in compliance with relevant Acts.

ABSTRACT

MALAYSIAN TIMBER INDUSTRY: Gearing Towards a Resilient Industry

Timber sector is the third-largest contributor among the Agricommodity sectors after palm oil and rubber. Sectoral GDP contribution of the timber industry was recorded at RM15.2 billion, accounting for 1.1% of the country's GDP. In 2020, timber export value was registered at RM22.02 billion. The highest contributor to timber exports was wooden furniture, which captured 48.2% (RM10.63 billion) of the total exports, followed by plywood at 12.9% (RM2.84 billion) and sawn timber at 10.9% (RM2.39 billion). It is within our aspiration that Malaysian timber industries to strengthen its resilience. Comprehensive strategies have been outlined within the policy directions, and it is hoped that Malaysia to export more value-added downstream products, compared to merely focusing on primary products. Issues faced by the timber sector are the challenges that require special attention. Raw materials supply and labour constraints are the two major challenges that have impacted timber businesses. Sustaining raw material supply via re-planting as well as promoting alternative timber material by harnessing the application of biomass as a sustainable material have been part of MTIB's activities. Economic competition, coupled with technological changes, poses a need for the sector to upgrade the skills of the employees. Hence, various solutions have been outlined in the National Timber Industry Strategic Plan (NTISP), 2021-2025 to provide a structural shift due to the challenges faced, as well as the fallout from the COVID19-pandemic.

FORUM SPEAKER

Title: From surviving to thrive: Harnessing the circular economy for wood and biofibre in the post-pandemic era

YBhg. Datuk Wira Sheikh Othman Rahman
Chairman of the Malaysian Panel-Products Manufacturers' Association (MPMA), MALAYSIA

YBhg. Dato' Dr. Jalaluddin Harun
Fellow Alternate Chairperson of the Science & Technology Dev. and Industry Discipline, Academy Sciences Malaysia, MALAYSIA

Assoc. Prof. Dr. Yasir Nawab
National Textile University, PAKISTAN

INVITED SPEAKER

ASSOC. PROF. MOHAMED ANSARI MOHAMED NAINAR
Universiti Tenaga Nasional, MALAYSIA

ABSTRACT

Wood-Based Actived Carbon for Supercapacitor Electrode

Energy storage, energy efficiency, renewable energy and sustainability are the most significant areas in current research. Existing materials and electrodes used in energy storage devices such as in supercapacitors, and hybrid batteries etc., does not meet the requirements of the modern-day energy storage systems. Hence, alternate, and novel materials are being explored by many researchers worldwide. Recently, Activated Carbon is one of the active material components mainly focused in the electrode development. Activated carbons are generally produced from organic waste materials and other plant-based fibre materials. In this paper, Activated Carbons from different types of wood as precursor is studied with regards to its various characteristics and morphological properties that are suitable for supercapacitor electrodes. Wood based waste particles are taken through series of steps before using pyrolysis method for converting the wood particles into carbon at 5000C. Then, the carbonized materials are treated with various chemicals such as Sodium Hydroxide (NaOH), Sodium Sulphate (Na2SO4), and Potassium Hydroxide (KOH) followed by the thermal activation at temperatures of 6000C – 9000C and holding time of 30min- 120min. The activation process variables were investigated and through the results it was found that the activation temperature of 7000C and holding time of 90 minutes produced the maximum energy storage capacities. Finally, the effect of molar concentration of the chemicals used for treatment, different types of wood materials on the specific capacitance, energy density and power density will be discussed during the presentation.

Keywords: Activated Carbon, wood-precursor, supercapacitor, electrode, energy storage properties

PROF. DR. SARAT KUMAR SWAIN
Veer Surendra Sai University of Technology, INDIA

ABSTRACT

Nano BN incorporated Cellulose-based Tripolymeric Hybrid Nanocomposites for Packaging Applications

Tripolymeric nanocomposites of polyacrylic acid (PAA), polyethylmethacrylate (PEMA) and carboxymethyl cellulose (CMC) are synthesized by emulsifier free emulsion technique with nano Boron nitride (BN) as reinforcement. The interaction of BN with the tripolymers is investigated by FTIR. The exfoliation of BN platelets is achieved due to increase in basal spacing obtained from XRD. The electron microscopic study of PAA-PEMA-CMC/BN hybrid nanocomposites is done establishing BN dispersion with the tripolymers. It is seen that nano BN creates a torturous path with matrix to arrest the penetration of gas. The permeability of as-synthesized hybrid nanocomposites is decreased five folds with incorporation of BN platelets. When 5% nano BN is allowed to disperse with PAA-PEMA-CMC matrix, the tensile strength is increased by more than five times with thermal stability upto 450 °C. The significant lowering of permeability with combined improvement in tensile strength and thermal stability enables the as-synthesized hybrid nanocomposites for potential packaging applications.

Keywords: Tripolymer, Hybrid nanocomposites, Barrier properties, Packaging applications

DR. RAMZI KHIARI
Higher Institute of Technological Studies in Ksar-Hellal, TUNISIA

ABSTRACT

Cellulose NanoFibril from Prunus amygdalus: Mechanical Properties and morphological features
Important quantities of *Prunus amygdalus* accumulate every year in Tunisia. The rational valorization of this available renewable resource fits very well with the recent sustainable approach, established nowadays. In this context *Prunus amygdalus* stem was used as the starting material to produce nanofibrillar cellulose. Thus, CNF gel was prepared by disintegration in a high-pressure homogenizer of cellulose pulp extracted from *Prunus amygdalus*. The ensuing CNF suspension was characterized by serval methods such as the fibrillation yield, transparency, and morphological features. The reinforcing potential of the ensuing NFC was also established using dynamic mechanical analysis (DMA) from measurements carried out on nanocomposite films prepared by casting a mixture of CNF suspension and commercial acrylic latex. The prepared materials have showed promising mechanical properties.

Keywords: *Prunus amygdalus,* CNF gel, TEM, DMA

DR. MOHAMED MIDANI
Wilson College of Textiles, USA & German University in Cairo, EGYPT

ABSTRACT

Optimizing And Benchmarking the Performance of Date Palm Textile Fiber Composites

Recently date palm has been emerging as a rich source of vegetable fibers which could be utilized as fiber reinforcements in polymer composites. Yet, to harness the full potential of these fibers they must be prepared in a formal textile architecture and surface treated. Moreover, their properties must be benchmarked and compared with other commonly used natural fibers and their composites. The aim of this study is two-fold, first to characterize and compare the properties of the textile fibers extracted from the midrib and spadix stem of date palm to sisal, abaca, and banana fibers. Second, to study the effect of the fiber architecture, weight fraction, and treatment on the mechanical properties of date palm - polypropylene composite and compare them with those of other leaf fibers. The comparison includes the fiber morphological, physical, chemical, mechanical, and thermal properties in addition to comparing the tensile and flexural properties of their polypropylene composites. The results showed that the tested leaf fibers had cellulose wt.% ranging between 60 % and 80 % and hemicellulose and lignin wt.% values less than 25% and 13% respectively. The thermogravimetric analysis showed that the fibers are thermally stable nearly till over 200 °C. The composites mechanical properties showed that the nonwoven date palm had tensile and bending strength of 20 – 22 MPa and 32 – 34 MPa respectively, which were equivalent or higher than the other leaf fibers. However, changing the fiber reinforcement architecture showed significant difference in the date palm composite properties. The core-wrapped unidirectioal, and commingled unidirectional architectures exhibited higher tensile and bending strength up to 40 MPa and 58 MPa respectively. It was also revealed that 50% date palm fiber weight fraction had the optimum mechanical performance. Surprisingly, the fiber treatment with maleic anhydride has negatively affected the mechanical properties when compared with the non-treated samples. This research will help in identifying the position of date palm midrib and spadix stems fibers among the other leaf fibers. Additionally, it will open the doors for date palm textile fibers to be used in various applications and consequently increase the biodiversity of natural fiber sources.

DR. MUHAMMAD MOHSIN
University of Engineering and Technology PAKISTAN

ABSTRACT

Development of environment friendly and nontoxic bio finishing for cotton

Cotton is the most widely used natural fibers due to its comfort, biodegradability, ease of dyeability and availability. However, lack of fire retardancy as well as oil and water repellency are considered as major drawbacks of cotton. Therefore, cotton fabric needs be finished for certain end use products. Unfortunately, majority of the commercially available fire retardant involve toxic halogenated and formaldehyde compounds. Similarly, oil and water repellents include toxic fluorocarbon. Both above compounds are included in manufacturing restricted substance list (MRSL) by ZDHC which is signed by majority of the brands. Our research group has successfully developed halogen and formaldehyde free fire retardant which is bio based and it exhibited good fire retardancy for cotton as well as additional properties of easy care, better shrinkage and antimicrobial performance. Similarly, fluorocarbon free bio-based oil and water repellents have been developed which exhibited good water repellency and moderate oil repellency. Toxic and harmful finishes are being banned for textile and more bio and non-toxic finishing needs to be developed for making textile industry a truly sustainable industry.

DR ZAINAB IDRIS
Malaysian Palm Oil Board, MALAYSIA

ABSTRACT

Oil Palm Biomass: Sustaining the Oil Palm Industry Through Value Addition

The oil palm industry generates about 100 million tonnes of biomass annually. Within the 5.87 million hectares of oil palm plantations in 2020, 7.40 million tonnes of empty fruit bunches, 7.78 million tonnes of mesocarp fibres, 64.38 million tonnes of palm oil mill effluent and 4.49 million tonnes of palm kernel shell were generated by the 457 mills in Malaysia as the by-product. On the other hand, 65.03 million tonnes of palm fronds and 11.92 million tonnes of oil palm trunk were considered as in-field by-products because of periodic pruning and replanting activities, respectively. In the circular economy, the biomasses were no longer considered as wastes but a form of valuable resources for high value products where additional revenue could be created for the country, creating additional income for the community, and subsequently protecting the environment. MPOB, through its commitment in achieving the sustainable development goal through the oil palm industry, embarked on research and development to utilize the waste as feedstocks for bio-energy and bio-fuel, bio-agriculture inputs, wood products and bio-based chemicals and polymers. This presentation will share issues and challenges faced, highlights or achievement with respect to oil palm biomasses research, development, and commercialization.

DR. AHMAD ILYAS RUSHDAN
Universiti Technology Malaysia MALAYSIA

ABSTRACT

Emerging development of sugar palm *(Arenga pinnata (Wurmb.) Merr)* nanocellulose: from macro to nanoscale

Over the past decade, nanocellulose (NC) has been proven to be one of the most prominent green materials of modern times. This renewable NC has been used in various applications, from flexible packaging to advanced bio-scaffolds for tissue regeneration. It is due to its outstanding properties such as excellent mechanical properties, high thermal resistance, good optical properties, high aspect ratio with anisotropic shape, good biocompatibility, high crystallinity, large specific surface area, abundant surface hydroxyl groups for modification, and tailorable surface chemistry. Sugar palm *(Arenga pinnata)* fibre is considered a waste product of the agricultural industry. The fibres are mainly lignocellulosic and multicellular, which have a high percentage of cellulose content. Therefore, sugar palm fibres have a considerable potential to be commercialized, specifically by producing highly valued nanomaterial products from agricultural waste. The outline of the current development of sugar palm, including the extraction and isolation of sugar palm nanocellulose, will be discussed. Besides that, we hope to impart the audience with some of the excitement that currently surrounds sugar palm nanocellulose research, which ascends from the renewable source nature of the lignocellulosic fibre, their fascinating, morphological, mechanical, chemical, and physical properties, and the variety of applications that can be developed from this nanomaterial.

Keywords: Sugar palm, *Arenga pinnata*, agricultural waste, sugar palm nanocellulose, natural fibre, nanocellulose

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ABSTRACT

Dry Pre-Pregs by Commingling technique: A alternative route of thermoplastic composite fabrication
The thermoplastic composite materials have potential to replace metals due to their lightweight, comparable mechanical performance and excellent formability. The thermoplastic composites are finding applications in automotive and aerospace applications. Conventionally, compression molding is the most widely used approach for thermoplastic composite fabrication. There are certain limitations that may arise during processing of thermoplastics using compression molding, e.g. improper impregnation, non-uniform distribution of matrix, etc. The dry pre-pregs produced by commingling technique serve as a potential alternative route of thermoplastic composite fabrication. This approach can be employed at two scales, either at yarn level or at fabric level. In the first approach, commingled yarn is prepared by wrapping a thermoplastic yarn over natural fiber-based yarn (jute) or some high-performance yarn. This yarn is then used for reinforcement fabrication (woven, knitted or unidirectional). The resulting reinforcement is a dry thermoplastic pre-preg that can be processed to fabricate composite. The other route of dry pre-pregs is to use to different yarns for reinforcement fabrication. The natural fiber-based yarn and thermoplastic yarn are used in a specific pattern in the reinforcement, to produce a dry pre-preg. The first approach produces more intimate structure, ensuring a proper impregnation of reinforcement and uniform resin distribution.

Keywords: Natural fibers, commingling, thermoplastic, dry pre-preg

OTHER INVITED SPEAKERS

PROF. DR. AHMAD AINUDDIN NURUDDIN
Institute of Tropical Forestry And Forest Products (INTROP),
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Title: Forest Fires And Iot

DR. ALI KILIC
Istanbul Technical University TURKEY

Title: Biofibres for Advanced Applications: Energy, Medical, Food and Composites

ABSTRACTS OF ORAL PRESENTATION

PROPERTIES AND CHARACTERISATION OF BIODEGRADABLE PACKAGING MATERIAL

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ABSTRACT

Kappaphycus alvarezii was used to fabricate seaweed film. This film has poor water barrier and mechanical properties because of its hydrophilic nature. Therefore, incorporation of neem leaves extract into the seaweed matrix and gamma irradiated to improve the film properties as potential packaging material were studied. The ethanolic neem leaves extract was incorporated at different concentrations, 0.5%, 1.0%, 2.5%, 5.0% and 7.5% w/w to fabricate seaweed-neem films. The addition of neem leaves extract on the tensile, wettability, antimicrobial, water barrier properties and morphological of the films were investigated. It was found that the incorporation of 5% w/w neem leaves extract showed the most optimum improvement in the film properties. The tensile properties and contact angle (CA) were increased. Water vapour permeability (WVP) value was reduced. The film exhibited excellent antimicrobial activities towards *Staphylococcus aureus* and *Bacillus subtilis*. The seaweed-neem film with 5% w/w neem leaves was further enhanced with gamma irradiation at various doses, 0.5 kGy, 1.5 kGy, 2.5 kGy, 3.5 kGy and 4.5 kGy. The physical, tensile, barrier, antimicrobial, biodegradability properties and physicochemical characterisation of the irradiated films were investigated. It was found that the gamma radiation dose of 2.5 kGy was the optimal irradiation dose for the development of irradiated seaweed-neem film with improved properties. The yellowness and greenness values of the film were intensified and lowest opacity was exhibited. Moisture content (MC), water solubility (WS) and WVP values were decreased. The CA, TS and TM of the irradiated film were increased. Conversely, EAB value was decreased. The irradiated seaweed-neem film decreased the rate of film biodegradation. Higher antimicrobial activities against bacteria and smoother film surface was displayed in the physicochemical characterisation studies. The seaweed film incorporated with 5 % w/w neem leaves extract and gamma irradiated with 2.5 kGy (ISN film) was used for further analysis on the film suitability as packaging material. Products packaged with the ISN film were stored for 180 Days and the film properties were investigated. The packaging film showed an excellent storage stability with negligible loss of its tensile, MC, WVP and antimicrobial properties. Therefore, the fabricated film could potentially use as biodegradable packaging material for various packaging applications.

Keywords: *Kappaphycus alvarezii,* neem leaves, gamma irradiation, antimicrobial, biodegradable, packaging film.

EFFECTS OF BORON AND COPPER CHROME BORON (CCB) TREATMENT ON PHYSICAL AND MECHANICAL PROPERTIES OF *GIGANTOCHLOA SCORTECHINII*

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ABSTRACT

As similar to wood, the use of bamboo in any application needs to be treated with preservative solution to enhance its durability, most importantly to protect from the attack of any bio-deteriorating agents such as insects and fungus. Various preservatives are available in the market, but waterborne preservatives were commonly used due to its lesser impact to environment. In this study, Semantan *(Gigantochloa scortechini)* bamboo strips were treated using 2 preservatives namely boron and copper chrome boron (CCB). The effects of the treatment on the physical and mechanical properties of the bamboo strips were evaluated. The results showed that the preservatives treatment impacted both properties. Waterborne preservatives influence the physical properties through the decrease of both swelling and shrinkage at 19.7% to 28.6% for boron and 15.9% to 25.2% for CCB compared to that of the control sample. The retention threshold was found to be stable for both preservatives, but CCB recorded a higher value. A significant difference was observed in mechanical properties where CCB- treated strips possess higher strength than boron-treated strips.

Keywords: Preservative treatment, waterborne preservative, physical properties and mechanical properties.

THE PROPERTIES OF 3D PRINTED POLY (LACTIC ACID) (PLA)/POLY (BUTYLENE-ADIPATE-TEREPHTHALATE) (PBAT) BLEND AND OIL PALM EMPTY FRUIT BUNCH (EFB) REINFORCED PLA/PBAT COMPOSITES USED IN FUSED DEPOSITION MODELLING (FDM) 3D PRINTING

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ABSTRACT

Recently, Fused Deposition Modelling (FDM) technique has become a research highlight in 3D printing technology for its low cost in use and maintenance. Poly (lactic acid) (PLA) is one of the commonly used biopolymers in 3D printing application, especially in FDM 3D printing. Unfortunately, PLA is relatively brittle and has low elongation at break. In this study, PLA was blended with Poly (butylene-adipate-terephthalate) (PBAT) (PLA/PBAT blend) via twin-screw extrusion with contents of PBAT from 20, 50 and 80 wt.% to improve the ductility and impact properties of PLA, and thus expand its application in FDM 3D printing. Oil palm empty fruit bunch (EFB) was also added as the reinforcement in the selected PLA/PBAT blend (80/20 wt.%) with 10 wt.% EFB to reduce the cost of the PLA/PBAT blend as filament used in FDM 3D printing. The mechanical (tensile and impact) and morphological (scanning electron microscopy, SEM) properties of the prepared 3D printed PLA/PBAT blend and PLA/PBAT/EFB composite were then characterised. The tensile result indicated that the addition of PBAT decreased the tensile strength and tensile modulus of 3D printed PLA/PBAT blend. The terephthalate group in the PBAT affects the mechanical properties of 3D printed PLA/PBAT blend, resulting in high elongation at break but relatively low tensile strength. Besides, the tensile strength and tensile modulus of 3D printed PLA/PBAT/EFB composite decreased and lower than 3D printed PLA and PLA/PBAT blend. The impact test results in high impact strength of PLA in 3D printed PLA/PBAT blend, and 50/50 and 20/80 wt.% of 3D printed PLA/PBAT blend are unbreakable. The impact strength of 3D printed PLA/PBAT/EFB composite is also increased from 3D printed PLA but lower than 3D printed PLA/PBAT blend. The SEM results revealed that the filament layering on 3D printed PLA/PBAT blend (80/20 wt.%) was oriented than 50/50 and 20/80 wt.% of 3D printed PLA/PBAT blend. Besides, the SEM images of 3D printed PLA/PBAT/EFB composite revealed the inhomogeneous and large agglomeration of EFB particle dispersed in PLA/PBAT matrix. Therefore, in the future, the polymer blend and polymer blend composite from PLA, PBAT and EFB can be developed where the properties will be based on the study and this study also shed light on the importance of extrusion settings during the manufacture of filament for 3D printing.

Keywords: Poly (lactic acid), Poly (butylene-adipate-terephthalate), oil palm empty fruit bunch, polymer blend, composite, Fused Deposition Modelling, 3D Printing

STARCH-BASED BIOCOMPOSITES FOR PACKAGING APPLICATIONS: A REVIEW

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ABSTRACT

In the last decade, petroleum-based polymers have been widely employed in the packaging industry because of their low cost, excellent barrier properties, and good chemical stability. However, the use of synthetic polymers in packaging applications has created environmental problems. Consequently, various studies have been conducted to replace the packaging materials with environmentally friendly materials to avoid the persistent issues with plastic waste disposal. Starch could be a promising renewable source for the production of biodegradable materials as an alternative to plastic. A current study of starch-based materials focuses on characterization techniques of starch-based biocomposites and their applicability in food packaging are summarized. This study aims to present a short review of recent works on characterizations starch-based biocomposites for packaging applications as valuable packaging materials.

Keywords: Starch film; biocomposites; packaging.

THE EFFECT OF DELIGNIFICATION ON THE MECHANICAL, THERMAL AND MORPHOLOGICAL PROPERTIES OF *GIGANTOCHLOA SCORTECHINII* (BULUH SEMANTAN) FIBER

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ABSTRACT

By combining several types of cellulosic fibres with man-made synthetic fibres, a green polymer such as bioplastic can be created. A potential replacement is a nanocrystalline cellulose made from bamboo fibre *(Gigantochloa scortechinii)*. The key criteria to determine a good nanofiller reinforcement agent, which may be employed in bioplastics, is the character of the nanofiller itself. However, due to its incompatibility, employing natural fibres as reinforcement in bioplastic has caused a number of issues. Delignification and mercerization, as well as benzoylation treatment, were used by various researchers. Thus, the delignification (NaClO2 and CH3COOH) and mercerization (NaOH), as well as benzoyl treatment, must be tuned to acquire improved nanofiller qualities. The main purpose of this study was to determine the effects of bamboo fibre delignification and mercerisation method as well as benzoyl treatment on *Gigantochloa scortechinii*. Furthermore, the properties of the bamboo fibre (BF) for the chemical process of producing nanocrystalline cellulose (NCC) for reinforcement in polymer composites were investigated. The morphological structure, thermal stability, and functional groups of bamboo *(Gigantochloa scortechinii)* cellulose (BC) were investigated using scanning electron microscopy (SEM), thermogravimetric analysis (TGA), and Fourier transforms infrared (FTIR) spectroscopy, respectively. The physical and chemical analysis of bamboo fibre also has been review. The high cellulose content of this species (together with its fibre properties) shows its good potential as a raw material for reinforcing in bioplastics, regardless of age and culm height.

Keywords: *Gigantochloa scortechinii*, Bamboo, Cellulose, Bioplastic, Natural fibres, Benzoyl treatment

FOREST PLANTATION MAPPING USING RANDOM TREE OF SUPERVISED CLASSIFICATION

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ABSTRACT

Forest plantations can be found next to natural forests as well as on other agricultural properties. Land use classification-based remote sensing can be used to map land usage for company forest management activities. Land cover was identified using PCI Geomatica Catalyst software based on WorldView-2 satellite images. The Sabah Softwood Berhad (SSB) Forest Plantation in Brumas, Tawau, Sabah, Malaysia's west coast, was chosen as the study's testing site. The investigation resulted in six different land uses based on Random Tree of supervised classification techniques. The map had a low overall accuracy of 36.89 percent and a Kappa statistic of 0.198. The study used supervised Random Tree classification, with the buildings class having the greatest Producer's accuracy (87.50 %), followed by the roads class (43.18 %). Roads had the highest user accuracy (67.85 %), followed by low density vegetation (63.15 %). The map has a low overall accuracy, but it can be used to map land for distinguishing features with higher reflectance, such as open area, roads, and land with low vegetation cover. This type of map can be used for company forest management in pest and disease management, land resource distribution, and production purposes.

WOOD DUST FIBRE COMPOSITE MECHANICAL PROPERTIES INFLUENCE ON FUSED DEPOSITION MODELING (FDM) FOR FUSED FILAMENT FABRICATION (FFF)

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ABSTRACT

: Fused filament fabrication (FFF) uses thermoplastic deposition via a nozzle to build up an object layer by layer, much like traditional 3D printing such as FDM. The technology enables the creation of complicated forms with a degree of creative flexibility not possible with standard production processes. However, when compared to conventional engineering materials, the mechanical characteristics of the thermoplastic materials utilised are poor. Material research and development in the bio composites industry is being driven by the rising need for sustainable materials. Body panels on cars, X-ray couches on medical instruments, and performance footwear on sports goods are all made using bio-composite reinforced with natural fibres. Use natural fibres to produce FDM filament bio-composite to enhance FDM filament quality. Extruder size, temperature, length, and speed are key factors in producing good filament and consistent size. Following the precise size, mechanical tests such as wire pull out and porosity tests will be conducted to determine the best process parameter. For FDM fused filament manufacturing, researchers have investigated many natural fibres and their fused filament fabrication (FFF).

Keywords: wood dust composite, fused deposition modelling, mechanical test

FABRICATION AND CHARATERIZATION OF 3D FILAMENTS OF KENAF/POLYLACTIC ACID BIOCOMPOSITE

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ABSTRACT

This study aims to provide an alternative fully green biodegradable 3D printing filament other than Polylactic Acid (PLA) with better properties and lower prices using a fully environmentally friendly process. Two sets of PLA-KF bio-composites are to be prepared at similar filler percentages (10wt.% and 20wt.%). The first set is to be prepared without treatment of any type. Meanwhile, A similar bio-composites set is also to be prepared with a similar filler amount while the only treatment to be applied on kenaf fibres is carried out using an eco-friendly superheated steam (SHS) to lower the water uptake of kenaf fibres and the relevant bio-composite. It is expected that the emerging bio-composite under the SHS treatment is to have increased component compatibility, as well as lower waterabsorption and better suitability for 3D printing. In order to obtain a homogeneous blend, kenaf fibres will be ground in a cutting mill to around 30 mesh. The average fibre length of the KF fibres is 0.4 mm with a 38 µm diameter. The blend bio-composite is then extruded in a single extruder machine to prepare it as a 3D printing filament with a standard diameter of around 1.75mm. The samples are to be designed using SOLIDWORKS software according to the American Society for Testing and Materials (ASTM) standards. The prepared designs are then to be converted to gcode using Cure software. FDM Creality 3D printer (Model: CR10S-PRO) to be used printing a set of specimens for each required test. The prepared samples then undergo several mechanical testings to specify their exact properties and the ideal ratio to be proposed based on the experimental results. Aside from the prepared filament, another two filaments (PLA, PLA/Coconut fibre) to be purchased and used to prepare a similar sample under the same conditions to compare the obtained properties of the prepared filament.

Keywords: Polylactic Acid (PLA), Kenaf Fibre, 3D printing, Filament, American Society for Testing and Materials (ASTM)

THE ENERGY-ABSORBING CAPABILITY OF FOAM-FILLED HONEYCOMB STRUCTURES MADE OF FLAX/POLYLACTIDE COMPOSITE

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ABSTRACT

Natural fibre is gaining popularity for its use in a variety of fields and as a potential replacement for synthetic fibre due to its availability from renewable natural resources. In this paper, the compression properties and subsequent failure mode in foam-filled honeycomb-core of sandwich structures made of flax fibre reinforced polylactide (PLA) composite are investigated. Initially, a corrugated mould is used to create the corrugated core composite profile, which later cut into corrugated webs and assembled to form the honeycomb core. A total of eight specimens with a dimension of 85 mm x 85 mm x 20 mm (length x width x height) are fabricated; an empty honeycomb core, and honeycomb core filled with high density foam (HP80). Following that, the sandwich structures are tested under quasi-static loading condition at a crosshead displacement rate of 2 mm/min. The experimental results showed that honeycomb filled with high density foam sandwich structure offer greater strength and specific energy absorbing capability (SEA) by 33% than those obtained from an empty honeycomb core sandwich structure. Finally, delamination, cell wall crushing and core buckling are the dominated failure mechanism.

Keywords: Compressive strength, Energy absorption, Flax, Honeycomb core.

THE ISOLATION OF CELLULOSE NANOFIBRILLATED FIBERS BY SUPERCRITICAL CARBON DIOXIDE ASSISTED BY HIGH-PRESSURE HOMOGENIZATION AND THE REINFORCEMENT IN BIOPOLYMER FILM

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ABSTRACT

The production of nanocellulose required several steps depending on its characteristics and applications. However, these production pathways lead to several concerns of environmental issues. Supercritical carbon dioxide (Sc-CO2) is an isolation method that has the potential to assist the isolation process of nanocellulose. Therefore, in this study, cellulose nanofiber (CNF) undergo series of isolation process including Sc-CO2 assisted by mild acid hydrolysis and high-pressure homogenization. The obtained CNF was verified by TEM and FTIR analysis to approve the effectiveness of the method. The produced CNF is then used as reinforcement in PLA biocomposites. The CNF addition (1, 3 and 5 wt.%) into the PLA matrix was cast by solvent casting method. The nanocomposites film was characterized by mechanical, morphological and thermal properties. The CNF isolated through these combined approaches provided better characteristics compared to those achieved by conventional methods. The fabricated bionanocomposite has the potential to comply with any advanced applications in the nanotechnological industry.

Keywords: Biopolymer, supercritical carbon dioxide, homogenizer, cellulose nanofiber, reinforcement.

ENHANCEMENT OF MANUFACTURING PROCESS FOR OIL PALM TRUNK PLYWOOD

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ABSTRACT

: The Malaysian timber industry is an important income generator for the Malaysian's economy. In 2020, the export revenue of timber and timber products was valued an excess of RM22 billion. The supply of raw material is require in order to further develop this thriving industry towards continuous growth. There are 5.8 million hectares of oil palm plantations in Malaysia. After 25 years, the oil palm trees will begin yielding less fruit and need to give way for replanting of new young trees. This presents a boon to the timber industry as the felled is a renewable source of alternative raw material. Initiative that carried out by Malaysian Timber Industry Board (MTIB) together with the timber industry, both in the past and present, hasenabled OPT to become a new and an important source of raw material for conversion into veneer, plywood and then furniture. In plywood manufacturing, there are three main challenges that need to be solved for fully commercialization of this product which are extremely high moisture content (MC) (i.e., 200% 400%) that requires much longer drying time compared to wood, high density variation (180- 460 kg/m3) and diverse anatomical structure along the stem. The improvement in palm plywood manufacture included veneer segregation (density), enhanced drying process and automation feeders have been carried out to overcome the crucial problems facing by the manufacturers as mentioned. The research has a positive impact on the timber industries. This new enhanced processing system can be used as a standard / model which will reduce the drying time and increase 60% of production's capacity and plywood quality, thus developing the oil palm trunk plywood industry in Malaysia.

Keywords: oil palm trunk, plywood, drying process, veneer segregation

NAPIER GRASS COMPOSITE: A REVIEW

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ABSTRACT

Non-biodegradable plastic waste accumulation had become the principal source of several environmental concerns, wreaking havoc on the world's flora and wildlife. Numerous studies have been conducted on biopolymers derived from renewable resources, as they are one of the most promising materials that might potentially be used in place of petroleum-based polymers. Napier grass is prized for its excellent output, sturdy perennial nature, and insect resistance. Additionally, this perennial tropical grass has a flexible harvesting season and a great fiber reserve due to vegetative regrowth via stem cutting. Napier grass is discussed in this study as a natural fiber that may be utilized to fabricate reinforced polymer composites. Using a water retting technique, the raw material was removed as a single fiber strand. Numerous experiments have been conducted to evaluate the fiber's characteristics, including its chemical composition, physical and mechanical capabilities, and scanning electron microscopy (SEM). This review also focuses on the environmental characteristics of the fibers. In general, the fiber contain high amount of cellulose i.e 45 to 47% which is comparable to the other commonly used natural fiber. In terms of the performance, napier grass has has shown excellent characteristics as reinforcement in polymer matrix composites such as polyester. Significant improvement in the mechanical properties of the samples were reported. This improvement were further enhanced with alkaline treatment of the fiber. Overall, it can be conclude from this review that Napier grass is fairly comparable to other natural fibers currently utilized in the market. This paper was funded by RACER research grant (RACER/2019/FTKMP-Care/F00413).

Keywords: Napier grass; biocomposites

CELLULOSE NANOCOMPOSITE IN CONSTRUCTION APPROACH TOWARDS INNOVATIVE, SUSTAINABLE AND DURABLE FORMWORK

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ABSTRACT

Enormous challenges such as global demand for sustainability, shortage of skilled labour and safety controls facing the construction industries in developing countries including Malaysia had brought the attention on application of cellulose nanocomposite as formwork on commercial scale as replacing conventional formwork used in the construction areas. Formwork acted as an important part of concrete construction as it provides the mould in which an element is cast. Noteworthy improvements in formwork strength, durability and sustainability are being achieved with the appropriate use of nanotechnology advances techniques and driven mainly from government, institutions as well as academics and researchers working in the field. The addition of small amounts of nanomaterials has a substantial impact in the construction industry by improving the mechanical properties of cellulose nanocomposites. Even though there have been significant improvements in the properties of cellulose nanocomposite materials as they had been used widely in numerous engineering fields including construction fields as alternative of the conventional materials, but there is still insufficient knowledge on how these properties can further be improved with the usage of fully biodegradable, sustainable and more durable nanocomposite. This nanotechnology advancement is seems beneficial for formwork application of construction industries which brings significant impacts to the country's economy as well as environmental and social aspect of the country that would be more resilient in the near future.

Keywords: Cellulose, nanocomposite, construction, innovative, sustainable, durable

CONSTRUCTING A FRAMEWORK FOR SELECTING NATURAL FIBRE AS REINFORCEMENT COMPOSITES BASED ON GREY RELATIONAL ANALYSIS

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ABSTRACT

Material selection is crucial in product development, especially when material from a composites process application is involved. Numerous Multi-Criteria Decision-Making tools each have their own set of advantages and disadvantages. Using grey relational analysis (GRA), this research proposes a systematic framework evaluation approach for generating a sensible rank for material selection of natural fibre as reinforcement composites. The framework was created using the GRA technique, a robust evaluation tool that employs the grade of relation to determine the degree of similarity or difference between two sequences. The MCDM approach can be straightforward for the material selection problem. A GRA technique is used to investigate the performance of the potential material, which includes grey relational sequence creation, reference sequence definition, grey relational coefficient calculation, and grey relational grade determination. This framework is applied with a case study to identify the optimum natural fibre composite material for a bike helmet. End results revealed that pineapple is the best candidate for construction of safety gear (bike helmet). The best possible of evaluation model for material selection of the composite can be referred by design engineer in composite industry for a multiple application. Moreover, the proposed framework is an aid to help engineers and designers to choose most suitable material.

Keywords: Natural fibre–reinforced composites (NFRCs), Biocomposites Products, Grey Relational Analysis (GRA), Multiple Criteria Decision Making (MCDM)

AQUATIC FAUNA COMPOSITION AND THEIR ECOLOGICAL INTERACTIONS IN EUCALYPTUS AND OTHER FOREST PLANTATIONS

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ABSTRACT

Eucalyptus spp. And other commercial tree species are increasingly being planted worldwide as an alternative option to reduce direct timber extraction from natural forests. Establishing such planted forests with less complex habitat structure in a non-native country may lead to changes in the local biotic communities including aquatic life in these simplified habitats. Currently, there are scarce documentations on the response of native aquatic fauna to such habitat alteration and the potential impact associated with the terrestrial fauna. This paper provides a review on past studies that examined aquatic fauna composition in forest plantations with emphasis given on the associated ecological impact on the biotic communities in these habitats. The type of ecological interactions among aquatic fauna in the eucalypt plantations as well as potential habitat improvement measures are specifically discussed with case studies obtained from different countries.

Keywords: Aquatic life, macroinvertebrate, ecological interactions, Eucalyptus, habitat alteration.

RECENT DEVELOPMENT OF BIOMASS AND PLASTIC WASTE DERIVED CHAR FILLED NATURAL STARCH BIOCOMPOSITE BRIQUETTES

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ABSTRACT

Biomass and plastic wastes which produced from various sources including agricultural, industrial and domestic activities had created a chronic situation towards environmental health. The recycling of these wastes by mean of transforming it into carbon-based product via thermal decomposition approach is one solution for the environmental pollution problem. The production of carbonaceous materials could be utilized into several applications. Plus, eliminate the contaminants. Some applications require carbonaceous materials with high mechanical strength, high porosity degree and better adsorption characteristics. Carbon-based products are the conformed to a procedure involving blending and pressing of char with adhesive materials in order to form char pellets or briquettes. In addition, the impact of adhesive materials on the mechanical and surface properties as well as combustion properties of biocomposite briquettes was studied and compared with different previous works. This review discusses the recent developments of char filled natural starch biocomposite briquettes derived from biomass and plastic waste.

THE EFFECT OF BAMBOO AGES ON THE TENSILE PROPERTIES FOR TEXTILE APPLICATION: A REVIEW

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ABSTRACT

Bamboo has been widely recognized for various applications. Apart from being used in engineered products, bamboo can be extracted in fibres form for textile and polymer reinforcement. Tensile properties are one of the important characteristics in textile materials. This paper reviews the properties and focuses mainly on the tensile properties of bamboo at various ages. The tensile properties of bamboo species are comparable with bast and other fibres. Bamboo age has been focussed since the properties of bamboo are influenced by age, whereas young bamboo was stated to be more suitable for textile. This review also involves several extraction methods used, the morphology and current use of bamboo fibres especially in textile application.

Keywords: Bamboo, age, tensile, textile application.

DURIAN RIND AS AN ALTERNATIVE NON-WOOD BASED RESOURCE FOR PULPING AND PAPERMAKING: A REVIEW

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ABSTRACT

Over the years, various types of non-wood based raw materials for pulping and papermaking have been widely utilised globally to reduce the dependent on wood based materials and overcome the resources shortage. However, durian rind (DR) or so called husk, skin, shell, hides and peel has hardly been investigated as a pulping and papermaking material. DR which has usually been disposed as an agricultural waste is natural, renewable, and biodegradable. Thus, DR suitability as a pulping and papermaking resource is reviewed in this study based on its resource availability, current applications, fibre characterisation, material preparation, pulping process and also pulp and paper characteristics reported by previous studies. DR is available in huge volumes as a waste in top commercial durian producer countries such as Thailand, Malaysia and Indonesia. DR is widely investigated as a raw material for activated carbon, bio-briquette, bio-composites, particle boards, thermal insulation, light weight construction material, adsorbent material, compost, textiles and also pharmaceuticals products. In papermaking and packaging, some researchers utilised durian rind to produce handmade paper products, magnetic composites sheets, bio-plates, biodegradable cellulose film, carboxymethyl cellulose film and antioxidant packaging material. Natural and oven drying method is usually used to prepare durian rind raw material. In fibre characterisation review, DR indicates suitable chemical properties, fibre morphology and characteristics as a pulping and papermaking material. Chemi-mechanical and Soda pulping method has been successfully employed in producing DR pulp. Durian pulp and paper produced in previous studies also have promising physical, mechanical and optical characteristics. In conclusion, this review reveals that DR has a good potential as pulping and papermaking alternative resource. Therefore, Malaysia as one of the top durian producer and exporter should utilise its abundance of durian rind waste in producing alternative non-wood based pulping and papermaking material.

Keywords: Durian, Durian Rind, Pulping, Papermaking, Packaging

SIMULATION OF WOOD POLYMER COMPOSITES USING SUSTAINABLE RAW MATERIALS

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ABSTRACT

Wood particles and their composites gained massive popularity due to the plastic waste generated from single-use plastics. More recently, the application of wood polymer composites in the construction industry has rapidly increased mainly due to low handling costs and being an environmentally friendly material. Additionally, there was a significant concern about the wood waste generated from demolition and construction. Thus, researchers looking into aspects using recyclable wood and recyclable plastics as future construction materials. The tensile and bending properties of the wood polymer composites were experimentally studied but limited in simulation. Thus, a finite element analysis (FEA) strategy for predicting the mechanical strength of recycled wood polymer composite (r-WPC) with stacked up layers was developed in this study. The expected strength properties were validated using experimental data. The developed model of r-WPC successfully predicted the tensile strength, fracture strength and major failure nodes. The FEA results agreed well with experimental results regarding the load and displacement response and ultimate strength capacity.

Keywords: WPCs, ANSYS, Finite element analysis, stress, strain, simulation

THE INFLUENCE OF AGAR ON THE MOISTURE CONTENT OF THERMOPLASTIC SAGO STARCH

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ABSTRACT

The need to reduce the environmental effect of conventional plastics has prompted development into biodegradable and green materials. One of the most promising materials with the most economic potential is thermoplastic starch, which can be produced using conventional techniques and a plasticizer. However, pure thermoplastic starch has a number of shortcomings in practice. Thus, the characteristics of thermoplastic sago starch in the presence of agar were investigated. The samples for this investigation were produced by dry mixing the mixes (sago: glycerol: agar). The percentage of agar was differentiated between 0 and 15% by weight. The mixtures were moulded and subjected to 30 minutes of hot pressing at 158oC. The moisture content of 3 mm thick samples was determined. The results indicate that adding agar to thermoplastic sago starch has a substantial effect on the moisture content. The thermoplastics' moisture content was elevated from 12.04 % to 14.02 % as the agar ratio increased. In a nutshell, this study aids in determining the optimal processing conditions for formulating and developing thermoplastics with improved characteristics. This paper was funded by RACER research grant (RACER/2019/FTKMP-Care/F00413).

Keywords: Thermoplastic, sago starch, agar, biopolymer.

THE EFFECT OF CHEMICAL AND HIGH PRESSURE HOMOGENIZATION TREATMENT CONDITIONS ON THE MORPHOLOGY OF NANOCELLULOSE

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ABSTRACT

Nanocellulose were fabricated from microcrystalline cellulose (MCC) through combined acid hydrolysis with sulfuric and hydrochloric acids and high-pressure homogenization. The effect of acid-to-MCC ratio and number of high-pressure homogenizations passes on nanoparticle morphology was investigated. The MCC were treated with different concentrations of sulphuric acid (5% to 25%) through the hydrolysis process. From the Scanning Electron Microscopy (SEM) micrograph, the diameter of the acid treated MCC fibres had highly decreased to around 8 µm while the length of the fibres is shortened to several microns compared to untreated fibres. The suspensions of MCC were passed through a high-pressure homogenizer at a constant pressure of 800 bar with passing times of 10, 20 and 30 cycles. After 30 cycles, the final suspension of nanocellulose (NC) became cloudy. This was a visual indication that the particles were converted to smaller sizes and were less entangled. Field Emission Scanning Electron Microscopy (FESEM) results showed that the particle size of nanocellulose ranged between 18 to 20 nm. Thus, the combination of sulphuric acid hydrolysis and high-pressure homogenization processes could be utilized as an effective chemo-mechanical process for nanocellulose production from various cellulosic sources.

Keywords: empty fruit bunch fibre, microcrystalline cellulose, nano cellulose, acid hydrolysis, high pressure homogenizer.

OPTIMIZATION OF WET DISC MILLING PROCESSING CONDITIONS FOR MINIMIZING THE ENERGY CONSUMPTION DURING CELLULOSE NANOFIBRILS PRODUCTION FROM CELLULOSE WITH HIGH DEGREE OF POLYMERIZATION

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ABSTRACT

Wet disc milling (WDM) is one of the mechanical processing methods commonly used for cellulose nanofibrils production. As in any mechanical processing methods, WDM utilizes high energy during CNF production. The energy-intense processing is related to the power required to break the substantial number of intermolecular and intramolecular hydrogen bonds in the cellulose. In the case of WDM of cellulose with high degree of polymerization (DP), there is a need to optimize the processing conditions in order to minimize the energy requirement. In this study, oil palm empty fruit bunch (OPEFB) cellulose with DP of 2900 was used. Process optimization involved the manipulation of the rotational speed (rpm), number of cycles and the concentration of the cellulose. Results showed that the lowest energy consumption was 34.2 kWh/kg, which was obtained when the mechanical fibrillation was conducted at 2100 rpm for 20 cycles, at cellulose concentration of 4 wt%. The difference in the energy consumption was 62% lower as compared to the baseline study (90 kWh/kg) conducted at 1800 rpm and 20 cycles, with 2 wt% cellulose. FE-SEM micrographs showed that complete nanofibrillation (100% CNFs with <100nm width) occurred at 20 cycles. Comparison with our previous data which used OPEFB cellulose with lower DP (DP = 1400), processed at two different conditions; 1800 rpm, 20 cycles and 2 wt% cellulose, and 1800 rpm, 20 cycles and 4 wt% cellulose showed the correlation between the energy required and DP, in which the energy recorded were 61 and 48 kWh/kg, respectively. The results indicate that the cellulose DP is indeed affecting the energy requirement during CNF production, and manipulation of processing parameters particularly the rotational speed and cellulose concentration is important in reducing the energy consumption.

Keywords: Cellulose nanofibrils, degree of polymerization, wet disc milling, energy consumption, oil palm empty fruit bunch.

BOND-SLIP MODEL OF BAMBOO IN CEMENTITIOUS MATERIAL: A REVIEW

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ABSTRACT

Bamboo is perceived as a green, sustainable and seemingly promising construction material. However, its use as reinforcement (partial replacement of steel) in concrete shows some uncertainties. For examples, the ultimate strength of bamboo is only about half of the yield strength of steel rebar, most of the bamboo has no apparent ductility behaviour, and the deterioration of the bamboo surface may not guarantee good bonding strength with cementitious materials. It is noted that bamboo readily absorbs water and swells significantly during concrete curing, leading to voids forming after the concrete dries. The void will significantly reduce the bonding strength between the bamboo and concrete, which leads to slips and bonding failures. Moreover, the alkali condition in concrete leads to a chemical reaction where lignin and hemicellulose phases of the bamboo are dissolved, resulting in a weaker fibre structure. The unfavourable environment in the cementitious material may further affect the bond properties of bamboo. Recognising the potential setbacks of the bonding strength of bamboo in cementitious material, it is essential to quantify the bond-slip model. Hence, this paper first reviews the bond properties of bamboo, which include untreated and chemically treated bamboo surfaces. Then, bond-slip models are reviewed and summarised based on past experiments collected in the literature. The bond-slip model is useful for numerical analysis in using bamboo to partially replace steel in concrete.

EFFECT OF PLASTICIZER TYPES AND CONCENTRATIONS ON PHYSICAL AND MECHANICAL PROPERTIES OF PLANT BASED NANOCELLULOSE/STARCH BIOCOMPOSITE FILMS INCORPORATED WITH ESSENTIAL OIL: A REVIEW

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ABSTRACT

Bionanocomposite films mostly were developed using glycerol (G), sorbitol (S) or their combination (GS) as plasticizers at the variety of ratio incorporated with essential oil (EO) using solution casting technique and dry processing technique (hot pressing) to create biodegradable film for plastic application. The addition of plasticizers to composite film-forming solutions helped to overcome the brittle and fragile nature of unplasticized composite films. Increased plasticizer concentration resulted to an increase in film thickness and moisture content. In contrast, density of plasticized films decreased with increasing plasticizer concentration. Raising the plasticizer content showed less effect on the moisture content of S-plasticized films. Films containing glycerol and glycerol-sorbitol plasticizer (G, and GS) demonstrated higher moisture content compared to S-plasticized films. The results obtained in this study showed that plasticizer type and concentration significantly improves film properties and enhances their suitability for food packaging applications.

Keywords: Plasticizer types; plasticizer concentrations; Cinnamon essential oil; sugar palm starch; bionanocomposites; mechanical properties; physical properties.

A REVIEW OF THE RECENT DEVELOPMENTS IN NATURAL FIBRES REINFORCED BIOCOMPOSITE IN STRUCTURE AND DEFENCE TECHNOLOGY

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ABSTRACT

The present review deals with recent advances of various natural fibres nanocomposites. The enhanced natural fibre reinforced polymer composites consist, depending on their applications, of thermoplastic or thermoset matrix. In many applications, the coupling of natural fibres such as kenaf, bamboo, aramid, flax and jute fibres, with over two fibres hybrid biocomposite, boosts the potential utilization of the fibres in structure and defence technology. Natural fibres are well-known by their disadvantages of lack of thermal stability, deterioration of strength, water absorption and poor impact qualities, thus, hybridizations promote improved biocomposites performance. Hybridization of natural/synthetic fibre or natural/natural fibre produced hybrid composites of comparable strength, rigidity, weight strength ratio, resistance and other physical and mechanical characteristics. In natural fibre reinforced composites the selection of matrix materials also plays a significant role. The usage of natural fibre hybrid composites in industries of structure and defence technology will rise. We review the literature studies on natural fibre reinforced composites and biocomposites. This review addresses the matrix types employed, the processes employed in hybrid composites manufacture and the prospective application of hybrid composites especially in structure and defence technology.

BIBLIOMETRIC STUDY ON DURABILITY OF BAMBOO LITERATURE 2011-2021

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ABSTRACT

Bamboo is a fast-growth and resilient material used as raw material for construction. However, bamboo application is limited by their susceptibility towards degradation by wood borers, termites and decay fungi that may cause severe damage to bamboo's mechanical strength. Long-term exposure to outdoor condition also contributed to the decreasing of strength properties of bamboo. This study aimed to analyse and access literature published in the topic of bamboo durability and protection to biodegradation and outdoor condition. Scopus was used to retrieve literature related to bamboo durability from 2011 to present (July 2021). The analysis covers the growth of literature, degree of collaboration, authorship pattern, top cited articles and other relevant criteria. The presented data will serve to help direct future research in promoting bamboo as a viable construction material.

Keywords: Bibliometric, bamboo, durability, decay, insects, weathering

MECHANICAL PERFORMANCE AND MODES OF FAILURE OF CROSS LAMINATED TIMBER (CLT) MANUFACTURED FROM TROPICAL HARDWOODS SPECIES

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ABSTRACT

The study on the mechanical properties of cross laminated timber (CLT) panels made from tropical hardwood species is essential in order to promote the use of CLT as building material in Malaysia. The objective of this study was to evaluate the mechanical performance and modes of failure of CLT fabricated from tropical timbers species namely batai *(Paraserianthes falcataria)*, sesendok *(Endospermum malacensis)*, rubberwood *(Hevea brasiliensis)* and kedondong *(Burceraceae sp)*. The modulus of rupture (MOR), modulus of elasticity (MOE), and compressive strength were determined. The modes of failure of each samples was visually examined and recorded. The results indicated that CLT made from kedondong (KKK) had the highest value of MOR (82.63 N/mm2) and MOE (11371.33 N/mm2) compared to other species. For compressive strength, CLT made from kedondong (KKK) and rubberwood (RRR) were not significantly different. The modes of failure observed from bending test were tension, rolling shear and glue-line failure while the crushing, shearing and splitting failure were found during compression test. Based on the results obtained, it showed that, the tropical hardwood is suitable to be used as raw material to produce CLT. However, more study should be conducted to observe the performance of CLT on durability and outdoor weathering.

Keywords: cross-laminated timber, tropical hardwoods, mechanical performance, modes of failure

RECOVERY AND PHYSICOCHEMICAL CHARACTERISATION OF CELLULOSE DERIVED FROM OIL PALM EMPTY FRUIT BUNCHES

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ABSTRACT

High-value products such as cellulose can be derived from agro-industrial lignocellulosic residues, for instance, oil palm empty fruit bunch (OPEFB) fibres whose presence is underutilised and mostly discarded. An estimated 24% of the fresh fruit bunches processed during palm oil extraction are OPEFB, which contain higher amount of cellulose (44 wt.%) than other similar resources such as rice husk (35 wt.%) and bamboo cane (41 wt.%). Therefore, this work aims to extract cellulose from EFB fibres based on ASTM standard method D1103-60 to create value and minimise the environmental impact during disposal. In this study, the extracted cellulose (OPEFBC) was compared with commercial cellulose (CC) in terms of morphological structure, functional groups, thermal stability, crystallinity and aromaticityviascanningelectronmicroscopy-energydispersiveX-ray(SEM-EDX),Fourier-transforminfrared spectroscopy (FTIR), thermogravimetric analyser (TGA), X-ray diffraction (XRD), and Raman spectroscopy. The maximum recoverable EFBC yield was 36.4 ± 0.3 wt.% (dry basis). Both the SEM images of OPEFBC and CC were similar with a separated distribution of fibrillar and smoother surfaces for the former, thereby suggesting that a substantial amount of hemicelluloses and lignin had been removed from EFB. This was further supported by the EDX spectra, which displayed only carbon and oxygen. The absence of FTIR adsorption bands for ester linkage of the carboxyl groups of lignin (1248 cm−1) and C–O stretching vibration at 1722 cm−1 and 1533 cm−1, which corresponds to acetyl and ester groups of hemicelluloses demonstrated effective removal of non-cellulosic components, in both OPEFBC and CC. TGA showed that thermal decomposition of OPEFBC and CC took place at 301.7°C and 327.6°C, respectively, with a single derivative weight loss curve that implied high purity of both the celluloses. The XRD crystallinity index for both OPEFBC (66.6%) and CC (59.1%) was greater than 50%, thus signifying the distinctive characteristic of an amorphous material. The crystallite size of OPEFBC and CC at (110) plane was recorded at 0.0220 nm and 0.0515 nm, respectively. The aromaticity of celluloses, as verified via Raman analysis, showed that the intensity for both OPEFBC (350.9 cm-1 and 1094.6 cm-1) and CC (377.2 cm-1 and 1094.4 cm-1) were recorded at 347.15 a.u. and 420.2 a.u (OPEFBC) and 1032.2 a.u. and 1766.6 a.u. (CC)., respectively. In summary, this study has successfully extracted OPEFBC whose properties are comparable to that of the CC, in providing value to the underutilised OPEFB for example potential application as a raw material for paper and biocomposites production as well as it can be re-used and recycled.

Keywords: Biomass, cellulose, empty fruit bunch, lignocellulosic, oil palm

THERMAL AND FIRE SMOKE TOXICITY BEHAVIOUR OF HYBRID PALF/GLASS/ CARBON IN JATROPHA BLENDED BIO-EPOXY

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ABSTRACT

Recently, nanocellulose such as pineapple fiber had becoming popular in composite material area as it promotes sustainable process and products. Due to its diversity of the plant itself, such as origin of seeds, condition and treatment during cultivation, and process of obtaining the fiber vary, its properties also vary greatly. In this presentation, unbleached cellulose fiber which is pineapple leaf fiber was hybridized with carbon and glass fiber and sandwiched with aramid honeycomb core for the purpose of mimicking the floor panel of an commercial aircraft. The matrix used was blended jatropha bio-epoxy at 25 wt.% and fully synthetic epoxy as control specimen. When palf was arranged as middle layer in the sandwich skin composite, it was revealed improvements in thermal properties such as viscoelastic properties, higher peak of loss modulus, and better damping factor. However the Jatropha bio-epoxy in the matrix led to decrement of glass transition temperature. As for the fire response, jatropha bio-epoxy had successfully lowered the heat released of the composite and maintained without ignition up to 555 s at 25 kW/m2 heat flux. On the other hand, palf led the composite becoming more combustible product in which it released higher heat released rate and faster to be ignited, 210 s for with spark and 75 s for without spark set up. For the smoke and toxicity behaviour, incorporating palf and Jatropha blended bio-epoxy led to significance improvement on the smoke toxicity.

THERMO-PHYSICO-MECHANICAL PROPERTIES OF CHEMICALLY MODIFIED KENAF/PP NONWOVEN COMPOSITE WITH PVA UREA/SILANE

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ABSTRACT

Kenaf fibre demonstrates enormous potential as the reinforcement in polypropylene (PP) nonwoven composite with excellent performance and environmental benefits. In this work, kenaf fibre was chemically modified to increase the mechanical, thermal, and physical properties of the kenaf PP nonwoven composite (KPNC) by a practical method for industrial applications. The polyvinyl alcohol (PVA), silane, urea, and combination of PVA/silane, PVA/urea, and 5% wt of silane/urea were used during the chemical treatment. The combination of PVA/urea treatment was proven to significantly improve the mechanical, thermal, and water absorption of KPNC. From SEM images, the chemically modified KPNC showed an improvement on interfacial bonding between kenaf and PP. The suggested treatment method in this study possesses a great potential in producing high performance composite for many industrial applications.

Keywords: Textile composite, Surface modification, TGA, Water absorption

FLEXURAL ANALYSIS OF HEMP AND KENAF WITH GLASS HYBRID FIBRE LAMINATES FILLED POLYESTER RESIN

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ABSTRACT

Fibre-reinforced composites are well known in opening great material potential used in structural applications. But there are still some drawbacks especially low toughness, therefore, the fibre hybridisation is a promising method used to toughen it. The use of natural fibres in hybrid composites, on the other hand, makes the structure more cost-effective as well as environmentally friendly. In this study, two different natural fibre; Hemp and Kenaf was used along with glass (woven and chopped strand mat) fibre involving polyester resin as a matrix. The influence of hybridization of Hemp and Kenaf on glass fibre reinforced polymer composites has been assessed in term of different core material, core thickness and fibre arrangement. Twelve systems of composites specimens were prepared using hand lay-up techniques which then subjected to flexural test according to ASTM D7264. The results indicates that hybrid Kenaf/glass fibre exhibits better flexural modulus and strength up to 12.87Gpa and 160.17Mpa, respectively compared to Hemp/glass fibre for varies laminate plies evaluated on different parameters. Nevertheless, when it comes to excellent composites influenced by the hybridization, the glass (chopped strand mat) fibre shows better results among other hybrid composites. The fibre orientation of chopped strand mat restricted matrix mobility chain movement, causing hybrid glass composites to toughen better in fibre-matrix bonding.

Keywords: Composites, flexural properties, Hemp, Kenaf, glass fibre, polyester resin, hybridization

CHARACTERISTICS OF UNBLEACHED OIL PALM EMPTY FRUIT BUNCH PAPER INCORPORATED WITH LIGNOCELLULOSE NANOFIBRILS

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ABSTRACT

Cellulose nanofibrils (CNF) have been utilized as an additive in papermaking, with the aim to enhance the mechanical properties of the paper. The large surface area of CNF and the high presence of hydroxyl groups on its surface promotes the interconnectivity between adjacent fibers through hydrogen bonding and, hence, improved mechanical properties. Nevertheless, this has caused the drainage times of the papermaking process to increase. Nearly all CNF are produced from fully bleached pulp materials. Therefore, using lignin-containing cellulose nanofibrils (LCNF) as an additive in unbleached paper from Oil Palm Empty Fruit Bunch (OPEFB) has arisen motivation in this study. This study focuses on the effect of LCNF on the drainage times of papermaking and paper properties. For this purpose, four concentrations of LCNF were used (1, 2, 4, and 8 wt.%), and the data were compared with that of CNF paper. The drainage times results demonstrated that with the incorporation of LCNF, the duration for the water to drain was faster than the CNF. However, the mechanical properties of paper such as tensile index, burst index, and tear index showed that CNF had better in the paper's mechanical strength, respectively. The optical properties results showed that the LCNF paper was lower in brightness than the CNF paper due to the presence of the chromophoric group of the residual lignin. Therefore, it can be concluded that by using LCNF, the bleaching process could be removed and improve the drainage times compared to CNF. However, the mechanical properties of the paper were improved by CNF.

Keywords: Lignocellulose nanofibrils, Oil palm empty fruit bunch (OPEFB), Mechanical properties, Drainage times, Composite paper.

OVERVIEW OF FIBRE ASH SYNTHESIS AND CHARACTERIZATION FOR INDUSTRIAL APPLICATIONS

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ABSTRACT

Fibre is a typical agro-waste that is generally common in large quantities and, if not properly harnessed, can pollute the environment. To avoid environmental damage, it is necessary to use these environmentally friendly and cost-effective agro-waste fibres. The chemical and morphological features of the fibres are assessed after they are transformed to ash by a carbonization procedure. Glass manufacture, reinforcement material in aluminium matrix, electronic chips, biopolymer, energy storage, and medication delivery are just a few of the applications for silica, which is a key ingredient of fibre ash. This article aimed at reviewing the processing and characterization of fibre ash for industrial application and to minimize environmental pollution.

Keywords: Environmental pollution, fibre ash, morphology, silica, synthesis.

INFLUENCE OF STACKING SEQUENCE AND HYBRIDIZATION ON THE TENSILE PROPERTIES OF GLASS, HEMP AND KENAF COMPOSITES

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ABSTRACT

Natural fibre reinforced polymer composites have potential to be utilized at various applications due to their non-hazardous to the environment, biodegradable properties as well as enhanced mechanical characteristics. Nevertheless, mechanical properties of these composites are complicated to understand and predicted due to complex interaction between matrix and different fibres and fabrication process parameters. This paper aims to study the effect of varied core, core thickness as well as fibre arrangements on mechanical behaviour of natural fibre reinforced polymer hybrid composites under tensile test. Samples were prepared through combinations of hand lay-up and vacuum methods, both commonly employed techniques in industry. Analysis was conducted using tensile test based on tensile modulus, tensile strength, and tensile strain. The results show a better tensile behaviour for Kenaf hybrid composites at different core and core thickness, while Hemp shows better behaviour based on fibre arrangement. The findings are important for natural/synthetic fibre reinforced polymer hybrid composites potential applications such as in the field of automobiles, aviation, military, biomedical, infrastructure, and transportation, and thus this study has substantially provided new understanding.

Keywords: Hemp, Kenaf, Tensile properties, Hybridization, Stacking sequence.

PHYSIOCHEMICAL, MORPHOLOGICAL AND THERMAL ANALYSIS OF MICROCRYSTALLINE CELLULOSE EXTRACTED FROM OIL PALM EMPTY FRUIT BUNCH USING DIFFERENT DELIGNIFICATION APPROACHED

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ABSTRACT

The past decades have seen the rapid development of microcrystalline cellulose (MCC) in many areas due to its renewability, physical and chemical properties. Previous studies have reported that MCC can be fabricated from lignocelluloses materials by using different approaches. However, to date, there is no report dealt on the effect of different pretreatment on the final product of MCC from oil palm empty fruit bunch (OPEFB). Thus, the major objective of this study is to evaluate the effect of two main delignification processes which are acidified chlorite (NaClO2) and total chlorine free (TCF) on the properties of MCC produced from OPEFB. Two different delignification processes are carried out to isolate pure cellulose from OPEFB. Following this, MCC particles have been produced via acid hydrolysis of all cellulose produced. Then, all the MCC produced were characterized using X-ray diffraction (XRD), scanning electron microscopy (SEM), and thermogravimetry (TGA). From XRD analysis, it is indicated that all MCC belongs to cellulose type 1 and OPEFB-NaClO2-MCC showed a high crystallinity index than OPEFB-TCF-MCC. All MCC samples showed a higher decomposition temperature compared to those pure cellulose under TGA analysis. But, OPEFB-NaClO2- MCC showed better thermal stability than OPEFB-TCF-MCC. SEM images also clearly demonstrated that the different MCC particle shows rough surface and micro-sized particle. All the result suggests that the obtained MCC samples display comparable properties with those of commercial MCC. As a conclusion, MCC produced from OPEFB using NaClO2 delignification method displayed better features in thermal stability, higher crystallinity index and with smaller micronized structure which makes it a promising candidate to prepare high-value products compared to the MCC produced using TCF delignification treatment.

Keywords: Oil palm empty fruit bunch, Microcrystalline cellulose, delignification acidified chlorite, total chlorine free

A REVIEW ON DEGRADATION OF BIOPOLYMER COMPOSITES IN LIQUID ENVIRONMENTS

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ABSTRACT

Most biopolymer such as poly (lactic acid) (PLA), polybutylene succinate (PBS), polyhydroxyalkanoates (PHA) and polycaprolactone (PCL) can be degraded in composting environment conditions. However, improper management of waste especially short shelf-life plastics end up in the landfill and water bodies (sea, lake, river, pond). PLA and PBS does not degrade in seawater, thus natural fibres and water-soluble biopolymers are often incorporate to promote moisture retention for microbial organism inhabitation. PLA/starch (60:40) experienced 9.5% of weight lost incubated in laboratory set up seawater tank for six months. PLA/starch/gelatin/CaCO3 demonstrated significant weight lost within 4 weeks while PLA/starch/CaCO3 has slow degradation rate up until 4 months in seawater. Meanwhile, PCL shows a complete degradation within 56 days. At 28 weeks of incubation period in microorganisms filled water, PCL/starch showed highest weight loss (15.5%) followed by unmodified PCL (8.5%) and PCL/CaCO3 (6.6%). PLA/flax (70:30) experienced higher mechanical degradation at higher temperature for 90 days of immersion in seawater.

Keywords: Biopolymer composites, natural fibre, starch, seawater degradation.

FIBER REINFORCED POLYLACTIC ACID (PLA) HYBRIDCOMPOSITES: A REVIEW

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ABSTRACT

Polylactic acid (PLA) has gained much interest since it is an environmental-friendly and biodegradable polymer. Most researchers have used it as a research material due to its favourable properties at competitive prices. Polylactic acid (PLA) is compatible with both natural and synthetic fibres. Natural fibres are abundantly available in nature and frequently used as reinforcement for polymer composites. The growing environmental concern, depletion of fuel-based polymers and stringent environmental regulations has prompted researchers and industries to search for natural-based materials. Extensive attempts have been carried out for the past few years in developing composites to fulfil the demands. The demand for high-performance materials is globally increasing due to the advancement of technology in the manufacturing sector. However, hybridizing fibres between natural fibres/natural fibres and natural fibres/synthetic fibres for composite manufacturing has offered its own set of advantages. The use of natural fibres only in hybrid composite fabrication can sometimes be unsuitable for some products, making the natural fibres are combined with synthetic fibres to enhance the properties of the composites. The current research trend is to produce a new class of material combining different fibres as reinforcement for polylactic acid (PLA). The brief review aims to provide a summary of various fibre reinforced polylactic acid (PLA) hybrid composites and their properties.

Keywords: Hybrid composites, polylactic acid (PLA), natural fibres, mechanical Properties.

SIMULATED FRAMEWORK AS FEEDER DATA FOR BIOMASS MANAGEMENT ANALYTICS

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ABSTRACT

Countless investigations on biomass management and processing for product development or smart direct applications are available in the publication database. Among these are publicised in accessible journals, pay-per-view journals, patents, works partially accessible and masterpieces that are inaccessible. This study aims to simulate frameworks that can potentially serve as feed data for the development of biomass management analytics. The chosen scopes cover two of the abundant biomass in Malaysia; the rice bagasse (RB) and the oil palm empty fruit bunches (EFB). Process-Product-Cost (PPC) triangulation is demonstrated for rice bagasse while and feedstock Form-Process-Product (FPP) triangulation is proposed for EFB. These triangulation processes are the mechanisms driving the decision-making process. The primary role of the proposed big data analytics (BDA) is to be an efficient reference system for farmers, plantation managers and venture capitalists to make sound selection of product to develop from a specific biomass based on process economy and environmental impact. BDA on biomass management supports quick and sustainable decision-making process mainly by ruling out the needs to go through the vast wealth of scientific literature. The frameworks in focus demonstrate how the scientific principles underpinning a process affects decision-making via analytics. The findings serve as a gateway for a futuristic industrial and agro-based decisions that promise a sustainable operation of the manufacturing sector.

Keywords: Biomass, Sustainable management, Zero-waste, Analytics.

THE EFFECTS OF LAYERING SEQUENCES ON FLEXURAL PROPERTIES OF KENAF/GLASS HYBRID COMPOSITES FOR BUS BUMPER APPLICATION

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ABSTRACT

Demand on natural fibre to be utilized as the reinforcing material has been increased especially in automotive sector. However, the limitation of natural fibre composite in the development of bus bumper material is to resists the bending force. Hence, the addition of synthetic fibre was introduced to the composite to enhance the flexural properties of the composite. This research explores the layering sequences of the woven kenaf (K) and woven glass (G) fibre with a thin layer of gelcoat at one side of the outermost layer part of the composites. The composites reinforced unsaturated polyester were prepared in three different layering sequences which were glass/kenaf/glass hybrid (GKG), glass/kenaf/kenaf hybrid (GKK), and kenaf/kenaf/kenaf composites (KKK), by using hand lay-up technique. Three-point bending test were conducted to evaluate the flexural properties of the composites. From the data obtained, due to the layer of glass fibre was located at both of the outermost layer of the hybrid composite, GKG recorded the flexural strength and flexural modulus as 183 MPa and 7.65 GPa, respectively, which were the highest values compared to other composites. The stress – strain results presented the higher results for all composites when the gelcoat located at the bottom side compared to gelcoat located at the top side of the composites. This indicated that that gelcoat helps to resist the tensile failure when bending force was applied. The observation through the microscopic analysis showed that all the composites experienced severe failure such as fibre breakage and matrix crack at the tensile side compared to the compression side. Based on the findings, GKG has potential to be develop as the material for bus bumper.

Keywords: Kenaf fibre, glass fibre, hand lay-up, hybrid composite, flexural

DESCRIPTIVE STUDY OF ARROWROOT *(MARANTA ARUNDINACEA)* BASED BIOCOMPOSITES

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ABSTRACT

The rising worldwide concern for environmental preservation has driven the search for alternatives to conventional polymers derived from fossil fuels. Natural fibers and biopolymers have attracted the attention of scientists and industries due to their ecologically friendly and sustainable properties. Materials that are environmentally friendly are biodegradable, safer, non-toxic, lightweight, inexpensive, and widely available. Arrowroot is a multipurpose plant that is planted in tropical regions and is considered to be a potential source of natural fibers and biopolymer. Arrowroot starch has a high amylose concentration (~35.20 %), making it appropriate for improved film production. To increase their attributes, arrowroot starch can be blended, plasticized with other polymers, or reinforced with fibers. The current study focuses on recent research on the characteristics of arrowroot fibers and starch, as well as their application in biocomposites.

Keywords: Arrowroot, mechanical property, thermal property, physical property, biopolymer, biocomposites

FATIGUE LIFE ESTIMATION OF RICE HUSK FIBRE REINFORCED POLYPROPYLENE COMPOSITE BY EQUIVALENT INITIAL FLAWS CONCEPT

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ABSTRACT

In the industry, an engineering approach to determining the fatigue life of fibre reinforced polymer composite material is required due to overcoming the numerous aspects in the damage mechanism of components. This paper presents a fatigue life estimation considering the equivalent initial flaw size (EIFS) on rice husk fibre reinforced polypropylene composite specimen and the effect of different stress ratios for R=0.1, 0.3 and 0.5. Constant amplitude for loads *S80, S85* and *S95* were carried out for the CT specimens to determine the Paris parameters. As a result, the S-N curve may be used to describe a comparison between estimated and measured life, which may then be used to predict structural fatigue life. It has been demonstrated that the validation shows good agreement between the experimental and calculated fatigue life which the model gives a coefficient of determination, *R2* in the range of 0.92 to 0.99 and root mean square logarithm error *ERMSLE* give minimal error between 1.7% to 2.4% for all stress ratios.

Keywords: Crack growth; fatigue; fibre-reinforced composite; fracture; life prediction

FATIGUE LIFE OF NATURAL FIBRE REINFORCED POLYMER COMPOSITES: A REVIEW

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ABSTRACT

The rising environmental concerns caused by petroleum-based plastics used today highlight the need to produce environmentally friendly bioplastics to protect our ecosystem. To meet this need, research on natural fibre reinforced polymer composites has been conducted over the last decade. Besides the numerous advantages of natural fibre reinforced polymer composites, the range of applications for natural fibre composites in engineering design is still constrained, owing in part to a lack of knowledge of these materials' long-term behavior, particularly under cyclic (fatigue) stress. The purpose of this review is to determine the fatigue life of a natural fibre-reinforced polymer composite. Because the fatigue property of material can define its nature under cyclic stress. Fatigue is a widespread phenomenon in most engineering materials that refers to microstructural damage and failure induced by applied cyclic loads or stresses. The SN curve of various bio-based composite help as to understand the fatigue life cycle of natural fibre. The fatigue life of hemp-fibre–reinforced High-Density Polyethylene, jute fibre vinyl ester resin matrix, sisal fibre-reinforced composites, wood flour/ high-density polyethylene composites, natural fibre reinforced thermoplastic composites in dry and wet environments, and natural fibre thermoplastic composites are reviewed in this paper. In contrast to metallic alloys or polymers, where failure is associated with the initiation and propagation of a dominant fracture event, composite failure is characterized by the accumulation of multiple damage modes, including (1) debonding between reinforcing fibres and the polymer matrix; (2) fibre failure; and (3) matrix failure.

Keywords: Natural fibre, Fatigue life, SN curve, Polymer composites, Biocomposites.

SOCIO-ECONOMIC IMPACT OF EUCALYPTUS PLANTATION: PERSPECTIVE OF LOCAL COMMUNITY IN SABAH, MALAYSIA

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ABSTRACT

Forest plantations continue to present themselves as an essential global forest resource. Forest plantation plays a significant role in influencing patterns of economic development and improving livelihoods. Not only does it houses flora and fauna, but it also has an impact on environmental, social and economic, which ultimately affects the local communities who live in the forest plantation area. *Eucalyptus* has shown its ability to grow rapidly and adaptability growing in a wide range of conditions. However, there has been a lack of current information on the impact of the Eucalyptus plantation from the local community perspective, especially issues concerning the socio-economic impact intended to benefit the local community. Thus, this study aims to examine the impact of local worker's employment in the Eucalyptus plantation company towards their capital dimensions (financial, human, natural, physical and social) and their livelihood in Malaysia. Using purposive sampling, a face-to-face interview was performed among 427 local community involved in the Eucalyptus plantation in Sabah. The results indicated that there were significant and positive relationships between the local workers' employment towards all the five capital dimensions and their livelihood. Understanding the impact of the Eucalyptus plantation helps in formulating a forestry establishment program that generates a win-win situation for both the company and the local community. Insight from this study may provide essential information that can be utilized to develop and manage rural landscape plantations and ensure sustainable human development in the community.

Keywords: Eucalyptus, Socio-economic, plantation, local community, impact

STRUCTURAL ANALYSIS AND THERMAL PROPERTIES OF NANOCRYSTALLINE CELLULOSE EXTRACTED FROM SEMANTAN AND BETING BAMBOO SPECIES

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ABSTRACT

Nanocrystalline cellulose (NCC) was successfully isolated from *Gigantochloa scortechinii* (Semantan) and *Gigantochloa levis* (Beting) bamboo fibers via sulphuric acid hydrolysis. Soda-AQ pulping and alkaline-peroxide bleaching were performed to remove the non-cellulosic materials from raw bamboo fiber. Bleached pulp was hydrolyzed in sulphuric acid (30%, v/v) for 3 h. Structural analysis and thermal properties of isolated NCC were carried out by Fourier Transform Infrared Spectroscopy (FT-IR), Thermogravimetric Analysis (TGA) and Differential Scanning Calorimetry (DSC), respectively. FT-IR proved the disappearance and alteration of some peaks in pulp and bleached pulp, thus confirmed the elimination of non-cellulosic materials from the raw fiber. Both TGA and DSC analysis explained that the isolated NCC exhibited good thermal stability. *Semantan* and *beting* are known to be among Malaysian commercial bamboo species. This study aims to determine the structural and thermal properties of NCC extracted from these two bamboo species, to further exploit their potential in related fields.

Keywords: *Gigantochloa scortechinii;* Gigantochloa levis; nanocrystalline cellulose; structural analysis; thermal properties

EFFECT OF BEESWAX ON THE DENSITY AND MOISTURE CONTENT BEHAVIOR OF THERMOPLASTIC CASSAVA STARCH

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ABSTRACT

Development of biobased polymer has been increasingly promoted due to environmental concerns of synthetic polymer. Cassava starch, for example, has acquired many attentions owing to its ability to be developed as thermoplastic cassava starch (TPCS) where it can be obtained in low cost, making it to be one of alternatives to substitute petroleum-based plastic. However, biopolymer made from starch are fragile with poor mechanical properties and hydrophilic in nature. In this study, an attempt was made to investigate density and moisture content properties of thermoplastic cassava starch blending with beeswax (TPCS-BW). The bio-composites were fabricated using hot moulding compression method in the range of beeswax loading from 0, 2.5, 5 to 10 wt %. The finding presents the addition of beeswax has slightly reduced the density of TPCS-BW from 1.30 g/cm3 to 1.11 g/cm3. Meanwhile, the moisture content shows reduction of moisture percentage from 5.51% to 3.11% as the beeswax loading is increasing which might beattributed to the beeswax's hydrophobic properties in improving water barrier of the TPCS-BW bio-composite. Overall, the functional properties of thermoplastic cassava starch show improvement when beeswax are added into the formulation to produce an eco-friendly composite for various applications. This paper was funded by RACER research grant (RACER/2019/FT-KMP-Care/F00413).

Keywords: Thermoplastic starch, beeswax, biopolymer, biocomposite.

THE EFFECT OF DIFFERENT CONCENTRATION OF SODIUM HYDROXIDE ON CARBOXYMETHYL CELLULOSE PROPERTIES

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ABSTRACT

Carboxymethyl cellulose (CMC) is a versatile polymer derived from cellulose, most common natural polymer. The source of cellulose can range from woods, cottons to even agriculture waste. CMC is important as its water soluble, where have been used in food industry, pharmaceutical, detergent, drugs, cosmetics, textile, paper and as well as oil drilling operation. A-Cellulose extracted from oil palm empty fruit bunch (OPEFB) was used as a raw material for the production of different grades of carboxymethyl cellulose (CMC). The objective in producing different grades of CMC is to diversify the applications in varieties products as mention earlier. The important parameter for the preparation of different quality and the grade of CMC is concentration of sodium hydroxide (NaOH) used during mercerization process. Presence of NaOH will enhanced the reactivity of cellulose towards chemical reaction with monochloroacetic acid (MCAA). Preparation of CMC from cellulose was carried out by an etherification process, using different concentration of NaOH (25-40% v/v) and monochloroacetic acid (MCAA), with isopropanol as the supporting medium. The properties of resulting CMC were determined according to ASTM D 1439-03. From results, the content of CMC moisture ranged from 8.27% to 13.45% while the purity of all CMC produced was 90% and above. In addition, the chemical structure of resulting CMC were found comparable to standard CMC based on FTIR spectra. Different concentration of NaOH tended to produce different CMC characteristics and properties. This palm based CMC has huge potential for future green-chemical demand since it is being produced from renewable resource and it is sustainable.

Keywords: Carboxymethyl cellulose (CMC), oil palm empty fruit bunch (OPEFB).

OIL PALM BIOMASS ENHANCED PRODUCT COMPATIBILITY FOR THE COVID-19 AFFECTED PACKAGING INDUSTRY

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ABSTRACT

Emergence of Covid-19 has uniquely affected the industrial practices Gravitated by the changing demand profiles and the supply chain, the North American pulp and paper industry successfully met the demands for products like sanitary and medical paper-based products largely enabled by the reduced feedstock cost from the use of sapwood residues from the construction industry. Australia shows an increase in the demand for paper packages. The latter was principally moved by the hike in online purchase and remote activities that has set the work-from-home trend since the onset of the pandemic, foreseeing also the hype in the demand for inkjet printing tool and compatibility. The scenario shifts our research activities from looking at biomass potentials for papermaking to the enhancement of compatibility of the existing oil palm biomass paper products to accommodate the new trend in the packaging demand. This study highlights the surface science defining the direct correlation between surface properties and packaging inkjet printability. An 80% enhancement in inkjet printability is demonstrated by a human-friendly peroxide cascaded nano cells of oil palm origin. The effects create a closer relevance of the agro-waste industry to the trending packaging industry and promotes the productive co-existence between human, industry and Covid-19.

Keywords: Oil Palm Biomass, Sustainable management, Zero-waste, Packaging, Peroxides.

NANOBIOCHAR AS A FILLER TO IMPROVE THE THERMAL STABILITY OF POLY (3 HYDROXYBUTYRATE-CO-3-HYDROXYHEXANOATE)

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ABSTRACT

With the search for sustainable and environmentally friendly alternatives to conventional plastic packaging, research into biodegradable polymers have been on the rise. However, limitations to their thermal stability have slowed down the adoption of biodegradable polymers such as poly (3-hydroxybutyrate-co-3-hydroxyhexanoate) (PHBHHx). Nanobiochar (NBC) is a biodegradable, renewable and thermally stable material which can be added as a filler into polymers to improve their thermal stability. NBC with particle sizes below 100nm was produced from oil palm empty fruit bunch via pyrolysis followed by ball-milling. PHBHHx/NBC composites were fabricated using internal blending at 170°C for 10 mins. Thermogravimetric analysis (TGA) showed that the addition of NBC into PHBHHx improved the onset thermal degradation temperature (Td onset) by up to 11%. Dynamic mechanical analysis (DMA) of PHBHHx/NBC composites showed increased storage modulus of up to 19% at 60°C and up to 17% at 100°C with the addition of NBC. Differential scanning calorimetry did not show significant change to the melting temperature and the crystallization temperatures of the composites as compared to neat PHBHHx. Overall, NBC demonstrated high potential to improve the thermal capabilities of polyhydroxyalkanoates like PHBHHx which can prove useful when considering applications such as food packaging which requires higher thermal stability of polymers.

Keywords: biochar, polyhydroxyalkanoate, nanocomposites, carbon nanomaterial.

EFFECT OF PALM WAX ON THE DENSITY AND MOISTURE CONTENT BEHAVIOR OF THERMOPLASTIC CASSAVA STARCH

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ABSTRACT

Global pollution and environmental issues have led to a paradigm shift to look for the development of biodegradable materials as the alternative to replace petroleum-based plastics. Among biodegradable materials, thermoplastic starch has gained considerable attention recently due to renewability, wide availability, biodegradability, and low cost. Despite its great advantages, this biopolymer has drawbacks that limit the application. Thus, in this study, the effect of palm wax on thermoplastic cassava starch was evaluated as well as to investigate the properties of the bio-composites. The samples were prepared via hot pressing by varying the ratios of palm wax (2.5, 5, 10, and 15 wt%) with the presence of glycerol as a plasticizer. The resulting blend was thermo-pressed at 150°C to produced plates having 3 mm thickness. The prepared plates were characterized for the moisture content and density. Results showed that incorporating starch-based thermoplastics with palm wax has remarkably reduced the density of the composites from 1.34 g/cm3 to 1.25 g/cm3 meanwhile the moisture content of the composites was also decreased gradually following increasing amount of palm wax in thermoplastic cassava starch matrix from 7.31% to 2.59%. Overall, this study shows that the incorporation of palm wax into thermoplastic cassava starch has improved the functional properties of this green material especially on moisture behavior and has the potential to be used as biodegradable materials. This paper was funded by RACER research grant (RACER/2019/FTKMP-Care/F00413).

Keywords: Starch, thermoplastic cassava starch, palm wax.

INCORPORATING BLACK SEED FIBRE IN BIOCOMPOSITE BACKAGING MATERIAL A REVIWE

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ABSTRACT

Plastics and Non-biodegradable materials remain the most common material used by the food industry for packaging applications. As a result, the widespread use of these traditional plastics has resulted in a dangerous negative environment. Several studies have been conducted over the years to replace plastic packaging materials with environmentally friendly materials in order to stop the problems of continuous disposal of plastic waste. After these studies found that biodegradable materials are the alternative. In this context, the present research provides a review of the inclusion of black seeds in organic compound packaging materials to improve its performance as an effective bio packaging material.

Keywords: Black seed, Nigella sativa, bio composite, packaging, fibres

CELLULOSE NANOFIBER IMPROVED MECHANICAL-TRIBOLOGICAL PROPERTIES OF ULTRA-HIGH MOLECULAR WEIGHT POLYETHYLENE FOR TIBIAL INSERTS POTENTIAL APPLICATION

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ABSTRACT

Incorporation of nanocellulose could improve wear resistance of ultra-high molecular weight polyethylene (UHMWPE) for an artificial joint application. This study utilized a biocompatible cellulose nanofiber (CNF) as filler to improve the mechanical and wear resistance properties of UHMWPE. A 0.5 wt.% CNF was incorporated into UHMWPE through melt blending process at 150 °C, 60 rpm and 45 minutes in a triple screw kneading extruder. The resulted bionanocomposites exhibited approximately 22% and 15% improved tensile and flexural modulus, along with increment in flexural strength and toughness by 29% and 31%, accordingly. The improvement of mechanical properties was evident from polymer-filler mechanical interlocking observed through FE-SEM analysis. Significant reduction of wear rate and scar width were also observed by which the values reduced by 33% and 12%, accordingly as compared to UHMWPE/0% CNF. Overall, the results presented herein suggested the potential used of CNF as natural filler for UHMWPE tibial inserts application.

Keywords: Ultra-high molecular weight polyethylene, cellulose nanofiber, bionanocomposite, melt-blending, wear rated, tribological properties

A REVIEW ON COMPUTATIONAL WORK ANALYSIS OF NATURAL FIBER REINFORCED COMPOSITES

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ABSTRACT

The use of computational work for composite material analysis has become positive trends nowadays. Finite element analysis (FEA) is the most popular method where a virtual experiment with a complex shape can be revealed and viewed in graphical user interface environment. This paper provides a comprehensive review on the evaluation of composite materials using finite element analysis especially for natural fiber reinforced composite. The review comprises of microstructure and mechanical properties of natural fibers, computational analysis on natural-based composite and failure analysis based on material characteristic. Understanding of microstructure plant is important when defining mechanical properties of natural fiber process which preferred in computational analysis. In finite element of natural fibre, there is the most complex process due to various of parameters needed in this analysis. There are four steps on performing composite analysis; design, preprocessing, solver and post-processing. A characteristic composite laminate failure criterion also discussed on this paper.

Keywords: Computational analysis, finite element analysis, natural fiber reinforced composites, simulation of composite material

THERMAL PROPERTIES OF MISWAK FIBRES *(SALVADORA PERSICA)* COMPOSITE REINFORCED POLYLACTIC ACID

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ABSTRACT

The thermal properties of biocomposites of polylactic acid(PLA) with miswak (Salvadora Persica L.) (MF) fibre were investigated in order to obtain information on the possible compatibility between PLA and miswak fibre. The study was conducted by analysing the effect of sodium hydroxide(NaOH) on miswak fibre thermal properties of the biocomposites. Melt blending and compression moulding method was used in preparing the composite with 10wt%-30wt% of miswak fiber content in PLA matrix. The effects of NaOH treatment on miswak fiber with different loading in composites were investigated using chemical analysis, thermogravimetric analysis (TGA), differential scanning calorimetry (DSC) and dynamic mechanical analysis (DMA). The thermal properties of treated miswak fibre composites were expected to be changed in glass transition (Tg) and cold crystallization (Tcc) data. Moreover, the storage modulus, loss modulus and tan delta is expected to be affected with the presence of miswak fibre (untreated) and treated miswak fibre composites. The authors are suggesting 3% NaOH fibre's treatments shall be considered in future development. Nonetheless, the use of miswak fibre in PLA gives the possibility of lower final product costs and advocates a circular economy strategy for the valorization of natural toothbrushes and value enhancement of traditional Salvadora Persica chewing sticks.

Keywords: Miswak (*Salvadora persica)*; natural fibre; Polylactic acid (PLA); Thermal Properties; Biocomposites; NaOH fibre treatment.

EFFECT OF COCONUT FIBER ON THE DENSITY AND MOISTURE CONTENT BEHAVIOR OF THERMOPLASTIC CASSAVA STARCH

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ABSTRACT

Biodegradable materials have received increasing attention given the increase in environmental consciousness from the population, private organization, and governments. Among biodegradable materials, thermoplastic starch is one of the most promising material due to the highly abundant resources at low cost, sustainable, and biodegradable in nature. However, this biopolymer has limitation which hinders their application in the real plastic industry. Hence, in this study, thermoplastic cassava starch was modified by incorporation of coconut fiber in order to investigate the properties of the bio-composite. This study was carried out by varying the fiber content from 0 to 50wt%. The samples mixture comprised of starch, glycerol, beeswax, and coconut fiber was blended using high speed mixer and thermopressed at 155oC to produce 3mm thick plate. The prepared samples were evaluated for the density and moisture content behavior. The finding shows that increasing amount of coconut fiber from 10 to 50wt% has resulted to increase in the density of the composites from 1.15 g/cm3 to 1.39 g/cm3 . Meanwhile, addition of fiber from 10 to 40wt% has resulted to decrease in the moisture content of the composites from 4.97% to 2.32%. In general, the finding shows that addition of coconut fiber has increased the functional properties of the materials by reducing the moisture content of the composites. Overall, this improvement might increase the structural integrity of this material for the future study. This paper was funded by RACER research grant (RACER/2019/FTKMP-Care/F00413).

Keywords: thermoplastic starch, beeswax, coconut fiber, biocomposite.

BIOLOGICAL PROPERTIES OF HYDROTHERMALLY TREATED RUBBERWOOD (HEVEA BRASILLENSIS) IN DIFFERENT BUFFERED MEDIA

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ABSTRACT

The biological properties of hydrothermally treated rubberwood in different buffered media (Acidic buffer pH 4, 6), alkaline buffer 8, 10) and tap water (pH 7.43) with different temperatures (160 0C, 180 0C and 200 0C) were studied. In this study, the resistance against white rot fungus *(Pycnoporus sanguineus)* of the treated and untreated rubberwood were evaluated. Both the treatment temperature and buffered media significantly affected the biological properties. The results showed that the weight loss of the treated rubberwood samples caused by white rot fungus reduced as the treatment temperature increased. Better decay resistance was found in the samples treated in alkaline medium compared to acidic and water medium.

Keywords: Hydrothermal treatment, Buffered media, Rubberwood, Biological properties

THE ASSESSMENT OF SUPPLY CHAIN, BUSINESS STRATEGIES AND MARKETS IN BIODEGRADABLE FOOD PACKAGING

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ABSTRACT

Plastics pollution is a global pressing issue. The constitute of petrochemical polymers is causing detrimental pollution to the environment. The idea of bio packaging has evolved to overcome the pollution problem. Researchers all over the world are exploring the new materials and its potentials to substitute plastics. Many materials have been found to be suitable and have the potential to develop a sustainable bio packaging industry, however, there is a lack of macroeconomic perspectives to it. The economic perspectives help in understanding the overview of the business and important strategies driving the industry. This study highlights the assessment of the value and supply chains of food packaging, business strategies and its markets. It also reviews the context of bio packaging and the characteristics of biodegradable food packaging. By reviewing these domains, the biodegradable food packaging research will have a holistic view towards the development of sustainable and prosperous industry in the future.

Keywords: Bio-packaging, supply chains, business strategies, markets

PUTRA RIMBA RIMBUN - TROPICAL FORESTS AND THE ENVIRONMENT AWARENESS AND EDUCATION PROGRAMME FOR COMMUNITY

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ABSTRACT

The PUTRA Rimba Rimbun program is a community program host by Institute of Tropical Forestry and Forest Products (INTROP). The main purpose of the program is to expose and educate school students related to tropical forests and the environment. This program applies the concept of "fun learning" that combines aspects of theory and skills. Throughout the one-day program students will be introduced to activities that covering theory learning, exploration and experimentation. The program is divided into 2 sessions; morning and afternoon session. In the morning session, the program is conducted in a forest area and students will be introduced to Malaysia's tropical forests covering flora and fauna. Meanwhile, in the afternoon session, students will be taken to the INTROP laboratory and workshop to carry out sustainable product manufacturing and recycling activities. In 2019, the program had been successfully organised and participated by 15 schools involving more than 100 students. Therefore, it can be concluded that, this program is highly recommended to be organise yearly and promoted widely among the school education sector.

Keywords: community program, fun learning, exploration, activities

ENERGY ABSORBED OF NATURAL FIBRE COMPOSITES AND SYNTHETIC HYBRIDIZATION

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ABSTRACT

Natural fibre reinforced polymer composites have high potentials to be used in a variety of applications due to its environmental friendliness, biodegradability, and improved mechanical capabilities. However, due to the complex interaction between matrix and fibres, as well as the fabrication process, mechanical properties of these composites are difficult to comprehend and predict. The purpose of this study is to evaluate effects of core fibre type, core thicknesses, and fibre configurations on mechanical behaviour of hybrid natural fibre reinforced polymer (FRP) composites using impact test. The hybrid FRP composites samples were made of kenaf and hemp were chosen as natural fibre combining with chopped strand matt, woven fibreglass, and polyester as resin. These samples were fabricated using a combination of hand lay-up and vacuum procedures that are both commonly used in industry. The Instron Dynatup 8250 Drop Weight Impact Tester was used to analyse the drop weight impact test in accordance with ASTM D7136. At various core, core thickness, and fibre arrangement, the results demonstrate that Hemp hybrid composites have a better energy absorbing behaviour. The findings are significant for possible applications of natural/synthetic fibre reinforced polymer hybrid composites in the fields of vehicles, aircraft, military, biomedical, infrastructure, transportation, and other lightweight-moderate strength products/structures.

Keywords: Natural Fibre Reinforced Polymer (NFRP), impact test, energy absorbed, polyester resin, hybridisation, mechanical properties

INFLUENCE OF VARIOUS ADDITIVES ON PROPERTIES OF BORON-TANNIN BASED WOOD PRESERVATIVES

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ABSTRACT

The objective of this study was to investigate overall influence of different chemicals as additives in boron and tannin based preservatives. Caprolactam and hexamine were added in the preservatives at different percentages. Gelation time, viscosity and pH level of each combination was tested before the chemicals were used to treat two species namely Rubberwood (*Hevea brasiliensis*) and Laran (*Neolamarckia cadamba*) samples. Based on the findings in this work the combination of 2% boron and 10% tannin resulted in the highest gelation time with 51 minutes. The result indicated that the addition of additives (Caprolactam and Hexamine) into Boron-tannin formulation had improve the chemical uptake. However, boron-tannin formulation mixed with harderner (Formalin and LMWPF) and Additives shows low chemical uptake where the range is from 0.9 kg/m3 to 4.3 kg/m3 (Formalin Group) and 1.7 kg/m3 to 4.6 kg/m3 (LMWPF Group). The highest retention values of 0.176 and 0.927 kg/m2 were determined for rubberwood and laran sample respectively.

Keywords: Tannin; Boric acid; ε-Caprolactam; Hexamine; Wood Preservative;

CHARACTERIZATION OF NANOFIBRILLATED CELLULOSE FROM *MACARANGA GIGANTEA*

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ABSTRACT

Nanocellulose is considered as one of the emerging and promising nanomaterials that can be utilized in various industrial applications such as pulp and paper, composites, coating, cosmetic and pharmaceuticals. Nanofibrillated cellulose (NFC) is commonly prepared by mechanical disintegration to produce fibrils at nanometer. In this study, the raw material *(Macaranga gigantea)* underwent different stages of processing such as chipping, pulping and bleaching in order to produce pure cellulose for the preparation of NFC. The lignin-free cellulose in the form of bleached pulp was pre-treated with cellulase enzyme followed by grinding process until gel-like product was formed. The resulting NFC was then characterized by using AFM, FTIR, TGA and XRD. The successful conversion of *Macaranga gigantea* to NFC was supported by its nanoscale diameter with value in the range of 0.94nm and 76.94nm, (13.71nm) observed under AFM. Based on FTIR spectra, significant peaks at around 3420cm-1, 2800cm-1, 1700cm-1 and 1450cm-1 were detected which correspond to O-H stretching, C-H symmetrical stretching, H-O-H bending and H-C-H bending vibration respectively. The C-O-C vibration bonds on glycosidic bridges at 1165cm-1 were also observed. The crystallinity of NFC was calculated to be 70.34% via XRD analysis. TGA diffractogram of NFC showed two stages thermal degradation namely at 2500C and 3200C.

Keywords: fibril, nanomaterial, analysis, properties, Mahang gajah

RECENT DEVELOPMENTS IN SUGAR PALM (ARENGA PINNATA) BASED BIOCOMPOSITES FOR NON-STRUCTURAL APPLICATIONS: A REVIEW

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ABSTRACT

The introduction of natural fibres to lessen the use of synthetic fibres had emerged since the last few decades and has been a rapidly growth in research and innovation in the natural fibre composite (NFC) area. Varieties of plant fibres were reported to have comparable properties with added value, such as fast growing and lightweight, including low environmental impact and low production cost. Its provides good potential across a wide range of applications which in turns can be used to the extent of structural and non-structural applications. In last few years, sugar palm tree was exploited to be one of the potential fibre reinforcement in composites. A number of preliminary studies had been reported to evaluate the properties of this fibre and its composites towards the applications in industrial field. More effort has been done to increase their mechanical performance in order to extend the capabilities and applications of this group of materials. This review aims to provide an overview on recent development in sugar palm based with details achievements and applications made with them.

CELLULOSE NANOFIBRE FUNCTIONAL MATERIAL CHARACTERIZATION AND REINFORCEMENT IN POLYLACTIC ACID CHITIN BIOCOMPOSITE

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ABSTRACT

The miscibility of polylactic acid and cellulose nanofibre has been a great challenge because of the difference in their nature. Polylactic acid is hydrophobic, and cellulose nanofibre is hydrophilic. In this study, chitosan was used as a compatibilizer to enhance the miscibility between PLA and CNF. CNF was isolated from bamboo using combine hydrolysis and high-pressure homogenization. The isolated CNF was used as reinforcement in PLA and PLA/chitin. The mechanical, morphological, and structural properties of PLA, PLA/CNF, and PLA/chitin/CNF biocomposite were studied with tensile, flexural, scanning electron microscope, and FT-IR analysis. The result showed that the mechanical properties of PLA/chitin/CNF were higher than PLA and PLA/CNF. The result of the scanning electron microscopy showed better miscibility with PLA/chitin/CNF compared with PLA/CNF with no agglomeration. The FT-IR functional group analysis confirmed no new bond in PLA/chitin/CNF biocomposite compared with PLA/CNF. This confirmed that the best properties' enhancement in PLA/chitin/CNF was due to interfacial miscibility due to chitin incorporation. The biocomposite had the potential for use in a packaging application.

Keywords: bamboo cellulose nanofibre, chitin, biocomposite, isolation, characterisation

EFFECT OF MODIFIED TAPIOCA STARCH ON MECHANICAL, THERMAL, AND MARPHOLOGICAL PROPERTIES OF PBS BLENDS FOR FOOD PACKAGING

Rafiqah S. Ayu[1], Abdan Khalina[2*], Ahmad Saffian Harmaen[3], Khairul Zaman[4], Mohammad Jawaid[1] and Chin Hao Lee[1]

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ABSTRACT

Native starch and 5 types of modified starch from tapioca source was characterize in terms of chemical and physical characteristics. From this study, few testing were carried out on the starch itself to identify its properties. From FTIR testing, it was found different functional group for each starch represents its modification was made. From this FTIR analysis, showed all types of starch were showed significant result due to different modification method and processing. However starch A was chosen for further research due to most peak shifting was detected among other types of modified starch. This is an indicator shows the modification starch A which involve ether components was successfully made. For testing identified amylose and amylopectin content, starch A shows highest amylose (39.73%) and lowest amylopectin (60.27%) content compare to the others. In this case, starch A required lower energy to swells and burst during gelatinization process. Starch A start gelatinization temperature at 45.2°C which is lowest temperature among the other modified starch. In density testing modified starch A showed lowest density followed by starch B,E,C and D. Amylose and amylopectin in starch showed starch A has high amylose and low amylopectin content after modification was made. As a result starch A structure has low density compare with other types of starch. Therefore, modified starch A has a potential to blend with polymer and other materials.

OPENING CEREMONY

[23rd November 2021 (Tuesday)]

Time	Details
0900-0930	Arrival of Guests
0945-0950	Arrival of VIP
1000-1010	Arrival of **YBhg. Profesor Ts. Dr. M. Iqbal Saripan** Deputy Vice Chancellor (Academic & International/ Chief Information Officer (CIO)
	National Anthem Negaraku
	Doa Recital
	Welcoming Remarks by YBhg. Prof. Ir. Dr. Mohd Sapuan Bin Salit
	Official Opening Speech by **YBhg. Profesor Ts. Dr. M. Iqbal Saripan** Deputy Vice Chancellor (Academic & International/ Chief Information Officer (CIO)
1010-1030	Signing and Exchanging Memorandum of Understanding (MoU) UPM - Malaysia Timber Industry Board & UPM - Rimbun Foundation
1030-1040	Book Launching & Video Montage
1040-1100	Photo Session

CONFERENCE PROGRAMME

TUESDAY, 23 NOVEMBER 2021 (DAY 1)	
0900-0930	Registration
1000-1010	Welcoming Remarks by YBhg. Prof. Ir. Dr. Mohd Sapuan Salit, Chairman of WOBIC 2021
1010-1030	Opening ceremony by YBhg. Profesor Ts. Dr. M. Iqbal Saripan, Deputy Vice Chancellor (Academic & International), Universiti Putra Malaysia
	MoU Signing UPM & MTIB | UPM & Rimbun Foundation
1030-1040	Book Launching :Bio-based Packaging - Material, Environmental and Economic Aspects, S.M. Sapuan and R.A. Ilyas, 2021, Wiley USA
1040-1100	Photo session
1115-1200	**Plenary Session** **Chair Session:** Dr. Mohammad Jawaid **Speaker:** Prof. Dr. Salim Hiziroglu *Value-Added Composites From Underutilized Wood And Non-Wood Species* Oklahoma State University, USA **Q&A**
1200-1230	**Plenary Session** **Chair Session:** Prof. Dr. Ahmad Ainuddin Nuruddin **Speaker:** Dr. Jean-Marc RODA *Epistemology of Circular Economy, and implications for forestry and wood products* CIRAD Regional Director for the SouthEast Asian Island Countries **Q&A**
1230-1300	**Plenary Session** **Chair Session:** Prof. Ts. Dr. Khalina Abdan **Speaker:** Mdm. Hjh. Roslina Idris *Malaysian Timber Industry: Gearing Towards a Resilient Industry* Director, Licensing and Inspectorate, Malaysia Timber Industry Board **Q&A**
1300-1400	**LUNCH BREAK**
1400-1445	**Keynote Session** **Chair Session:** Prof. Ir. Dr. Mohd.Sapuan Salit **Speaker:** Prof. Vijay Kumar Thakur *Sustainable Materials From Macro to Nanoscale for a Circular Bioeconomy* Scotland's Rural College (SRUC) Scotland, UK **Q&A**

	THEME		THEME		THEME		THEME		THEME
	BIOPOLYMERS & BIOCOMPOSITES		**BIOPOLYMERS PACKAGING**		**ADVANCED MANUFACTURING IN BIOCOMPOSITES**		**NEW PLANTING AND FOREST PLANTATION**		**IR 4.0 IN FOREST INDUSTRIES**
	Chair Session: Dr.Mohamad Jawaid **Assistant Chair:** Dr. Ayu Rafiqah Shafi		**Chair Session:** Dr. Ridhwan Jumaidin (UTeM) **Assistant Chair:** Dr. Shahril Anuar Bahari (UiTM)		**Chair Session:** Dr. Shahril Anuar Bahari (UiTM) **Assistant Chair:** Mohamad Omar Syafiq bin Razali		**Chair Session:** Prof Ts. Dr. Hidayah binti Ariffin **Assistant Chair:** Nazrin Nurarief Mardi bin Asmawi		**Chair Session:** Dr. Noor Ida Amalina Ahamad Nordin (UMP) **Assistant Chair:** Amira Nabila binti Amir Mustafa
	Invited Speaker		Invited Speaker		Invited Speaker		Invited Speaker		Invited Speaker
	Assoc. Prof. Mohamed Ansari Mohamed Nainar		**Prof. Dr. Sarat Kumar Swain**		**Dr. Ramzi Khiari**		**Dr. Muhammad Mohsin**		**Prof. Dr. Ahmad Ainuddin Nuruddin**
1445-1510	**Wood-based Actived Carbon for Supercapacitor Electrode**	1445-1510	**Cellulosic fiber based nanocomposites for packaging application**	1445-1510	**Cellulose NanoFibril from Prunus amygdalus: Mechanical Properties and morphological features**	1445-1510	**Development of environment friendly and nontoxicbio finishing forcottonand morphological features**	1445-1510	**Forest fires and IoT forcottonand morphological features**
	Universiti Tenaga Nasional, MALAYSIA		Veer Surendra Sai University of Technology, INDIA		Higher Institute of Technological Studies in Ksar-Hellal, TUNISIA		University of Engineering and Technology PAKISTAN		INTROP, UPM
	Q & A		**Q & A**		**Q & A**		**Q & A**		**Q & A**
	Invited Speaker		**WOBIC 2021: 124-098**		Invited Speaker		**WOBIC 2021: 084-053**		**WOBIC 2021: 019-011**
	Dr. Zainab Idris		Dr. Norfaryanti Kamaruddin		**Prof. Dr. Rafaqat Hussain**		Norhazaedawati Baharuddin		**Nor Amira Izzati Ayob**
1510-1535	**Oil Palm Biomass: Sustaining the Oil Palm Industry Through Value Addition**	1510-1525	The assessment of supply chain, business strategies and markets in biodegradable food packaging	1510-1535	**Tailoring the in-vitro bioactivity of bioglass Synthesizing novel bio-ceramic materials for orthopedic applications**	1510-1525	**Effects of Boron and Copper Chrome Boron (CCB) Treatment on Physical and Mechanical Properties of Gigantochloa scortechinii**	1510-1525	**The Properties of 3D Printed Poly (lactic acid) (PLA)/ Poly (butylene-adipate-terephthalate) (PBAT) Blend and Oil Palm Empty Fruit Bunch (EFB) Reinforced PLA/ PBAT Composites Used in Fused Deposition Modelling (FDM).**

	Malaysian Palm Oil Board, MALAYSIA		**WOBIC 2021: 087-066**		COMSATS Institute of Information Technology (CIIT) PAKISTAN		**WOBIC 2021: 056-037**		**WOBIC 2021: 099-076**
			Zatil Hazrati Kamaruddin				Nor Izaida Ibrahim		Sheriza Mohd Razali
	Q & A	1525-1540	Starch-based biocomposites for packaging applications: A review		**Q & A**	1525-1540	The Effect of Delignification on the Mechanical, Thermal and Morphological Properties of Gigantochloa scortechinii (Buluh semantan) Fiber	1525-1540	Forest plantation mapping using Random Tree of Supervised Classification
	Invited Speaker		**TEABREAK**		Invited Speaker				
1535-1600	**Dr. Mohamed Midani**	1540-1550		1535-1600	**Dr. Ali Kilic**	1540-1555	**WOBIC 2021: 028-017**	1540-1555	**WOBIC 2021: 108-082**
	Optimizing and Benchmarking the Performance of Date Palm Textile Fiber Composites				**Biofibres for Advanced Applications: Energy, Medical, Food and Composites**		U. Seeta Uthaya Kumar		Nafis Syahmi Zainal Azali
							Properties and characterisation of biodegradable packaging material		Wood Dust Fibre Composite Mechanical Properties Influence on Fused Deposition Modeling (for Fused Filament Fabrication (FFF)
	Wilson College of Textiles, USA & German University in Cairo, EGYPT	1550-1615	THEME		Istanbul Technical University TURKEY	1555-1610	**WOBIC 2021: 041-094**	1555-1610	**WOBIC 2021: 113-091**
			NANO-BIOCOMPOSITES				Roziela Hanim Alamjuri		Mr. Moustafa Alaa Ibrahim Moustafa
			Invited Speaker				Influence of various additives on properties of boron-tannin based wood preservatives		Fabrication and Charaterization of 3D Filaments of Kenaf/Polylactic Acid Biocomposite
	Q & A		Dr. Ahmad Ilyas Rushdan		**Q & A**				
1600-1610	**TEABREAK**		**Emerging development of sugar palm (Arenga pinnata (Wurmb.) Merr) nanocellulose: from macro to nanoscale**	1600-1610	**TEABREAK**	1610-1620	**TEABREAK**	1610-1620	**TEABREAK**
			Universiti Technology Malaysia MALAYSIA						
			Q & A						

	WOBIC 2021: 070-042		**WOBIC 2021: 017-010**		**WOBIC 2021: 035-024**		**WOBIC 2021: 089-059**		THEME
	Saleh Naji Musaed Alsubari		Nurul Atiqah Mohd Saad		Dr. Loh Yueh Feng		Alyaa Ibrahim		**Nor Amira Izzati Ayob**
1610-1625	The energy-absorbing capability of foam-filled honeycomb structures made of flax/polylactide composite	1615-1630	The Isolation of Cellulose Nanofibrillated Fibers by Supercritical Carbon Dioxide Assisted by High-Pressure Homogenization and The Reinforcement in Biopolymer Film	1610-1625	Enhancement of manufacturing process for oil palm trunk plywood	1620-1635	Napier Grass Composite	1620-1645	Invited Speaker
									Assoc. Prof. Dr. Yasir Nawab
									Dry Pre-Pregs by Commingling technique: A alternative route of thermoplastic composite fabrication
	WOBIC 2021: 003-016		**WOBIC 2021: 024-018**		**WOBIC 2021: 046-049**		**WOBIC 2021: 106-079**		National Textile University, PAKISTAN
	Ayu Rafiqah Shafi		Siti Hasnah binti Kamarudin		Nurul Ain Maidin		Assoc. Prof. DrChong Leong Puan		
1625-1640	Characterization on different types of modified tapioca starch	1630-1645	Cellulose Nanocomposite in Construction Approach towards Innovative, Sustainable and Durable Formwork	1625-1640	Constructing A Framework for Selecting Natural Fibre as Reinforcement Composites Based on Grey Relational Analysis	1635-1650	Aquatic Fauna Composition and Their Ecological Interactions in Eucalyptus and Other Forest Plantations		Q & A
	WOBIC 2021: 054-035		**WOBIC 2021: 016-009**		**WOBIC 2021: 014-077**		**WOBIC 2021: 022-014**		**WOBIC 2021: 101-074**
	Muhammad Harussani Moklis		Niyi Gideon Olaiya		Dr. Juliana Abdul Halip		Shaiful Rizal Masrol		Satya Guha Nukala
1640-1655	Recent Development of Biomass and Plastic Waste Derived Char Filled Natural Starch Biocomposite Briquettes	1645-1700	Cellulose nanofibre functional material characterization and reinforcement in polylactic acid-chitin biocomposite.	1640-1655	The effect of bamboo ages on the tensile properties for textile application: A review	1650-1705	Durian Rind as an Alternative Non-wood Based Resource for Pulping and Papermaking: A Review	1645-1700	Simulation of wood polymer composites using sustainable raw materials
	WOBIC 2021: 094-069		**WOBIC 2021: 080-048**		**WOBIC 2021: 067-068**		**WOBIC 2021: 091-060**		**WOBIC 2021: 127-096**
	Nurul Hanan Taharuddin		Fatiha Ismail		Norhani Jusoh		George Lee Zhi Xuan		Md. Rowson Ail
1655-1710	The influence of agar on the moisture content of thermoplastic sago starch	1700-1715	The Effect of Chemical and High Pressure Homogenization Treatment	1655-1710	Optimization of Wet Disc Milling Processing Conditions for Minimizing the	1705-1720	Bond-slip model of bamboo in cementitious material: A review	1700-1715	Biological Properties of Hydrothermally treated rubberwood (Hevea brasillensis)

			Conditions on the Morphology of Nanocellulose		Energy Consumption During Cellulose Nanofibrils Production from Cellulose with High Degree of Polymerization				in Different Buffered media
1710-1725	**WOBIC 2021: 090-061** Muhammad Aizuddin Mohamad Flexural analysis of hemp and kenaf with glass hybrid fibre laminates filled polyester resin	1715-1730	**WOBIC 2021: 047-057** Niyi Gideon Olaiya Effect of plasticizer types and concentrations on physical and mechanical properties of plant based nanocellulose/ starch biocomposite films incorporated with essential oil: A review	1710-1725	**WOBIC 2021: 055-036** Muhammad Harussani Moklis A review of the recent developments in natural fibres reinforced biocomposite in structure and defence technology	1720-1735	**WOBIC 2021: 065-040** Dr. Shahlinney Lipeh Bibliometric study on durability of bamboo literature 2011-2021	1715-1730	**WOBIC 2021: 038-027** Alia Syahirah Yusoh Mechanical performance and modes of failure of cross-laminated timber (CLT) manufactured from tropical hardwoods species

WEDNESDAY, 24 NOVEMBER 2021 (DAY 2)	
0900-0945	**Keynote Session** **Chair Session:** Prof. Dr. Paridah Md Tahir **Speaker:** Prof. Dr. Alcides Lopes Leão *Natural Fibers and Its Role in Advanced Materials* São Paulo State University, BRAZIL **Q&A**
0945-1015	**Plenary Session** **Chair Session:** Dr. Lee Seng Hua **Speaker:** Prof Dr. Hazizan Md Akil *Advances, challenges and future outlook on the potential applications of Natural fibre reinforced composites* Universiti Sains Malaysia, MALAYSIA **Q&A**
1015-1045	**Plenary Session** **Chair Session:** Dr. Ainun Zuriyati Mohamed **Speaker:** Dr. Rushdan Ibrahim *Research and Development (R&D) Works on Non-Wood Species by Pulp and Paper Laboratory, Forest Research Institute Malaysia (FRIM)* Forest Research Institute Malaysia, MALAYSIA **Q&A**
1045-1115	**Plenary Session** **Chair Session:** Assoc. Prof. Dato' Dr. H'ng Paik San **Speaker:** Prof. Dr. Sarani Zakaria Biobased Polyuerthane Foam from Liquified Lignocellulose Materials Universiti Kebangsaan Malaysia, MALAYSIA **Q&A**

1115-1130	THEME		THEME		THEME		THEME		THEME
	BIOPOLYMERS & BIOCOMPOSITES		**BIOPOLYMERS & BIOCOMPOSITES**		**ADVANCED MANUFACTURING IN BIOCOMPOSITES**		**COMMUNITY INDUSTRY ENGAGEMENT PROJECT**		**ADVANCED MANUFACTURING IN BIOCOMPOSITES**
	Chair Session: Dr. Loh Yueh Feng (Malaysia Timber Industry Board) **Assistant Chair:** Moustafa Alaa Ibrahim Moustafa		**Chair Session:** Prof. Dr. Mansoob (BRUNEI) **Assistant Chair:** Amira Nabilah		**Chair Session:** Prof. Dr.Hazizan Md Akil **Assistant Chair:** Nur Diyana binti Ahmad Fazil		**Chair Session:** Prof. Dr. Ahmad Ainuddin Nuruddin **Assistant Chair:** Tarique Jamal		**Chair Session:** Dr. Rushdan Ibrahim **Assistant Chairperson:** Norihan Abdullah

1130-1145	**WOBIC 2021: 061-071**	1130-1155	Invited Speaker	1130-1145	**WOBIC 2021: 031-07**	1130-1155	Invited Speaker	1130-1145	**WOBIC 2021: 116-089**
	Stasha Eleanor Rosland Abel		**Assoc. Prof. Dr. Mohammad Mansoob Khan**		Dr. Mohd Hafiezal Mohd Radzi		**Dr. Sharoul Jambari**		Dr. Noor Intan Saffinaz Anuar
	Recovery and Physicochemical Characterisation of Cellulose Derived from Oil Palm Empty Fruit Bunches		**Green synthesis of composites for energy and environment applications**		Thermal and Fire Smoke Toxicity Behaviour of Hybrid Palf/Glass/Carbon in Jatropha Blended Bio-epoxy.		**Innovation-Network to Drive Industry Development leveraging on Industrial Collaboration Program (ICP) for Government Procurement**		Thermo-physico-mechanical Properties of Chemically Modified Kenaf/PP Nonwoven Composite with PVA Urea/Silane
	WOBIC 2021: 004-065		Universiti Brunei Darussalam, BRUNEI		**WOBIC 2021: 085-056**		Technology Depository Agency (TDA) MALAYSIA		**WOBIC 2021: 048-054**
	Farah Nabila Mhd Idris		**Q & A**		Mohamad Asrofi Bin Muslim		**Q & A**		Aliyu Isah
1145-1200	Characteristics of Unbleached Oil Palm Empty Fruit Bunch Paper Incorporated with Lignocellulose Nanofibrils			1145-1200	Energy absorbed of Natural Fibre Composites and Synthetic Hybridization			1145-1200	Overview of fibre ash synthesis and characterization for industrial applications
1200-1215	**WOBIC 2021: 020-062**	1155-1210	**WOBIC 2021: 045-052**	1200-1215	**WOBIC 2021: 095-070**	1155-1210	**WOBIC 2021: 079-046**	1200-1215	**WOBIC 2021: 050-032**
	Najieha Norazli		Nazrin Nurarief Asmawi		Mohd Azlin Mohd Nor		Siti Hajar Nadjwa Abdullah		Seri Nur Zumaimi Ahmad Nadzri
	Physiochemical, Morphological and Thermal Analysis of Microcrystalline Cellulose Extracted from Oil Palm Empty Fruit Bunch Using Different Delignification Approached		A review on degradation of biopolymer composites in liquid environments		Fiber Reinforced Polylactic Acid (PLA) Hybrid Composites: A review		Simulated Framework as Feeder Data for Biomass Management Analytics		The effects of layering sequences on flexural properties of kenaf/glass hybrid composites for bus bumper application

	WOBIC 2021: 009-006		**WOBIC 2021: 074-043**		**WOBIC 2021: 007-005**		**WOBIC 2021: 103-075**		**WOBIC 2021: 036-025**
	Tarique Jamal		Sity Ainy Nor Mohamed		Shah Faisal Khan Sherwani		Assoc. Prof. Dr. Zaiton Samdin		Asniza Mustapha
1215-1230	A descriptive study of Arrowroot (Maranta arundinacea) based biocomposites	1210-1225	Fatigue Life Estimation of Rice Husk Fibre Reinforced Polypropylene Composite by Equivalent Initial Flaws Concept	1215-1230	Fatigue Life Of Natural Fibre Reinforced Polymer Composites: A Review	1210-1225	Socio-Economic Impact of Eucalyptus Plantation: Perspective of Local Community in Sabah, Malaysia	1215-1230	Structural analysis and thermal properties of nanocrystalline cellulose extracted from Semantan and Beting bamboo species
	WOBIC 2021: 092-063		**WOBIC 2021: 075-044**		**WOBIC 2021: 086-055**		**WOBIC 2021: 015-041**		**WOBIC 2021: 044-045**
	Nur Diyana Binti Zakuan		Dr. Nur Eliyanti Ali Othman		Mohd Izwan Shaharuddin		Nur Haffizah Azhar		Lawrence Ng
1230-1245	Effect of Beeswax on the Density and Moisture Content Behavior of Thermoplastic Cassava Starch	1225-1240	The Effect of Different Concentration of Sodium Hydroxide On Carboxymethyl Cellulose Properties	1230-1245	Recent developments in hybrid biocomposites for non-structural applications: A review	1225-1240	Oil Palm Biomass Enhanced Product Compatibility for the Covid-19 Affected Packaging Industry	1230-1245	Nanobiochar as a filler to improve the thermal stability of poly(3-hydroxybutyrate-co-3-hydroxyhexanoate).
	WOBIC 2021: 093-064		**WOBIC 2021: 057-038**		**WOBIC 2021: 042-030**		**WOBIC 2021: 130-100**		**WOBIC 2021: 026-039**
	Zatil Hafila		Walid A M Abotbina		Dr. Ridhwan Jumaidin		Dr. Syeed SaifulAzry		Nur Sharmila Sharip
1245-1300	Effect of Palm Wax on the Density and Moisture Content Behavior of Thermoplastic Cassava Starch	1240-1255	Incorporating black seed fibre in biocomposite backaging material a review	1245-1300	Effect of Coconut Fiber on the Density and Moisture Content Behavior of Thermoplastic Cassava Starch	1240-1255	PUTRA Rimba Rimbun - Tropical forests and the environment awareness and education programme for community	1245-1300	Cellulose nanofiber improved mechanical-tribological properties of ultra-high molecular weight polyethylene for tibial inserts potential application
	WOBIC 2021: 049-033		**WOBIC 2021: 025-086**		**WOBIC 2021: 088-058**		**WOBIC 2021: 125-095**		**WOBIC 2021: 119-093**
	Nur Marini Zainal Abidin		Ms. Nur Diyana Ahmad Fazil		Mohd Azrul bin Jaafar		Nurul Ain Nadirah Jamaluddin		Norfarhana Abdul Samad
1300-1315	A review on computational work analysis of natural fiber reinforced composites	1255-1310	Thermal Properties of Miswak Fibres (Salvadora persica) Composites Reinforced Polylactic acid	1300-1315	Influence of stacking sequence and hybridization on the tensile properties of glass, hemp and kenaf composites	1255-1310	Characterization of nanofibrillated cellulose from *Macaranga gigantea*	1300-1315	Rice Husk reinforced thermoplastic ENR/PVC as potential Membrane Technology in Industrial Wastewater Treatment: A review

1315-1325	TEABREAK	1310-1320	TEABREAK	1315-1325	TEABREAK	1310-1320	TEABREAK	1315-1325	TEABREAK
	POSTER SESSION		**POSTER SESSION**		**POSTER SESSION**		**POSTER SESSION**		**POSTER SESSION**
	Assistant Chair: Shah Faisal Khan Sherwani		**Assistant Chair:** Aliyu Isah		**Assistant Chair:** Nur Diyana binti Ahmad Fazil		**Assistant Chair:** Tarique Jamal		**Assistant Chair:** Mohd Nor Hafizuddin bin Mohd Sahfani
	WOBIC 2021: 030-019		**WOBIC 2021: 032-022**		**WOBIC 2021: 023-013**		**WOBIC 2021: 078-067**		**WOBIC 2021: 040-029**
	Mohd Khairun Anwar Bin Uyup		Tumirah Khadiran		Revati Radakisnin (P6)		Fazliana Abdul Hamid (P18)		Nordahlia Abdullah Siam
1325-1335	Sorption behaviour of kedondong (Canarium spp.) wood treated with low molecular weight phenol formaldehyde (LmwPF) resin	1320-1330	Bamboo activated carbon produced using chemical activation method and potential as an absorbent for chemical pollutants from wood-based industry	1325-1335	Mechanical and Thermal Properties of Highly Porous PLA/CNF Scaffolds Prepared via Solvent Casting and Particulate Leaching	1320-1330	Neutral Sulfite Semichemical Pulping (NSSC) of Oil Palm Trunk (OPT) Fibre	1325-1335	Anatomical properties of Macaranga hosei and Macaranga gigantea
	WOBIC 2021: 002-004		**WOBIC 2021: 032-023**		**WOBIC 2021: 012-008**		**WOBIC 2021: 013-007**		**WOBIC 2021: 053-034**
	Fathi Aluhishi Muftah Masoud M Masoud		Tumirah Khadiran		Wan Nur Fatihah Amirah Nik Wan @ Wan Senik (P3)		Fathin Sakinah Mohd Radzi		Norihan Abdullah (P15)
1335-1345	Experimental Analysis of Heat-Affected Zone (HAZ) in Laser Cutting of Sugar Palm Fiber Reinforced Unsaturated Polyester Composites	1330-1340	Potential of bamboo nanocellulose as a bio-filler for waterborne wood coatings	1335-1345	Introducing vacuum assisted transfer moulding (vartm) for the enhancement of oil palm trunk (opt) reinforced epoxy	1330-1340	Manufacturing defects and interfacial adhesion of arenga pinnata and kenaf fibre reinforced fibreglass/kevlar hybrid composite in boat construction application	1335-1345	Waste Wood Flour Reinforced Recycled Polyamide Biocomposites
	WOBIC 2021: 061-085		**WOBIC 2021: 073-081**		**WOBIC 2021: 097-073**		**WOBIC 2021: 030-021**		**WOBIC 2021: 082-050**
	Stasha Eleanor Rosland Abel		Yanti Abdul Kadir		Noorshamsiana Abdul Wahab		Mohd Khairun Anwar Bin Uyup		Rafidah Jalil (P16)
1345-1355	Influence of Temperature on Yield and Physicochemical Characteristics of Carbonised Oil Palm Empty Fruit Bunch Cellulose	1340-1350	Properties of Plywood Made From Meranti temak nipis (*Shorea roxburghii*) a Part 2	1345-1355	Chlorine-Free Extraction of Cellulose from Oil Palm Plantation Residues	1340-1350	Four commercial rattan species used in furniture industry	1345-1355	High Yield of Fermentable Sugars Produced from Bamboo as Potential Feedstock for Biofuel and Biochemical

	WOBIC 2021: 037-026		**WOBIC 2021: 107-080**		**WOBIC 2021: 011-047**		**WOBIC 2021: 039-028**		**WOBIC 2021: 083-051**
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1355-1405	Influence of isopropyl alcohol and milling time on CNF isolation from Pineapple leave fiber	1350-1400	Rolling resistance of castor wheels based on BS EN 1728:2012, clause 6.30	1355-1405	Development Sustainability Design Of Ballistic Helmet Using Alternative Natural Fiber Reinforcement Hybrid Composites	1350-1400	Prototype development based on traditional knowledge documentation of orang asli Semai in Ulu Geroh, Gopeng Perak	1355-1405	Introduction of a biocide into bionanoparticles for rubberwood preservation
1405-1420	TEABREAK								
1420-1550	**Plenary Session** **Chair Session:** Prof. Ts. Khalina Abdan *Floor Manage:* Postgraduate 11 **Speaker:** Dr. Rob Elias *Pressurised Refining for MDF and the Circular Economy* Bangor University, UK **Q&A**								
1450-1600	**Forum Discussion** *From surviving to thrive: Harnessing the circular economy for wood and biofibre in the post-pandemic era* **Moderator:** Prof. Ts. Dr. Khalina Abdan Dato' Dr. Jalaluddin Harun, Fellow Alternate Chairperson of the Science & Technology Dev. and Industry Discipline, Academy Sciences Malaysia, MALAYSIA Assoc. Prof. Dr. Yasir Nawab, National Textile University, PAKISTAN Y.Bhg Datuk Wira Sheikh Othman Rahman, Chairman of the Malaysian Panel-Products Manufacturers' Association (MPMA), MALAYSIA								
1600-1630	Best oral and poster announcement and closing speech by YBhg. Prof. Ts. Dr. Khalina Abdan, Chairman of WOBIC 2021 Steering Committee								

LIST OF POSTER PRESENTERS

POSTER ID	NAME	TITLE OF POSTER PRESENTENTION
Advanced Manufacturing Of Biocomposites		
WOBIC 2021: 002-004	Fathi Aluhishi Muftah Masoud M Masoud	Experimental Analysis of Heat-Affected Zone (HAZ) in Laser Cutting of Sugar Palm Fiber Reinforced Unsaturated Polyester Composites
WOBIC 2021: 012-008	Wan Nur Fatihah Amirah Nik Wan @ Wan Senik	Introducing Vacuum Assisted Transfer Moulding (VARTM) For The Enhancement Of Oil Palm Trunk (OPT) Reinforced Epoxy
Biopolymers And Biocomposites		
WOBIC 2021: 011-047	Mohamad Asyraf Azman	Development Sustainability Design Of Ballistic Helme Using Alternative Natural Fiber Reinforcement Hybrid Composites
WOBIC 2021: 013-007	Fathin Sakinah Mohd Radzi	Manufacturing Defects and Interfacial Adhesion of *Arenga Pinnata* and Kenaf Fibre Reinforced Fibreglass/ Kevlar Hybrid Composite In Boat Construction Application
WOBIC 2021: 023-013	Revati Radakisnin	Mechanical and Thermal Properties of Highly Porous PLA/ CNF Scaffolds Prepared via Solvent Casting and Particulate Leaching
WOBIC 2021: 030-019	Mohd Khairun Anwar Bin Uyup	Sorption behaviour of kedondong (*Canarium* spp.) wood treated with low molecular weight phenol formaldehyde (LmwPF) resin
WOBIC 2021: 032-022	Tumirah Khadiran	Bamboo activated carbon produced using chemical activation method and potential as an absorbent for chemical pollutants from wood-based industry
WOBIC 2021: 032-023	Tumirah Khadiran	Potential of bamboo nanocellulose as a bio-filler for waterborne wood coatings
WOBIC 2021: 037-026	Surenthiran Gnanasekaran	Influence of isopropyl alcohol and milling time on CNF isolation from Pineapple leave fiber
WOBIC 2021: 053-034	Norihan Abdullah	Waste Wood Flour Reinforced Recycled Polyamide Biocomposites
WOBIC 2021: 083-051	Roszaini Kadir	Introduction Of A Biocide Into Bionanoparticles For Rubberwood Preservation

WOBIC 2021: 078-067	Fazliana Abdul Hamid	Neutral Sulfite Semichemical Pulping (NSSC) of Oil Palm Trunk (OPT) Fibre
WOBIC 2021: 097-073	Noorshamsiana Abdul Wahab	Chlorine-Free Extraction of Cellulose from Oil Palm Plantation Residues
WOBIC 2021: 061-085	Stasha Eleanor Rosland Abel	Influence of Temperature on Yield and Physicochemical Characteristics of Carbonised Oil Palm Empty Fruit Bunch Cellulose
Community Engagement Project		
WOBIC 2021: 039-028	Fadzureena Jamaludin	Prototype development based on traditional knowledge documentation of orang asli Semai in Ulu Geroh, Gopeng Perak
New Planting And Industrial Material		
WOBIC 2021: 030-021	Mohd Khairun Anwar Uyup	Four commercial rattan species used in furniture industry
WOBIC 2021: 082-050	Rafidah Jalil	High Yield of Fermentable Sugars Produced from Bamboo as Potential Feedstock for Biofuel and Biochemical
WOBIC 2021: 073-081	Yanti Abdul Kadir	Properties of Plywood Made From Meranti temak nipis (*Shorea roxburghii*) a Part 2
WOBIC 2021: 107-080	Noor Azrieda Abd Rashid	Rolling resistance of castor wheels based on BS EN 1728:2012, clause 6.30
Wood And Biofibre In COVID-19		
WOBIC 2021: 040-029	Nordahli Abdullah Siam	Anatomical properties of *Macaranga hosei* and *Macaranga gigantea*

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- Screw Withdrawal
- Surface Soundness
- Compression
- Hardness

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- Surface Roughness
- Thermal Conductivity
- Abrasion
- UV Weathering
- Viscosity

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- Differential Scanning Calorimetry (DSC)
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WOOD & BIOFIBRE - TRANSFORMATION TOWARDS CIRCULAR ECONOMY

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