



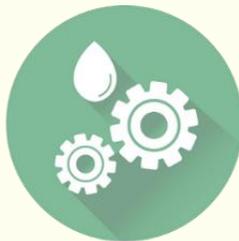
ABSTRACT BOOK

# PMIS 2023

*MATERIALS FOR SUSTAINABLE SOCIETY*

## The 8<sup>th</sup> Packaging and Materials Innovation Symposium 2023

9-10 March 2023



FACULTY OF  
AGRO-INDUSTRY

DEPARTMENT OF PACKAGING  
AND MATERIALS TECHNOLOGY

# Preface

This book includes the abstracts of all papers presented at the 8th Packaging and Materials Innovation Symposium 2023 (PMIS2023), co-organized by the Department of Packaging and Materials Technology, Faculty of Agro-Industry and the Department of Materials Engineering, Faculty of Engineering, Kasetsart University during the 9<sup>th</sup> and the 10<sup>th</sup> of March 2023.

The Packaging and Materials Innovation Symposium (PMIS) is a student symposium and was inaugurated jointly by the Department of Packaging and Materials Technology, Faculty of Agro-Industry and the Department of Materials Engineering, Faculty of Engineering, Kasetsart University in 2014. The events have been held annually and the host alternated between the Department of Packaging and Materials Technology and Department of Materials Engineering to strengthen a network for teaching and research collaboration in Materials Science and Engineering and Packaging. Moreover, the symposium is a platform for students to exchange their technical knowledge, improve their presentation skills and gain an industrial manufacturing perspective and a fresh outlook to innovate. Due to the COVID-19 pandemic, the 2020 and 2021 events were postponed and then was held virtually in 2022. With the strong collaborative relationship between the two host organizations, the 8<sup>th</sup> PMIS 2023 is being held on-site on March 9-10, 2023, at the Faculty of Engineering, Kasetsart University, hosting by the Department of Materials Engineering under the theme of “Materials for Sustainable Society.” The presentation includes two industry keynote speakers, 67 oral presentations by undergraduate students from the Department of Materials Engineering, Faculty of Engineering and the Department of Packaging and Materials Technology as well as the Department of Textile Science, Faculty of Agro-Industry, Kasetsart University.

It is our hope that through the 8<sup>th</sup> PMIS 2023, all participants can develop networks that would benefit their career development and advance the university towards the sustainable development goal for wider society based on the knowledge of the land.

For this symposium to be successful, the involvement of multiple parties is crucial. All participants, the main sponsor, BASF (Thai) Limited, members of the organizing committee and last but not least all the supporting staff of the 8<sup>th</sup> PMIS 2023 are greatly appreciated for their effort in putting this symposium together and their contributions towards the publication of this book.

Amornrat Lertworasirikul  
The General Chair of the 8<sup>th</sup> PMIS 2023

# Welcome Message for 8<sup>th</sup> PMIS 2023

Welcome to the Department of Materials Engineering, Kasetsart University. In today's competitive and globalized world, having a professional and specialized education becomes imperative for future success.

Materials serve as the actual building blocks of a robust national economy. Materials have been the impetus for scientific and technological advancement throughout the development of human civilization as the cornerstone of a wide range of enterprises. Materials science and engineering have historically been guiding, permeable, and infrastructural; as a result, the degree of materials research, along with its educational level, also reflects the overall strength of a nation. The achievement of our department's strategic goal of being a leader in the advancement of materials research and education to a level of world-class excellence is thus a crucial need.



At MatE KU, we are always striving to improve our programs to be at the forefront of higher education trends. Our objective is to achieve world-class accreditations to maintain excellent academic standards. Each current and prospective student has a bright future based on learning the technical and international skills needed to satisfy the expectations of businesses, industries, and international organizations.

And Welcome to the 2023 Packaging and Materials Innovation Symposium (The 8<sup>th</sup> PMIS 2023) on March 9-10, 2023 with the theme of “**Materials for Sustainable Society**”. The PMIS has satisfied the objectives in collaboration between Department of Packaging and Materials Technology, Faculty of Agro-Industry and Department of Materials Engineering, Faculty of Engineering, Kasetsart University.

We also keep this activity for almost a decade as one of our educational objectives. We applicate to create a scientific program that provides a chance for the exchange of knowledge and ideas between our invited speakers and students for our 25<sup>th</sup> Anniversary celebration period (to celebrate 25<sup>th</sup> Anniversary on 2022 and to this year). This platform would work very well on the active participation of the senior students.

I would like to thank all of you for your active involvement in keynote speaking, oral presentations, and informal discussions. Presenters will be able to share their unique insights into, and special viewpoints on scientific and research developments in their areas of expertise. It is also an invaluable experience for students and I hope they take advantage of the opportunity. I also would like to thank the students for attending, and bringing your expertise to our symposium. I hope that as senior students, you will be able to take advantage of what the hard work of the organizing of your and the others senior projects. For the committee from both departments, Department of Packaging and Materials Technology, Faculty of Agro-Industry and Department of Materials Engineering, Faculty of Engineering, Kasetsart University, that has produced this great symposium, I thank them for, what I believe will be, a great symposium with the expedient manner. Finally, I sincerely thank both keynote speakers for their valuable experience and great full presentation.

Associate Prof. Dr. SUREERAT POLSILAPA  
Head of the Department of Materials Engineering,  
Faculty of Engineering, Kasetsart University

# Welcome Message for 8<sup>th</sup> PMIS 2023

I would like to extend a warm welcome to all guests, key speakers, and student participants to The 8th Packaging and Materials Innovation Student Symposium (PMIS) 2023, jointly organised by Department of Packaging and Materials Technology (PKMT) and Department of Material Engineering (MAT-E).

PMIS 2023 is hosted by MAT-E this year, aims to bring together young researchers from both departments in the context of multi and inter-disciplinary forum and discussions. The symposium will provide an excellent opportunity of knowledge sharing and ideas exchange in the field of engineering, science and technology for a better quality of life to meet future challenges.

I hope that this event will be the benchmark for us to build a strong networking between young researchers, academic staff and industry. Finally, congratulations to all working committee and everybody who have supported our efforts in realising this symposium. I wish you all a memorable experience attending this event.

Assoc. Prof. LERPONG JARUPAN  
Head of Department of Packaging and Materials Technology (PKMT)  
Faculty Of Agro-Industry, Kasetsart University



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## The 8<sup>th</sup> Packaging and Materials Innovation Symposium (PMIS 2023)

*“Materials for Sustainable Society”*

Department of Materials Engineering, Kasetsart University

**DAY 1: 9 MARCH 2023**

08.30 - 09.00	<b>Registration</b> Room 0410 Chuchart Kampoo Building, Faculty of Engineering, KU					
09.00 - 9.30	<b>Welcome and Introduce to PMIS 2023:0</b> <b>Prof. Dr. Wanchai Yodsudjai</b> Dean of Faculty of Engineering, Kasetsart University <b>Assoc. Prof. Dr. Anuvat Jangchud</b> Dean of Faculty of Agro-Industry, Kasetsart University <b>Assoc. Prof. Dr. Sureerat Polsilapa</b> Head Department of Materials Engineering, Kasetsart University  Room 0410 Chuchart Kampoo Building, Faculty of Engineering, KU					
09.30 - 10.30	<b>Industry Trend and Sustainability Solution</b> <b>Keynote speaker: Mr. Surachai Thitirungrojkul</b> Regional Business Manager, Avery Dennison (Thailand) Ltd.					
10.30 - 10.45	Break					
10.45 - 11.45	<b>Insight from fhe Industry:</b> <b>How Innovation is Driving a Sustainable Future</b> <b>Keynote speaker: Dr.Wayoon Poonperm</b> Country Development, BASF (Thai) Ltd.					
11.45 - 12.45	Lunch					
	Room 0405 Chairperson : Nattapat Chaiammart	Room 0406 Chairperson : Pinuma Kaewrukxa	Room 0407 Chairperson : Pongpak Chiyasak	Room 0410 Chairperson : Jidapa Chantaramethakul	Room 0403 Chairperson : Anon Noochanong	Room 0313 Chairperson : Anchan Khankhuean
12.45 - 13.10	MAS-01	ASM-01	MPS-01	MPCT-01	ETA-01	MAS-14
13.10 - 13.35	MAS-02	ASM-02	MPS-02	MPCT-02	ETA-02	ETA-05
13.35 - 14.00	MAS-03	ASM-03	MPS-03	MPCT-03	ETA-03	
14.00 - 14.25	MAS-04	ASM-04	MPS-04	MPCT-04	ETA-04	MPCT-17
14.25 - 14.50	MAS-05	ASM-05	MPS-05	MPCT-05		ASM-12

**DAY 1: 9 MARCH 2023 (Continued)**

	Room 0405 Chairperson : Nattapat Chaiammart	Room 0406 Chairperson : Pinuma Kaewruksa	Room 0407 Chairperson : Pongpak Chiyasak	Room 0410 Chairperson : Jidapa Chantaramethakul	Room 0403 Chairperson : Anon Noochanong	Room 0313 Chairperson : Anchan Khankhuan
14.50 - 15.15	MAS-06	ASM-06	MPS-06	MPCT-06	MPCT-14	ETA-06
15.15 - 15.40	MAS-07	ASM-07	MPS-07	MPCT-07	MPCT-15	MAS-15
15.40 - 16.05	MAS-08	ASM-08	MPS-08	MPCT-08	MPCT-16	MAS-16
16.05 - 16.30	MAS-09		MPS-09	MPCT-09		ASM-13

**DAY 2: 10 MARCH 2023**

08.45 - 09.00	<b>Registration</b> Room 0410 Chuchart Kampoo Building, Faculty of Engineering, KU					
	Room 0405 Chairperson : Nattapat Chaiammart	Room 0406 Chairperson : Pinuma Kaewruksa	Room 0407 Chairperson : Pongpak Chiyasak	Room 0410 Chairperson : Jidapa Chantaramethakul		Room 0313 Chairperson : Anchan Khankhuan
09.00 - 09.25	MAS-10	ASM-09	MPS-10	MPCT-10		MPCT-18
09.25 - 09.50	MAS-11	ASM-10	MPS-11	MPCT-11		MPCT-19
09.50 - 10.15	MAS-12		MPS-12	MPCT-12		
10.15 - 10.40	MAS-13	ASM-11	MPS-13	MPCT-13		
10.40 - 11.30	Break					
11.30 - 12.30	<b>Awarding &amp; Closing Remark</b>					



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# PMIS 2023

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<sup>th</sup>  
The 8 Packaging and Materials  
Innovation Symposium 2023  
9-10 March 2023

## Keynote speaker



# WAYOON POONPERM, Ph.D

## Country Development (BASF Thailand)

## Speaker Profile

### 2021-2023: Country Development, BASF Thailand

- Leading sustainability activities & Strategic projects of BTL
- Strong engagement with key organizations in public and private sectors on the topic of “*Carbon Management, Circular Economy and Sustainable solutions*” in collaboration with BASF global and regional sustainability team.



### 2012-2020: Senior Manger, BASF Thailand

- Driving technical solutions of Agro-chemical – animal nutrition products of BASF - in ASEAN countries
- Several new developments on new molecules, new markets and new applications together with customers and universities.



### Education:

**Ph.D (Biotechnology)**, Faculty of Agriculture,  
Ehime University, Japan

**B.Sc (Microbiology)**, Faculty of Science,  
Chiang Mai University, Thailand





## **Mr. Surachai Thitirungrojkul**

Regional Business Manager, Avery Dennison (Thailand) Ltd.

- Work experience in printing industry more than 20 years
- Work experience in Label & Material more than 15 years



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## Advanced Functional & Smart Materials (ASM)

# Influence of crystallization time on microstructure and optical properties of mica-based glass-ceramics as restorative dental materials



**Pimpawan Chanmat<sup>1</sup>, Phusanisa Butsri<sup>1</sup>, Suphahud Pintasiri<sup>1</sup>  
Thapanee Srichumpong<sup>2</sup>, and Duangrudee Chaysuwan<sup>1\*</sup>**

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**ABSTRACT-** Nowadays, glass-ceramics is a type of ceramics used for restorative dental materials. The properties of glass ceramics depend on the crystalline phase and the remaining glassy phase (parent glass). The separated crystals, which are really tiny and uniformly dispersed affect properties and microstructures. The glass possesses an amorphous structure whereas the crystalline structures with disorder arrangement led to translucency, high strength and more fracture toughness. The properties of glass ceramics can be improved by the mixture of precursors, additives and controlling heat treatment, such as nucleation and crystallization. In this research, the influence of crystallization time may change mechanical properties, optical properties and microstructure of the glass-ceramics were studied with the controlled crystallization at different time (3, 5 and 7 min). The microstructure by SEM of glass-ceramics was crystallized at 3 min presented a large number of small crystals and those at 5 and 7 min gave crystals were larger crystals, while TEM analysis of nucleated glass (72 hr nucleation time) presented large number of nuclei were formed. The nuclei size were in ranged 30 to 70 nm. For the glass ceramics, lattice plane indicating the crystallinity of the material was found. The distance between the lattice ranges from 1 to 2 nm. The translucency by Colorimeter (Translucency parameter; TP = 0: opaque, TP = 100: translucent) of glass-ceramics at 3, 5 and 7 min were 8.33, 13.00 and 4.96, respectively, while, human teeth were 15. The Vickers hardness values of glass-ceramics of 3, 5 and 7 min were 6.95, 3.94 and 4.49 GPa, respectively, while that of human teeth (enamel) were 2.70 GPa.

*Keywords: Mica-based glass-ceramics, Heat treatment, Translucency, Hardness, Optical properties*

# Development of thermoplastic starch blended PBAT with papain and bromelain into functional film for meat tenderization



**Jenjira Leelapatarapun<sup>1</sup> and Nathdanai Harnkarnsujarit<sup>1\*</sup>**

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**ABSTRACT-** Papain and bromelain are proteolytic enzymes that catalyze degradation of actin and myosin in meat proteins. Incorporations of these enzymes into films possibly produces functional packaging materials which tenderize meat products. The aim of this study was to enhance functional properties of biodegradable films by incorporation of papain and bromelain for meat tenderization. Both enzymes were blended with polybutylene adipate-co-terephthalate (PBAT) and thermoplastic starch (TPS) at 10, 20 and 30% (w/w) via extrusion and the plastic sheets were produced by cast sheet extrusion. Higher concentrations of these enzymes increased oxygen permeability (OP) but decreased water vapor permeability (WVP) probably due to increased hydrophobicity. The functional films were placed on meat products and the meat firmness were monitored during incubation for 1, 2, and 3 hours. Films containing papain and bromelain effectively reduced firmness of packaged meat products after incubation for 1 hour. Papain gave a softer texture and hence more meat tenderization than bromelain. Films with 10% papain gave the highest meat tenderization due to fast dissolution and release of enzymes onto meat surface. The finding indicated high potential of functional enhancement in biodegradable films via incorporation of papain and bromelain produced by extrusion which can be further developed into larger scale production for commercial levels.

*Keywords: Functional packaging, Texture, Advanced material*

# ZnO seed layer on FTO Substrate for ZnO nanogenerator



**Sanpet Petcharuk<sup>1</sup> and  
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**ABSTRACT-** Nowadays, electrical energy is very necessary for life, leading to continuous development of power generators, including those that utilize the property of piezoelectric materials. Zinc oxide (ZnO) is popularly studied as a piezoelectric material. In the synthesis of nanogenerator, the key step is ZnO seed layer, which can be achieved through various methods resulting in different outcomes. In this work, for ZnO coating on a FTO glass substrate, there are two methods for ZnO seed layer: spray pyrolysis and spin coating. In the spray pyrolysis method, a solution of 1.119 g zinc acetate dihydrate solution in 100 mL methanol was sprayed onto the FTO glass surface for 15 minutes at 430 °C. In the spin coating method, a solution of 2.238 g zinc acetate dihydrate solution in 100 mL methanol was used to coat on the FTO glass substrate and heated in a furnace at 350 °C for 20 minutes. This process was repeated four times. Zinc oxide crystals were then grown by hydrothermal method. For the hydrothermal process, the seeded FTO glass substrates were put in a solution of 0.19 g zinc nitrate hexahydrate in 25 mL water and 0.09 g hexamethylenetetramine and heated inside an autoclave chamber at 90 °C for 12 hours. After removing from the chamber, the samples were heated at 90 °C for 15 minutes for the treatments of ZnO films on the FTO glass substrate. The two methods of ZnO growth resulted in different levels of dispersion. The spray pyrolysis method resulted in a higher degree of dispersion and a higher density of ZnO, but smaller crystals size than the spin coating method. Growing ZnO with spin coating method was more dispersed in bulk and exhibited larger crystals. The electrical energy harvesting of the two different ZnO films were tested and compared.

*Keywords: ZnO seed layer, ZnO nanorod, ZnO nanogenerator*

# Development of packaging system for extending the shelf life of mango cv. Nam Dok Mai



Pairpilai Khattiwong<sup>1</sup>, Supitchaya Hongai<sup>1</sup>, and Pattarin Leelaphiwat<sup>1\*</sup>

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**ABSTRACT-** Thailand now ranks as the second-top exporter of fresh mangoes in ASEAN and 7<sup>th</sup> in the world. However, the deterioration of mangoes was found during transportation due to anthracnose caused by *Colletotrichum gloeosporioides*, the major postharvest disease of mangoes. Antimicrobial packaging is a kind of active packaging that provides the special function of microbial growth inhibition in order to extend shelf life and prevent the loss of product quality. Moreover, due to environmental concerns, biodegradable plastic became one of the alternatives to reduce single-use plastic (SUP) for fresh produce packaging. This study aims to develop biodegradable packaging system with lignin-entrapped natural agents. The agar diffusion and agar dilution methods were used to determine minimal inhibitory concentrations (MICs) of cinnamaldehyde, with the concentration range varying from 6.25–400 mg/L for the fungal *Colletotrichum gloeosporioides*. The lignin-entrapped cinnamaldehyde with varied ratios of lignin to cinnamaldehyde (1:1, 1:2 and 1:3) was produced based on the minimum inhibitory concentration (MIC) starting at 400 mg/L, which indicated the inhibition effect on *Colletotrichum gloeosporioides*. In comparison to the control stored at 12±2 °C for the packaging application, a mango with a sachet of lignin-entrapped cinnamaldehyde was packed in microperforated PBS films with 24 microholes at 200 μs of pulse duration. For all treatments, the gas compositions in the mango package reached equilibrium on the first day after storage within the range of 13–19% CO<sub>2</sub> and 5–11% O<sub>2</sub>. The findings showed that a packaging system that combined the modified atmosphere with an antifungal agent inhibited fungal growth on the mango with regular ripening, resulting in good weight loss and overall appearance.

*Keywords: Fresh mango, Active packaging, Cinnamaldehyde*

# Influence of crystallization time on strength and fracture toughness of mica-based glass-ceramics as restorative dental materials



**Nareerat Komutthapong<sup>1</sup>, Suriya Wiangnon<sup>1</sup>,  
Suphahud Pintasiri<sup>1</sup>, and Duangrudee Chaysuwan<sup>1\*</sup>**

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**ABSTRACT-** The mica-based glass-ceramics were prepared in the SiO<sub>2</sub>-MgO-SrCO<sub>3</sub>-Al<sub>2</sub>O<sub>3</sub>-MgF<sub>2</sub>-CaCO<sub>3</sub>-CaF<sub>2</sub>-P<sub>2</sub>O<sub>5</sub> glass system. Yttria-stabilized zirconia (YSZ) and cerium oxide (CeO<sub>2</sub>) were added to improve mechanical and physical properties. This includes identifying any changes to the fracture toughness and chemical solubility of glass-ceramics through studying its microstructure, crystal size and chemical composition of mica-based glass-ceramics. The nucleation process at 643° for 72 hours and the crystallization process at 897°C for 3, 5 and 7 minutes were characterized by x-ray diffractometer and scanning electron microscope. The fracture toughness (K<sub>IC</sub>) was determined using the SEVNB method. The result of adding YSZ increased the number of crystals. The microstructures showed that the crystallization time affecting the crystalline morphology significantly, i.e., for 3 minutes: very fine uncrystallized particles size 460-699 nm, for 5 minutes: larger crystals with a diameter of 2.94-3.43 μm, and for 7 minutes: finer crystals and decreased to 2.22-2.45 μm. The phase analysis consisted of calcium-mica, fluorapatite and anorthite. The biaxial flexural strength (255.66 MPa) was accepted by ISO 6872:2015 type II class 2a. The K<sub>IC</sub> result was an average of 2.39 mPa·m<sup>1/2</sup> and chemical solubility tests with acetic acid gave result of 72.19 μg/cm<sup>2</sup>. The values of K<sub>IC</sub> and chemical solubility were accepted by ISO 6872:2015 type II class 3a stating the mechanical properties of fracture toughness 2.0 mPa·m<sup>1/2</sup> and chemical solubility <100 μg/cm<sup>2</sup>. The higher fracture toughness and less chemical solubility could attribute to the changed morphology of the addition of YSZ and CeO<sub>2</sub> and crystallization time. Therefore, the glass-ceramics is expected suitable to be utilized as a restorative dental material.

*Keywords: Mica-based glass-ceramics, Yttria-stabilized zirconia, Crystallization time*

# UV-Shielding Property of Monascus Azaphilone Pigments-Incorporated Methylcellulose-based Films for Bioactive Packaging



**Kannika Ratchawong<sup>1</sup>, Nattharima Silanin<sup>1</sup>, and Panuwat Suppakul<sup>1\*</sup>**

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**ABSTRACT-** Bioactive packaging has fascinatingly opened new horizons and opportunities in preserving the quality, enhancing the safety, and extending the shelf life of foodstuffs. Monascus azaphilone pigments (MonAzPs) are widely used as food colorants. Surprisingly, they also substantially possess UV-shielding property. In this present study, MonAzPs from *Monascus kaoliang* were adopted for bioactive agent in order to enhance UV-shielding property of methylcellulose (MC)-based film as a bioactive packaging material. The extracted MonAzPs including rubropunctamine (red pigment) and a mixture of monastic and ankaflavin (yellow pigment) have been incorporated into MC-based film with different concentrations. The incorporation of MonAzPs into MC-based films affected optically transparency with their transmittance depending upon MonAzPs concentrations. In the UV region, the transmittance values decreased with increasing MonAzPs concentrations. It was found that 15 % v/v MonAzPs incorporated MC-based film could be superior regarding to its UV shielding property by reducing transmittance from 60.11% to 2.90% in the UV-B band (280–315 nm) and from 72.04% to 9.67% in the UV-A band (315–400 nm) compared with the control MC film. The addition of MonAzPs into MC films was substantiated by FTIR spectra. Moreover, impregnation of MonAzPs into MC film demonstrated that MonAzPs virtually augmented the UV-shielding property of MC film. It is therefore recommended that MonAzPs impregnated MC-based films and coatings may be used as bioactive packaging materials, contributing to food preservation and shelf life prolongation.

*Keywords: Bioactive packaging, Methylcellulose, Monascus azaphilone pigment, Ultraviolet shielding*

# Effect of TiO<sub>2</sub> on barrier properties of PLA/PBAT biodegradable films

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**ABSTRACT-** People are becoming more environmentally aware of the current climate change crisis. Due to environmental problems, there is an increasing demand for biodegradable polymers to reduce the environmental impact from petroleum-based plastic packaging materials. The key properties of food packaging materials are extending the shelf life and protecting food from many factors, such as ultraviolet radiation, moisture or oxygen. The objective of this research was to study the effect of titanium dioxide (TiO<sub>2</sub>) on the permeability properties of polylactic acid (PLA) and polybutylene adipate-co-terephthalate (PBAT) blend films. The PLA/PBAT adding 1 and 3% TiO<sub>2</sub> composite films were made to be used as food packaging materials. The results of permeability studies by testing the permeability of water vapor and oxygen showed that the addition of 1% TiO<sub>2</sub> did not give a very different barrier effect from the control. At 3% TiO<sub>2</sub>, the permeability of water vapor and oxygen increased. The results showed that the barrier to water vapor and oxygen of the PLA/PBAT and 3% TiO<sub>2</sub> films decreased. This may affect its use as a food packaging material. For the contact angle test, it was found that adding 1% TiO<sub>2</sub> decreased the contact angle, but adding 3% TiO<sub>2</sub> increased the contact angle. This will affect printing performance of the films.

*Keywords: Biodegradable film, Barrier properties, Food packaging*

# Synthesis of Ni Nanoparticles Supported on Carbon Black as Electrocatalysts for Hydrogen Evolution Reaction



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**ABSTRACT-** Hydrogen evolution reaction (HER) is an important reaction in water electrolysis for hydrogen production. Nowadays, Pt is known as the most efficient HER electrocatalyst owing to its excellent catalytic activity. However, the high price and low abundance in nature of Pt are major obstacles to widespread implementation and sustainability. Therefore, the exploration and development of alternative low-cost HER electrocatalysts have gained a lot of attention and remain challenging. Herein, we studied the synthesis of Ni nanoparticles supported on carbon black (Blackpearls®2000) as HER electrocatalysts. The Ni nanoparticles were facilely synthesized via the solution plasma sputtering of Ni wire electrodes under the dispersion of carbon black in liquid solvent for 10, 20, and 40 min at room temperature. Ni nanoparticles exhibited good crystallinity and good distribution on the carbon black. The amount of Ni nanoparticles increased with increasing sputtering time. The HER activity of the electrocatalysts was examined by linear sweep voltammetry (LSV) with a three-electrode system in an N<sub>2</sub>-saturated 0.1 M KOH solution. With the increasing amount of Ni nanoparticles, the HER activity was significantly improved, as reflected by higher current density and lower overpotential. This indicates that Ni nanoparticles could serve as the active sites for HER. However, their HER activity was still inferior to a commercial Pt/carbon. The results obtained herein show that low-cost Ni-based HER electrocatalysts can be synthesized by an innovative plasma process for sustainable hydrogen production.

*Keywords: Hydrogen evolution reaction, Ni nanoparticles, Carbon black, Solution plasma*

# Enhancing the optical properties of poly(lactic acid) (PLA)/poly(butylene adipate-co-terephthalate) (PBAT) incorporating TiO<sub>2</sub>



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**ABSTRACT-** This research focused on the optical properties of poly(lactic acid) (PLA)/ poly(butylene adipate-co-terephthalate) (PBAT) blend film adding titanium dioxide (TiO<sub>2</sub>) 0, 1, and 3% (w/w) to improve the film's UV blocking. The measurement included color parameters and brightness. The increase in TiO<sub>2</sub> in PLA/PBAT/TiO<sub>2</sub> films increased the film whiteness and gloss, as well as the transmittance in the 200-800 nm range, compared to PLA/PBAT films. The results showed that the protection against UV-light increased by increasing the amount of TiO<sub>2</sub>. Bananas in heat sealed PLA/PBAT packaging film exhibited slower darkening color change and longer shelf-life than bananas without packaging. However, due to high opacity of the PLA/PBAT/TiO<sub>2</sub> film, the effect of TiO<sub>2</sub> on banana darkening and shelf-life was not observable.

*Keywords: Biodegradable plastic film, Titanium dioxide, Optical properties*

ASM\_10

# Efficacy of coatings on kraft paper containing star-anise and cinnamon essential oils against *Sitophilus Oryzae*



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**ABSTRACT-** The *Sitophilus oryzae* is considered a strong enemy of the rice grain. Causing damage to distributors as consumers dislike contamination of all kinds of insects. Nowadays, chemical repellents are commonly used which are dangerous and the use of plastic packaging is quite high. Therefore, a coating that can repel *Sitophilus oryzae* with natural substances must be developed in conjunction with easily recyclable packaging. star-anise and cinnamon essential oils were mixed with the hydrophobic starch solution. as an ingredient in coatings by acting as a carrier, it can be coated on paper. There will be a comparison of paper types to find the type that has the greatest impact on performance. and the same concentration of essential oils was used in the coating. which affects the efficiency of *Sitophilus oryzae* resistance paper and increases strength by using a coating containing hydrophobic starch at the concentration of 20 percent by weight of starch per distilled water as a carrier, star-anise, and cinnamon essential oils at the concentration of 7 percent were effective in repelling *Sitophilus oryzae*. Using ratios of 0, 25:75, 50:50, 75:25, and 100 percent of anise essential oil to cinnamon, respectively, it was found that the coating containing hydrophobic starch margins and star-anise and cinnamon essential oils are the compositions. Coated on both types of paper are effective in repelling *Sitophilus oryzae*. which can be further developed with other types of paper It is also made into environmentally friendly packaging.

*Keywords: Coatings paper, Essential oils, Sitophilus oryzae*

# Geopolymer from kaolin metakaolin and fly ash with zeolite for heavy metal encapsulation



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**ABSTRACT-** At present, the industries have eradicated heavy metals from water before pouring into the environment by methods either containing them in the bags encapsulated by cement in the shape of rods then buried under the plots of land far away from the communities and water reservoirs or melting together with glasses in the form of crystal enclosed in stainless steel or copper containers. However, both methods consume a lot of energy and emit carbon dioxide which creates the greenhouse effect. Therefore, the replacement of material of cement or glass is developed. Geopolymer is a new alternative material that can withstand high compressive strength and is expected to be used as material for encapsulating heavy metals. It was produced from pozzolan materials, kaolin, metakaolin, F class fly ash, alkali solution such as 8 molar sodium hydroxide, sodium silicate, and zeolite additive. Geopolymer pastes were formed and cured for the periods of 3, 7, 28, and 91 days for test and analyze their mechanical, physical, and chemical properties. It was found that compressive strength between raw materials of kaolin and metakaolin were 21.77 and 29.97 MPa, respectively. As an analysis of chemical compositions, phases of quartz, muscovite and mullite presented and were confirmed by the functional group of Si-O-(Si/Al) to show the reaction of complete geopolymerization. From the result of microstructure via SEM/EDS, it was found that heavy metals such as lead and copper encapsulated in geopolymer and they had been confirmed by leaching test with AAS. After encapsulation of heavy metals with geopolymer, contamination of heavy metals was very low. and result passed the Ministry of Industry Announcement on Prescribing standard control for sewage disposal from factories B.E. 2560 showed the geopolymer is a suitable material for encapsulating heavy metals.

*Keywords: Geopolymer paste, Kaolin, Metakaolin, Zeolite, Heavy metal encapsulation*

# Preparation of nano-silver coated poly(vinyl alcohol) as a material for metal ions detection kit



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**ABSTRACT-** Leakage of metal ions contamination in water sources is dangerous and toxic to health and the environment. Nowadays, there are many precise methods for metal ion detection widely used in the industry, however, these methods are still expensive, need technical expertise and take a long time for measurement. In this study, to solve the problems we, therefore, developed a metal ions-detected kit by coating poly(vinyl alcohol)/AgNPs on the filter paper. Nano-silver coated poly(vinyl alcohol) was synthesized by the green process and used ascorbic acid as a reducing agent. The obtained poly(vinyl alcohol)/AgNPs was prepared as a solution for coating on the filter paper as a layer by layer. The metal ions used in this study were Hg<sup>2+</sup>, Ni<sup>2+</sup>, and Pb<sup>2+</sup> ions. It was found that only Hg<sup>2+</sup> ion can be detected. The color of the metal ion-detected kit was changed from yellow to bright yellow and the shade of color was also related to the Hg<sup>2+</sup> concentration. The limit of Hg<sup>2+</sup> detection by the metal ion-detection kit was found to be 5 ppm. From the results, it can be concluded that the obtained metal ion-detected kit is cheap and shows high efficiency for detecting the Hg<sup>2+</sup> ion by the naked eyes.

*Keywords: Nano silver, Metal ion detection*

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# Synthesis of Copper-doped Titanium Dioxide as a Sensing Material for Nitrite Detection by Electrochemical Technique



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**ABSTRACT-** Nowadays, humans consume nitrite in the form of food additives which may lead to occurrence of cancer. Detection of nitrite is therefore crucial. This research project aims at synthesizing copper-doped titanium dioxide by the solution combustion technique for nitrite detection. X-ray diffraction results revealed copper-doped titanium dioxide with only a minimal amount of impurities. The average particles size was found to be  $280 \pm 69.632$  nanometers. When the copper-doped titanium dioxide/multi-wall carbon nanotube composite was tested for their electrocatalytic activities in the nitrite solution using cyclic voltammetry technique, the oxidation and reduction reactions were evident at the applied voltages close to 0.55 and -0.85 volt, respectively. The copper-doped titanium dioxide/multi-wall carbon nanotube composite demonstrated its capability in detection of nitrite at the concentration ranging from 100 to 1,000 micromolar. The experimental results indicated the potential of copper-doped titanium dioxide as a sensing material for nitrite detection.

*Keywords: Cu-doped TiO<sub>2</sub>, Electrochemical technique, Nitrite*



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## Emerging Technology and Applications (ETA)

# Innovative texture enhancement edible films for processed meat products from cassava starch blended transglutaminase



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**ABSTRACT-** Transglutaminase (TG) is an enzyme which cross-links networks of protein structures, causing a firmer texture of meat products. Incorporating TG into edible films and applied onto surface of meat possibly improved firmness of meat products. This research aimed to develop novel functional films which effectively enhanced firmness of meat products based on TG incorporated biopolymers. Novel films were prepared from pregelatinized cassava starch with different TG concentrations (0, 5, 10, 15 and 20%wt.) by solution casting. The films were determined for physical, mechanical and barrier properties as oxygen transmission rate (OTR) and water vapor transmission rate (WVTR), surface hydrophobicity (contact angle) and solubility. Films were applied on surface of ground pork and meat tenderness was determined for 5 hours during storage at  $7 \pm 1$  °C. Transglutaminase significantly increased contact angle of starch films, indicating improved surface hydrophobicity probably due to presence of hydrophobic groups in transglutaminase. Films containing transglutaminase displayed increased OP but decreased WVP with reduced light transmission within UV ranges. Interaction between starch and TG reduced solubility, but with regard to the color coordinates, the meat with TG films was lighter than the control group. Applications of novel films containing TG significantly enhanced firmness of meat products after applied on meat for 5 h.

*Keywords: Transglutaminase, Edible film, Food packaging*

# Permeation of aroma compound through the microperforated films

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**ABSTRACT-** The gas transmission rates of petroleum-based and bio-based films used for packaging fresh produce could be enhanced with the laser perforation technique. The oxygen and carbon dioxide transmission rates of the films increased with the number and diameter of microholes. However, data on the permeation of organic compounds through the microperforated (MP) films is limited. This study compared the cinnamaldehyde transport coefficients of microperforated poly (lactide) (MP-PLA), poly (butylene succinate) (MP-PBS), and polyethylene terephthalate (MP-PET) films with varying pulse durations of 100 and 200  $\mu\text{s}$  of a microhole to those of non-perforated films at storage temperature 25 °C. Furthermore, differential scanning calorimetry (DSC) was used to determine the thermal properties of films before and after the sorption phenomenon occurred at equilibrium. The mass of cinnamaldehyde permeation was measured using gas chromatography with a flame ionization detector (GC-FID), and the sorbed cinnamaldehyde was extracted from the film samples using dichloromethane at the equilibrium time. The transport coefficients of cinnamaldehyde through the packaging films were calculated. From the experiment, PLA had the highest permeability coefficients, followed by PBS and PET, respectively. The non-perforated films showed higher permeability than the microperforated films. The solubility coefficients of cinnamaldehyde were highest in PLA film, followed by PBS and PET, respectively. The solubility increased with decreasing glass transition temperatures ( $T_g$ ) and melting temperatures ( $T_m$ ) of the PLA and PBS films. The results suggest that there is no effect of the microperforations on the permeation of cinnamaldehyde, whereas cinnamaldehyde acts as a plasticizer, affecting the interactions between the aroma compound and the film samples.

*Keywords: Packaging films, Transport coefficients, Cinnamaldehyde*

# Development of lignin nanoparticles films with UV blocking to maintain vitamin in food



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**ABSTRACT-** Vitamin C or ascorbic acid is a dietary ingredient, especially fruits and vegetables that are beneficial to the human body. Vitamin C loses both quantity and quality from various factors during storage. Lignin is a natural material with UV-blocking properties which catalyzes the breakdown of vitamins. Therefore, lignin nanoparticles were added to the packaging materials to help slowing down the breakdown of vitamin C in food. The lignin nanoparticles with concentrations of 0.75% and 1.5% (by weight) were mixed into Poly(lactic acid) (PLA) and formed into film by blowing method. Then, the physical properties of films including non-lignin-addition films (Neat PLA), films with 0.75% lignin nanoparticles (0.75Lignin/PLA) and 1.5% (1.5Lignin/PLA) were tested. The results showed that films with the addition of lignin nanoparticles showed a darker color, less light transmittance, and lower tensile properties compared to the non-lignin-addition films. The films were packed with vitamin C solution and stored under ultraviolet light. The loss amount of vitamin C was analyzed by titration method. It was found that 1.5%Lignin/PLA and 0.75%Lignin/PLA were able to slow down the loss of vitamin C better than Neat PLA respectively. The results showed the high concentration of lignin nanoparticles helps to slow the degradation of vitamin C better than this might be caused by the increased ability of UV-blocking. To conclude, the results of this research can be further developed for food packaging to reduce the loss of vitamin C and can increase the shelf life of food.

*Keywords: Lignin nanoparticles, Poly(lactic acid) films, Vitamin C*

# Development of film packaging for preventing discoloration of Thai herbs



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**ABSTRACT-** Thailand is a country that grows many kinds of herbs and vegetables. The color quality, especially the green color of herbs and vegetables, is what consumers use to make the first purchase decision because it represents freshness. Light is one of the main factors that catalyze the degradation of chlorophyll, the green pigment in plants. In this research, lignin is an industrial waste, has the property of blocking ultraviolet radiation was added to the packaging materials to slow down the deterioration of the efficiency of chlorophyll in any Thai herb. The researcher team has developed a biodegradable polylactic acid packaging film by adding lignin nanoparticle at concentrations of 0.75% (0.75%Lignin/PLA) and 1.5% (1.5%Lignin/PLA) in the masterbatch and then formed into a film by blowing process and then it was found that the film with added lignin nanoparticles had an increase in Water vapor transmission rate and a decrease in Oxygen transmission rate when compared to that film without lignin added (Neat PLA). According to the light transmittance test results by UV-Vis spectroscopy technique, it was found that Neat PLA allows the most light to pass through, because neat PLA is transparent, followed by 0.75%/PLA Lignin and 1.5%/PLA Lignin, respectively.

When the film was packed with chlorophyll solution and keep it under ultraviolet light. It was found that the packaging containing 1.5%Lignin/PLA and 0.75%Lignin/PLA of lignin nanoparticles added slowed down the degradation of chlorophyll better than the packaging without lignin, respectively. This biodegradable lignin packaging could be applied to preserve the color quality of Thai herb.

*Keywords: UV-blocking; Lignin nanoparticles; Chlorophyll*

# Design and development of sustainable products from leftover fabric and scarp yarn

## Case study: Sabina Fareast Co. Ltd.



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**ABSTRACT-** Garment and textile production process generates a large amount of the pre-consumer textile waste. One of the methods to reduce these textile waste is to produce the new products. This research aims to design and develop new products from the leftover fabric and yarn by color stripping and re-dyeing with natural dye. The leftover stretch fabric from garment factory and scarp yarn from craft woven enterprise were stripped by the mixture of sodium hydroxide and sodium hydrosulphite. Then, the stripped textile material were dyed by natural dye (indigo dye, teak leaves, and sea almond leaves) with alum as a mordant. Wash fastness and tensile strength of these dyed material were also investigated. Lastly, the re-dyed materials were woven by card weaving technique and knitted by macramé and crochet technique in order to produce bra accessories and tote bag. It was found the stripping process was carried out at 50 g/l sodium hydroxide and 50 g/l sodium hydrosulphite at 100°C for 30 minutes. The results showed these re-dyed materials which was dyed with indigo dye gave a blue shade, the fabric dyed with teak leaves gave a pink shade, and the fabric dyed with sea almond leaves gave a brown shade. Wash fastness of the natural dyed material was moderate to good. The strength of the re-dyed material was not significantly decreased.

*Keywords: Color stripping, Natural dyeing, Product development*

# Manufacturing of glass ceramic foam reinforced with glass fiber for bio ceramic applications



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**ABSTRACT-** The purpose of this research was to study and improve the microstructures of forming cullet mixed with sodium bicarbonate. Reinforcement with glass fiber into products composed of cullet and sodium bicarbonate functioned as foaming agent effect to the received workpieces like lightweight concrete due to light weight, high compressive strength, good strength, low density, and low water absorption. The process is to mix glass cullet with sodium bicarbonate in the proportion of 0, 1, 3, and 5 wt% and compress in a cube shape formation. The specimens were calcined at 800°C and 900 °C for 1 h at each temperature. The final part is to addition glass fiber into the best formula of the received glass foam structure by using glass fiber 0 wt%, 1 wt%, 3 wt% and 5 wt% and then using firing temperature according to the best selected formula. From this research, it was found that the bulk density of fiber reinforced samples was 0.9-1.2 g/cm<sup>3</sup> and the actual density was 0.9-1.22 g/cm<sup>3</sup>. The obtained specimens had high compressive strength up to 9.66-16.77 MPa and low water absorption value of 1.3-2.7%. The deterioration test of all formulas was found that all formulas were not damaged at temperature 121 °C and at pressure 15 psi by autoclave. In addition, the increasing of pore volume had trend according to increasing of the amount of foaming agent.

*Keywords: Glass-foam, Glass fiber reinforcement, 3D glass fiber composites*



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## Materials for Sustainability (MAS)

# Effect of barium titanate on properties of polylactic acid films

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**ABSTRACT-** Polylactic acid (PLA) is a biodegradable plastic that shows a tendency to exhibit dielectric properties. This project aims to adjust the dielectric properties of PLA by mixing with barium titanate (BTO), a dielectric ceramic, and stretching to orient the PLA molecular chains. PLA and PLA-BTO films were prepared by solution casting and weight percentage of BTO was varied as 1.2, 2.4, 3.6, 4.8, 5.9 %wt. BTO could strengthen the films as tensile strength of PLA-BTO having higher BTO content were higher. The dielectric permittivity of the films decreased as BTO content increased. XRD results confirmed an increase in crystallinity of the films after stretching, resulting in a further reduction of dielectric permittivity and lower % light transmission of the films. The accelerated weathering test revealed that addition of barium titanate powder could accelerate the degradation of polylactic acid film.

*Keywords: Barium titanate, Bioplastic, Dielectric material, Polylactic acid, Degradation*

# Influence of calcium propionate on degradation of polylactic acid



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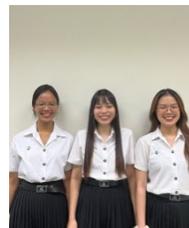
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**ABSTRACT-** This project aims to study properties and degradation of polylactic acid/ calcium propionate blends (PLA-CP). PLA-CP compounds were prepared in a twin screw extruder by varying weight percentage of calcium propionate (CP) as 0.025 0.05 0.075 0.1 0.25 0.5 and 1 %wt. The compression molded polylactic acid (PLA) and PLA-CP films were clear, and agglomeration of CP powder was clearly observed for the films containing higher content of CP. Phase separation was clearly observed in SEM images of PLA-CP films having CP content higher than 0.075 %wt. DSC thermograms revealed that the crystallization temperature was slightly decreased for the PLA-CP films having CP content in a range of 0.5-1 %wt. Tensile strength and % elongation at break of PLA-CP films were lower than PLA film due to a chain scission during film processing as confirmed by a lower molecular weight and broader molecular weight distribution of PLA-CP films. A larger decrease in %transmission of the films with higher content of CP was found after they underwent accelerated weathering test. XRD results revealed an increase of crystallization of the films after the accelerated weathering test and rougher surface observed in SEM images indicated the occurrence of surface degradation. After accelerated degradation test, tensile strength of PLA was 5% decreased while those of PLA-CP films at different CP content were 20-30% decreased due to their lower molecular weight. Slightly increased in % elongation at break and decreased in the glass transition temperatures of PLA-CP films after the degradation test indicated that the degradation products might involve in mobility of the molecular chain.

*Keywords: Bioplastic, Polylactic acid, Calcium propionate, Degradation*

# Feasibility study of using bioplastic films replaced commercial films for gas-release packaging



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**ABSTRACT-** The demand for active packaging has rapidly grown in recent years. Adding an active compound to plastic sachets and allowing it to evaporate is one common technique. Most of sachets are made of commodity plastic, which is non-biodegradable and appears to be environmentally harmful today. Replacing non-biodegradable sachets with biodegradable sachets adds value to the current supply-chain. In this study, polymer blend (70:30) from polybutylate adipate terephthalate (PBAT) and thermoplastic starch (TPS) was used as main polymer matrix. The main drawback of this polymer blend, its poor gas and moisture barrier, became a key point in the development of an active sachet for carbon dioxide (CO<sub>2</sub>) gas. The mixing ratio and desired quantity of CO<sub>2</sub> precursors from sodium bicarbonate and citric acid were study. The rate of moisture and gas transmission, gas generation, and concentration of CO<sub>2</sub> in the headspace were evaluated. When low barrier sachets (PBAT and PBAT/TPS) were used, the lifetime of the CO<sub>2</sub> emitting sachet was short (60hrs). The initial CO<sub>2</sub> concentration in headspace was >80% in air, which was too high, while the remaining CO<sub>2</sub> concentration after 40 hrs was low (<5% in air). The addition of zinc oxide nanoparticles (ZnO) to polymer blend slowed the rate of CO<sub>2</sub> emission. PBAT/TPS-ZnO 5% demonstrated promising properties for CO<sub>2</sub> emitting sachets. The initial concentration of CO<sub>2</sub> in headspace was lower (< 40% in air) while the releasing performance was maintained at over 100 hrs with at 5% CO<sub>2</sub> in air.

*Keywords: Carbon dioxide emitter, Polymer blend, Nano-ZnO*

# Improvement of deinking process using natural surfactants for paper recycling by air flotation technique



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**ABSTRACT-** Paper recycling is an important step toward reducing the environmental impact. In typical, chemical surfactants are used to remove the ink attached in deinking process. However, they caused environmental pollutions, especially the wastewater with the presence harmful chemical substances. The natural surfactant becomes the better alternative to moderate these issues. The aim of this work is to improve the ink removal efficiency for paper recycling using natural surfactants by air flotation technique. The effects of surfactant/paper ratio, type of surfactants, immersion time and immersion temperature on deinking efficiency were studied. Small pieces of shred paper were immersed in surfactant solution, pulped by blender, floated by air, filtered by filtration system, and dried by hot air oven. The results were evaluated in term of %brightness and %yield. As the ratio of surfactant/paper increased, the deinking efficiency increased. The optimum condition was found with the surfactant/paper ratio of 75  $\mu\text{l/g}$ -paper. The surfactant had a significant effect on the deinking efficiency. The natural surfactant provided the better brightness than the chemical surfactant. For chemical surfactants, hydrogen peroxide provided the highest brightness of 89.61%. The use of natural surfactant improved the pulp brightness up to 6.78% and 10.52%, compared to chemical surfactant and control case, respectively. The maximum pulp brightness of 92.49% was displayed as the natural surfactant of Plantacare 2000 was used. These results provided the guideline for improving the deinking process, which will be useful for paper recycling industry.

*Keywords: Bio-surfactant, Deinking efficiency, Paper recycling*

# Development of multilayer paper packaging from nanocellulose and poly-lactic acid



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**ABSTRACT-** Unmanaged plastic packaging wastes not only cause severe effects both on the environment and the eco system but also contribute to extensive economic loss. Consequently, research and development related to high barrier biodegradable coating of paper packaging as the functional alternatives become more significant. This research aimed to evaluate the possibility of using crystalline nanocellulose (CNC), cellulose nanofibril (CNF) and carboxy methylcellulose (CMC) as an additional barrier layer of PLA coated paperboard. Concentration of CNC, CNF and CMC for the coating solution were 5.0%, 0.5% and 0.5% respectively to maintain optimum viscosity of the coating solution. All nanocelluloses were applied as the first layer followed by PLA (15%) solution. Coating weight and thickness of the coated paperboard were significantly increased especially for the double layers coating. After the first layer coating of cellulose, water absorption was increased, and the water contact angle was decreased due to the hydrophilic nature of nanocellulose based substances. Among all coating formulation, CNF showed noticeable surface roughness with lowest water absorption. Moreover, contact angle of only CNF coating was as high as 107°. According to the results, air permeability of paper coating with CNC and CMC were as low as 0 ml/min compared to the uncoated paperboard (349.20 ml/min) and CNF (315.60 ml/min). The improvement was still significant after the double coating with PLA. For this study, WVTR of the coated paperboard still cannot be improved. For mechanical property, both single- and double-layers coating, stiffness of the coated papers was significantly improved. In conclusion, this research proved that CNC and CMC can be used together with the PLA double layer for paper coating to improve the air permeance and mechanical properties.

*Keywords: Paper packaging, Nanocellulose, Poly-lactic acid*

# Activated Porous Carbons Derived from Mangosteen Peel Wastes for Supercapacitor Electrode Applications



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**ABSTRACT-** Mangosteen, the queen of Thai fruits, is an important economic crop in Thailand. The vast amount of mangosteen peels is discarded as waste. The difficulty in natural decomposition causes several environmental problems, such as foul smell, spoilage, a source of pathogens, etc. In this work, we aim to study the synthesis of activated porous carbons (APCs) from mangosteen peel waste via hydrothermal carbonization and chemical activation processes. The hydrothermal carbonization was performed at 180 °C for 24 h. Afterward, the hydrochars were mixed with phosphoric acid (H<sub>3</sub>PO<sub>4</sub>) at concentrations of 1 M and 2 M and then activated at 700, 800, and 900 °C for 1 h under an argon atmosphere. The products were washed with sodium hydroxide (NaOH) followed by deionized water until pH neutral and dried, yielding APCs. The surface morphology of APCs was rougher and more fractured after chemical activation. All APCs mainly exhibited an amorphous carbon phase. The development of a microporous structure and the increase of the specific surface area of APCs were observed from the N<sub>2</sub> sorption analysis. H<sub>3</sub>PO<sub>4</sub> concentration and temperature in the activation process had a considerable influence in adjusting the porous structure of APCs. The potential application of APCs as supercapacitor electrodes was further evaluated with a three-electrode system by cyclic voltammetry (CV) and galvanostatic charge-discharge (GCD) in 1 M Na<sub>2</sub>SO<sub>4</sub> solution. The specific capacitance varied depending on the surface area and porous structure of APCs. Among all samples, the APCs activated with 2 M H<sub>3</sub>PO<sub>4</sub> at 700 °C had a maximum specific electric capacitance of 175 F/g at a current density of 1 A/g. The results in this work reveal that APCs derived from mangosteen peels have great potential to apply for supercapacitor electrode.

*Keywords: Mangosteen peels, Activated porous carbon, Hydrothermal carbonization, Chemical activation, Supercapacitor*

# Geopolymer from metakaolin and class F fly ash with alumina powder and potassium-based solution for high-temperature resistance material



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**ABSTRACT-** Geopolymer is a new alternative material that resists to high temperature and has high compressive strength produced from pozzolan materials and alkali solution. Pozzolan materials such as metakaolin and F class fly ash were utilized at ratios of 60:40 80:20 and 100:0 where alkali solution, 8 molar potassium hydroxide and potassium silicate, at ratio of 1:1. Geopolymer paste were prepared from pozzolan to alkali solution ratios of 1:0.6 1:0.8 and 1:1. The geopolymer cube was formed and cured at room temperature in a mold for 24 hours and kept at room temperature until 7 and 28 days. Then, the mechanical, physical properties, chemical properties and thermal properties were tested in order to find the formula that gave the highest compressive strength before and after firing at 800, 1,000 and 1,200 °C. We would select the formula that met the requirements then added some alumina powder to enhance the thermal resistant property of the geopolymer. It was found that the highest compressive strength before and after firing were 41.00 MPa and 68.8 MP in 0.6MK80A110 (pozzolan to alkali solution ratios of 1:0.6, metakaolin and F class fly ash at ratios of 80:20 and alumina powder 10 %) formula, respectively. From XRD result, pre-firing specimen presented phases of muscovite, mullite, quartz, alunite, potassium, aluminum silicate and calcium aluminum silicate. While the post-firing specimen possessed the kalsilite and leucite phases, both phases indicate high temperature resistance. It was confirmed the chemical composition by the functional group of Si-O-(Si/Al) which explained the complete geopolymerization. The coefficient of thermal expansion (CTE) was  $15.53 \times 10^{-6}$  1/°C and thermal conductivity was  $0.2645 \pm 0.0331$  W/m·K according to ASTM C182 standard test method for thermal conductivity of insulating. Therefore, the geopolymer paste 0.6MK80A110 is expected to be a high temperature resistance material.

*Keywords: Geopolymer paste, High temperature resistance material, Alumina powder*

# Improvement of physicochemical properties of cassava starch modified by single and dual techniques



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**ABSTRACT-** Native cassava starch has some constraints to use in a wide range of its industrial applications, i.e., low solubility and high viscosity etc. It is necessary to improve its properties by the chemical modification. The objective of this research is to improve physicochemical properties of cassava starch modified by hydrolysis, acetylation, and oxidation. Modification by hydrolysis was studied for different HCl concentrations of 0.1, 0.5 and 1 mol/L and for different reaction time of 30, 60, 90 min. The acetylation reaction was studied for different acetic acid concentrations of 1wt%, 3wt% and 5wt% and for reaction times of 15, 30, 60 and 90 mins. Oxidation reaction was studied for H<sub>2</sub>O<sub>2</sub> concentrations of 2%, 5%, 10%, 15% and 20%. As HCl concentration increased, %yield decreased due to better hydrolysis. The water solubility increased but the swelling power decreased with concentration. Hydrolyzed starch had better water solubility about 12.54% and less swelling power about 68.54%, compared to native starch. For acetylation, there is no significant effect on the starch yield. These results can be used as the guideline to develop a process with higher performance and to evaluate the optimum condition for modifying the starch with hydrolysis, acetylation, and oxidation.

*Keywords: Cassava starch, Chemical modification, Physicochemical properties*

# Antibacterial property of cellulose nanofiber film based on basil essential oil



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**ABSTRACT-** Consumers are increasingly concerned about food quality and safety; however, there are several factors (such as bacterial growth, light, temperature, oxygen gas, and humidity) influence food quality. Bacterial growth is thought to be a major cause of fresh food quality degradation. Active packaging with antimicrobial function plays an important role in combating food spoilage; however, the majority of them are made from petroleum-based films that are difficult to recycle and decompose. As a result, the goal of this research is to develop an active packaging material made from natural plant extract. Cellulose nanofibers (CNF) extracted from hardwood fiber planted in Thailand were used as the film matrix. The antimicrobial activity was enhanced by essential oil extracted from basil leaves. Tween80 was used as a compatibilizer between hydrophilic cellulose and hydrophobic essential oil. The experiment revealed that the biodegradable film made entirely of CNF was easily produced using a casting technique with 0.5 to 1.0 %wt. However, the addition of essential oil and compatibilizer challenges the formation of CNF film due to fluid penetration in the CNF solid matrix. The film was partially dried and formed in the manner of gel formation. As a result, cellulose nanocrystal (CNC) was introduced to the slurry as filler to increase solid content in film. The highest loading of basil essential oil at 0.3 % in slurry can be achieved with the incorporation of 10 %wt. The as-prepared films were then test with *Escherichia coli*, a gram-negative bacterium, and *Staphylococcus aureus*, a gram-positive for antimicrobial activity.

*Keywords: Basil essential oil, Cellulose nanofiber, Antibacterial activity*

# Development of Shrink Film from Polylactic Acid, Polybutylene Adipate-co-Terephthalate and Thermoplastic Starch



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**ABSTRACT-** Shrink film made from polyvinyl chloride (PVC) is a toxic polymer. This problem continues to affect a wide area of the environment. It is a synthetic material that cannot be decomposed naturally or eliminated by combustion causing a greenhouse effect. Thus, this work aimed to develop novel, heat-shrinkable, fully biodegradable films for packaging applications and to analyze their functional performance. Films were obtained from blends of polylactic acid (PLA) and poly (butylene-adipate-co-terephthalate) (PBAT) and Thermoplastic Starch (TPS) at different mass ratios. Biodegradable resins can be prepared from a twin screw extruder with a temperature ranging from 135 °C to 140 °C and put the resins into the blown film machine to form the film in the temperature range of 180-190 °C to test melt flow index the increased ratio of PBAT and TPS in fact leads to an increase in mass flow rate and a decrease in viscosity. Scanning electron microscopy (SEM) was used to examine the cross-sectional morphology. Differential scanning calorimetry (DSC) analysis was performed to determine the thermal properties of glass transition temperature (T<sub>g</sub>), melting temperature (T<sub>m</sub>) and cold crystallization temperature (T<sub>cc</sub>) and water vapor permeability test (WVP). The results showed that PLA, PBAT and TPS had rough cross-sectional characteristics. Some of the incompatibilities are due to the pellet extrusion process. When the amount of PBAT and TPS were increased, the percentage shrinkage of the film on the MD and TD side was increased as observed from the thermal properties. In this presentation, we will cover the crystallization rate decreased with increasing PBAT, TPS and the ratio of PLA decreased due to PBAT and TPS having the same amorphous structure. and result in increased permeability of water vapor through the film due to gaps between molecules, water vapor can penetrate more.

*Keywords: Polylactic acid, Biodegradable packaging film, Shrink film*

## Packaging design for recycling

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**ABSTRACT-** The problem of plastic garbage that escalates into the environment is going to be more radical. It induces the theory of circular economy, being a design of the recycle economy in terms of the infinite circuits. The introduction of this research aims to enhance efficiency in optimising resource utilisation by raw material recycling to mitigate negative impacts and increase positive effects on the environment. It can be a cost reduction for organisations and also able to reduce garbage. Such research uses LDPE plastic milk bags from students that have been used to clean up and then recycled to be converted into plastic granular. Comparing pure LDPE granular with pure LDPE plus used LDPE granulated in a ratio of 50:50. The Next step is to set up a mold to make milk package once again. The research focuses on testing a property of milk bag changing after being recycled and compares cloudy milk bags with transparent milk bags in a condition after being recycled to find which one can be better in resistance to efficiency decline by studying chemical properties and aspects of mechanical efficiency assessment of plastic film to get efficient and safe film for consumers. The main goal is to obtain films with good enough performance to be used in cybercorporation.

*Keywords: Circular economy, LDPE, Milk bags*

# Effect of Zeolite with Agricultural Waste and Hydrogen Peroxide Foaming Agent on Porous and Lightweight Geopolymer



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**ABSTRACT-** Nowadays, porous materials are utilized in a wide range of applications. This research focuses on porous geopolymer foam due to its easy fabrication and interesting applications. The geopolymer foam is produced from pozzolans as metakaolin and bagasse ash with hydrogen peroxide foaming agent. As a heavy metal adsorption, it was prepared with the ratio of metakaolin to bagasse ash at 80:20 and zeolite addition at 0, 0.25, 0.5, 0.75 and 1 wt%. For heat resistance applications, the ratio of metakaolin to bagasse ash was 75:25, 80:20 and 85:15 while ratio of pozzolan material to alkali solution was 1:0.9 and sodium hydroxide solution to sodium silicate was 1:1. Then, hydrogen peroxide as foaming agent was added in the proportion of 1.5 wt% of pozzolan material. The specimens were cured at 50°C for 24 hours and kept at room temperature until the required aging for testing. Actually, it was found that the increasing compressive strength was affected by the amount of zeolite and metakaolin. Based on the result of chemical composition, sodium aluminium silicate was confirmed by the functional group of Si-O- (Si/Al) which represented the complete geopolymerization. Furthermore, the results of AAS presented that heavy metals adsorption of geopolymer foam could absorb cadmium (Cd) and arsenic (As) well and the MK85BA15 (pozzolan to alkali solution ratios of 1:0.9, metakaolin to bagasse ash at 85:15 with hydrogen peroxide 1.5 wt%) could withstand up to 1,000°C with the lowest shrinkage. In addition, the compressive strength of all formulas passed the TIS 1505-2541 standard of autoclaved aerated lightweight concrete at 5 MPa. therefore, the geopolymer foam can be utilized in many applications such as heavy metal adsorption, heat resistance, and construction (lightweight geopolymer foam) materials.

*Keywords: Porous geopolymer, Lightweight geopolymer, Zeolite, Hydrogen peroxide, Heavy metal adsorption*

# Development of multilayered films from polylactic acid and poly(butylene adipate-*co*-terephthalate) for packaging application



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**ABSTRACT-** Most food products available in the market have been packaged in the multilayer flexible packaging due to the versatile functions of materials, i.e., product information illustration, gas and moisture barriers, packaging forming. However, these functions could not have all in a single-layer plastic packaging. In general, the multilayer films can be formed through the lamination process, in which film layers are bonded together using an adhesive as a tie layer, in order to enhance the mechanical and barrier properties including heat sealability. This research aims to develop the biodegradable multilayer flexible packaging from the biaxially oriented polylactic acid film (BOPLA) and polylactic acid/poly(butylene adipate-*co*-terephthalate) (PLA/PBAT) blend via lamination process, and to study the properties of the as-prepared films. BOPLA films were prepared by biaxial stretching process with varied draw ratios of 3 x 3 and 4 x 4. Meanwhile, PLA/PBAT blend films were fabricated by blown film extrusion, using different blend ratios between PLA and PBAT, which were 80PLA/20PBAT and 60PLA/40PBAT. The properties of single-layer BOPLA and PLA/PBAT blend films were investigated. BOPLA films exhibited greater mechanical and barrier properties than blown PLA film. For blend films, the mechanical and barrier properties depended on the ratio of PBAT in the film. The blend film with higher amount of PBAT (60PLA/40PBAT) had better mechanical properties, but poorer barrier properties than the one with lower PBAT content (80PLA/20PBAT). For further work, the BOPLA (3 x 3) and 80PLA/20PBAT blend films which have desirable properties will be selected to produce multilayer films, and tested for their functional properties.

*Keywords: Biodegradable, Multilayer films, Lamination*

# Development of banana bunch stalk fiber nonwoven for biodegradable filter in fabric face masks



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**ABSTRACT-** Recently, face masks plays an important role in everyday life according to the pandemic crisis and air pollution. Most of the available face masks in the market were produced from plastic which might take years to decompose. The objective of this project is to develop the biodegradable nonwoven fabric from the banana bunch stalk and use it as the filter in fabric face masks. Banana bunch stalk was extracted by the mixture of water retting process and chemical extraction. Then, the nonwoven fabrics were prepared by wet-laid method. Pectin was also used as a binder in the chemical bonding process. Later, the biodegradability of banana bunch stalk nonwoven was investigated by composting technique. Later, banana bunch stalk nonwoven filter fabric was filled in the fabric mask and evaluated the particulate filtration efficiency and air permeability. It was found that the optimal condition of fiber extraction from banana bunch stalk was at 5 g/l of sodium hydroxide at 100°C for three hours after three day of retting. Results showed that the banana bunch stalk nonwoven filter fabric was biodegradable, particulate protection and breathability.

*Keywords: Banana bunch fiber, Nonwoven, Biodegradable*

# TiO<sub>2</sub> Film for dye degradation and wastewater treatment

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**ABSTRACT-** Nowadays, several industrial plants discharge wastewater containing organic dye into water resources, causing water pollution. Methylene blue is among the common dyes used in the industry. This research project therefore aims at fabricating titanium dioxide films for degradation of methylene blue. To produce the film, titanium dioxide was synthesized by solution combustion technique, prepared into slurry, and coated onto glass substrates via spin coating. Experimental results revealed that the synthesized titanium dioxide contained the single phase of anatase with an average particle size of  $687 \pm 135.011$  nanometers. The particles, nevertheless, agglomerated into clusters. Results from the peeling test of titanium dioxide film indicated that the film adhered to the substrate relatively well, with the remaining film after the peeling in the range between 66.4 and 96.8%. When the film was submerged into the methylene blue solution under the UV irradiation (wavelength 662.5 nanometers), concentration of the dye reduced from 100% to 25%

*Keywords: Titanium dioxide, Dye degradation, Solution combustion technique*

# Synthesis of TiO<sub>2</sub> & ZnO Coating on Cement Blocks for Wastewater Treatment



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**ABSTRACT-** Nowadays, textile industries discharge wastewater containing organic dyes into water resources, leading to water pollution and unpleasant odor. One of the organic dyes commonly used in industries is methylene blue. This research project aimed at synthesizing titanium dioxide (TiO<sub>2</sub>) and zinc oxide (ZnO) for degradation of methylene blue in water. X-ray diffraction results revealed the anatase phase in the synthesized TiO<sub>2</sub>, whereas the wurtzite structure was evident in the synthesized ZnO. Scanning electron micrographs showed the average particle sizes of 250±75 and 289±86 nanometers in TiO<sub>2</sub> and ZnO, respectively. As the TiO<sub>2</sub> and ZnO were coated onto cement cubes and submerged into methylene blue solution, degradation of the methylene blue was observed. Photocatalytic performance of the coated cement cubes was examined under UV irradiation at the wavelength of 662.5 nanometers. It was found that the concentration of methylene blue of the solution treated with TiO<sub>2</sub>-coated cement cube (C/C<sub>0</sub>) was reduced from 100 to 84 percent. For the one treated with ZnO-coated cement cube, the methylene blue concentration decreased from 100 to 70 percent. The experimental results demonstrated the potential of TiO<sub>2</sub> and ZnO-coated cement cubes in wastewater treatment.

*Keywords: Titanium dioxide, Zinc oxide, Dye*



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# Development of Anticorrosion Agents for Iron and Steel from Natural Source



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**ABSTRACT-** Mild steel is widely used in a variety of industries because of its long-lasting properties and low cost of production. Corrosion is a significant issue for mild-steel workpieces in acid environments. Corrosion inhibitors have been added to mild steel in order to use it effectively in acid deposition applications. The addition of organic compounds into the transported media, among a variety of corrosion inhibitor methods used in an acid environment, is a simple and highly effective procedure for inhibiting mild steel corrosion. Heteroatoms (such as N, S, O or P), conjugated double bonds, negative functional groups, or electron donors/acceptors are commonly found in the structures of effective organic corrosion inhibitors. Here in, we report the use of Oolong extract as a corrosion inhibitor for mild steel in H<sub>2</sub>SO<sub>4</sub> medium. The steel samples were cut to 1x1 cm and polished with coarse silicon carbide sand paper numbers 80, 120, 150, 320, 500, 800, 1000 and 1200, respectively. Before electrochemical measurements, the samples were cleaned with acetone to remove grease. The mechanism of corrosion prevention is the replacement surface-adsorbed water molecules with organic inhibitors, forming a compact layer that acts as a corrosion prevention barrier.

*Keywords: Corrosion inhibitors, Oolong, Mild steel*

# Influence of particle arrangement in coating layer on barrier property



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**ABSTRACT-** Bio-based plastics, especially polylactic acid (PLA), have been increasingly demanded in packaging industry to replace non-degradable petroleum plastics. PLA has good mechanical properties but barrier properties are limited. Coating is one of methods to improve barrier properties of plastic films. Most colloidal coatings have random particle packing structure with large free volume comparing to coatings with ordered packing. This work aimed to study the effect of particle packing order in the coating layer on barrier properties of bio-based plastics. PLA was coated with silica suspension using the convective deposition technique for ordered packing structure. For random packing structure, the coatings were prepared by blade coating method. Microstructure and particle arrangement of the coatings were determined by laser diffraction and visualized by scanning electron microscopy. Barrier properties of the coatings including water vapor transmission rate (WVTR) and oxygen transmission rate (OTR) were determined. By using convective coating technique, the structure of the coatings varied from ordered multilayer to ordered submonolayer at different coating speeds. The results of laser diffraction showed that two types of diffraction patterns were observed. The patterns with six diffracted beams indicated an ordered structure with hexagonal closed packing. On the other hand, cloudy patterns indicated random structure or submonolayer. For barrier properties, WVTR and OTR of the coatings with the ordered structure were lower than the random structure. However, the lowest WVTR was observed at the coating with submonolayer structure.

*Keywords: Convective deposition, Particle arrangement, Barrier properties*

# Effect of anodization and chemical etching on wettability of SS304 Stainless Steel Surface



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**ABSTRACT-** Stainless steel plate is a type of steel plate that is widely used. It can be seen in both the household and the industrial level. that can always be found and touched on the surface. In the past 2-3 years there is an epidemic situation that arises that causes caution in contact with various materials. As there is a higher opportunity to be infected by contact with others. Causing us to find a variety of cleaning methods including improving the metal surface to make it easier to clean. Improving the surface by anodizing and chemical etching processes is a simple process. The steel sample is cut to 2x4 cm and anodized in 0.3 M dilute sulfuric acid solution using electric potential of about 2 V, current 2.5 mA/cm<sup>2</sup> for 40 min. Chemical etching with 15 M nitric acid solution for 10 min or 0.1 M myristic acid solution for 48 hr. was also carried out. The sequence was then compared. between before and after that During the Anodizing process followed by Chemical Etching process and the Chemical Etching process followed by Anodizing process. The Contact Angle Measurement machine was used to measure the hydrophobic contact angle. From the experiment, it was found that anodizing stainless steel in a dilute sulfuric acid solution followed by a Chemical Etching process with myristic acid solution. will cause the surface to be hydrophobic. The contact angle of the droplets was able to agglomerate into a ball at most in 10 seconds and followed by anodizing with sulfuric acid. This was followed by Chemical Etching with a secondary nitric pressing solution. Come down and do Chemical Etching with both acids followed by Anodizing least, which was made to facilitate cleaning from this experiment. Such as getting rid of germs that will stick to the surface. which can also be further developed in the future that may be a way to improve other types of metal surfaces for further benefit

*Keywords: Anodizing, Etching, Hydrophobic*

# Effect of film converting process on migration of food contact materials made from polylactic acid



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**ABSTRACT-** Polylactic acid (PLA) is one of the most promising biodegradable polymers for food packaging applications due to its biodegradability and processability. PLA is hydrolyzed to produce chemical substances including lactic acid, lactide and oligomer. However, these chemicals can migrate to food when PLA is used as food packaging. This work aims to study the effects of different conversion processes on the chemical migration from PLA films. Blown film extrusion and biaxial stretching process were used to prepare PLA films. PLA film from the blown film was prepared with a temperature range of 140–190 °C. Biaxially oriented PLA (BOPLA) film was prepared by sheet extrusion and biaxial stretching processes. The biaxial stretching was performed at a stretching rate of 150 mm/s and varied draw ratios of  $3 \times 3$  and  $4 \times 4$ . Overall migration and specific migration tests were investigated. The migration tests were performed using 3% acetic acid, 10% ethanol and 95% ethanol as food simulants under testing conditions of 40 °C for 5 and 10 days, respectively. All samples were also tested for mechanical and gas barrier properties. Toughness of PLA were improved after biaxial stretching with the increases of tensile strength, elongation at break and impact strength up to threefold, thirtyfold and one hundredfold, respectively. Moreover, BOPLA had enhanced oxygen and water vapor barriers 33% and 5%, respectively.

*Keywords: Polylactic acid, Biaxially oriented film, Migration*

# The effect of surface treatment by pulsed fiber laser on corrosion resistance of AISI304 stainless steel



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**ABSTRACT-** Stainless steel is a preferred material for many tools and equipment due to its high strength and resistance to corrosion. In order to track malfunctions or defects in production, a unique identification (UID) is necessary for these tools. There are various techniques for marking UIDs on products, including mechanical techniques such as dot peen or scribe marking, as well as optical techniques such as laser marking. Laser marking is often preferred due to its fast process, high contrast, and flexible code patterns, but it may have an impact on the corrosion resistance of metals. Many studies have explored the effects of laser marking on carbon and stainless steels.

In this report, the impact of pulsed fiber laser marking on AISI 304 stainless steel was investigated. The marks produced by laser marking can exhibit varying colors and contrast ratios depending on the laser power (3-15 Watts) and scan speed (250-1,000 mm/s) used during the process. The best contrast ratio was achieved with higher power and slower speed settings. The marked surfaces were analyzed using scanning electron microscopy equipped with energy dispersive spectroscopy, revealing differences in both surface structures and chemical compositions. Following a corrosion test, it was observed that the marks showed varying degrees of corrosion depending on the laser power and scan speed used. The specimens with a high contrast ratio experienced greater areas of corrosion. The results were expected as higher power and slower scan speed settings generate more heat during marking, leading to increased oxidation and corrosion. To minimize the effect of corrosion, the contrast ratio was optimized for the readability of the UID while reducing the potential for corrosion.

*Keywords: Stainless steel, Laser marking, Corrosion*

# Effects of Metal Oxides on the Properties of Biodegradable Plastic Films



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**ABSTRACT-** This research focused on the effects of titanium dioxide (TiO<sub>2</sub>) on the properties of biodegradable plastic films by comparing properties of polylactic acid (PLA)/polybutylene adipate-co-terephthalate (PBAT) blend film with PLA/PBAT blend films adding TiO<sub>2</sub> (PLA/PBAT/TiO<sub>2</sub>) 1 and 3% (w/w). TiO<sub>2</sub> was added to improve the films as UV-shielding. When adding TiO<sub>2</sub> 3% in PLA/PBAT films, the tensile strength decreased from 58.71 to 36.03 N/mm<sup>2</sup>, and the elongation at break increased from 2.59 to 3.98%. When adding TiO<sub>2</sub> 1%, the seal strength (heat sealed at 110 °C) decreased from 0.779 to 0.574 N/mm. Differential scanning calorimetry (DSC), one of the thermal property tests, showed that the glass transition temperature (T<sub>g</sub>) of the films slightly increased from 54.65 to 57.95°C, and melting temperature (T<sub>m</sub>) from 148.50 to 151.00 °C when adding TiO<sub>2</sub> 3%. Fourier-transform infrared spectroscopy (FTIR), a technique to analyze chemical bonds or functional groups in molecules, showed that the PLA/ PBAT/ TiO<sub>2</sub> 1 and 3% films exhibited higher adsorption peaks than PLA/PBAT peaks at wavenumbers 750-500 cm<sup>-1</sup> which corresponded to stretching vibration of hydrocarbon groups (C-H). Therefore, the properties of biodegradable plastic films might be altered when TiO<sub>2</sub> was added, which might affect applications of films such as packaging of heavy products.

*Keywords: PLA/PBAT, Titanium dioxide, Biodegradable plastic film*

# Optical, Chemical, Mechanical, and Barrier properties of OPP and OPET Films for Packaging Printing



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**ABSTRACT-** The strength and dimensional stability of oriented polypropylene (OPP) and oriented polyethylene terephthalate (OPET) films makes them ideal substrates for printing. This present study aimed at investigating the optical, chemical, mechanical, and barrier properties of OPP and OPET films and at comparing their properties. It was found that the optical transparency of OPP and OPET were the transmittance of 74.56 % and 75.03 %, typically, 600 nm (the midpoint of the visible range), respectively. For OPP, both bands at 1340  $\text{cm}^{-1}$  and 1472  $\text{cm}^{-1}$  were assigned to the symmetrical bending  $\text{CH}_3$ , whereas band at 2969  $\text{cm}^{-1}$  was assigned to the asymmetrical stretching  $\text{CH}_3$ . For OPET, the strong band at 1725  $\text{cm}^{-1}$  was assigned to the stretching vibration of the  $\text{C}=\text{O}$  bond of the ester group. The  $\text{C}-\text{H}$  stretching band of the aromatic ring existed at 3055  $\text{cm}^{-1}$ . Also the band at 1579  $\text{cm}^{-1}$  is assigned to the  $\text{C}-\text{H}$  bond stretching vibration of the phenyl ring. The  $\text{C}-\text{C}$  phenyl ring stretching band exists at 1409  $\text{cm}^{-1}$ . Tensile properties of OPET had better than those of OPP. Moisture barrier of OPP was higher than that of OPET, whereas oxygen barrier of OPP was lower than that of OPET. It is therefore recommended that both transparent OPP and OPET films could be typically used as the reverse-printed outer web of laminations for packaging printing.

*Keywords: Barrier property, Chemical property, Mechanical property, Optical property, Oriented polyethylene terephthalate, Oriented polypropylene, Packaging printing*

# Mechanical stability of PBAT/TPS nanocomposites under UV exposure

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**ABSTRACT-** The demand of biodegradable materials has continuously increased in packaging industry. Due to high cost of the materials, a commercial use of biodegradable packaging is limited. Polymer blends between biodegradable poly(butylene adipate-co-terephthalate) (PBAT) and thermoplastic starch (TPS) have been extensively developed to obtain cost-effectiveness and superior properties. Incorporation of nanoparticles into PBAT/TPS matrices also enhances the properties of bioplastics such as mechanical properties. However, the properties of PBAT/TPS nanocomposites could be potentially influenced by external factors during storage such as UV light. Therefore, this work aimed to study the effect of UV light on the mechanical properties of PBAT/TPS nanocomposites during storage. In this work, the films of PBAT/TPS with 1% CuO were prepared by blown film extrusion process. The nanocomposite films were exposed to the UV light at light intensity of 0.68 and 1.10 W/m<sup>2</sup> for 48, 96, 144, and 168 hours using QUV accelerated weathering tester. Film microstructure, mechanical properties, and UV transmittance were determined at each exposure time. The results showed a microstructure change especially for PBAT/TPS films at exposure time of 168 hours. The tensile strength and elongation at break of the nanocomposites decreased and reached plateau at 144 hours, indicating the maximum deterioration. In contrast, Young's modulus increased at the exposure time of 48 hours and then decreased, suggesting that the films were stiffer at 48 hours, possibly due to microstructure rearrangement of polymer matrices. Nonetheless, the films with CuO nanoparticles tended to have a slower deterioration rate than the films without particles. Moreover, the UV transmittance of the films with CuO were lower, showing the property of UV blocking.

*Keywords: Biodegradable nanocomposites, UV exposure, Mechanical properties*

# Parametric study of 3D Printing of Nylon-Based Composite by Fused Deposition Method



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**ABSTRACT-** This project aims to adjust the 3D printing variables of carbon fiber-reinforced nylon (12) filaments. It is a composite material with outstanding properties of strength and lightweight, suitable for use as a material to produce prototypes or parts that require high quality and accuracy. By studying the thermal behavior of carbon fiber-reinforced nylon (12) filaments with Differential Scanning Calorimeter, study the factors affecting the strength and accuracy of 3D printing. Then, Fused Deposition Modeling was formed using the Design of Experiments by full factorial experiment with the R program, which determined the main factors: the nozzle temperature was 265 and 285°C. The nozzle speed is 40 and 60 mm/s, and the pattern is zigzag and grid. Set other factors to be stable, including the bed temperature is 90°C, and infill of 50% and 100% using the standard for forming and testing, namely ASTM D638 for tensile test, then studying the crack surface with the optical microscope and stereo microscope. The study found that the molten temperature range ranges from 260 to 290°C. A statistically significant factor in strength is the nozzle temperature of 285°C, zigzag pattern, the nozzle speed is 60 mm/s (for infill 50%) and the nozzle temperature is 285°C, zigzag pattern, the nozzle speed is 40 mm/s (for infill 100%), and the statistically significant factor for accuracy is the nozzle temperature of 265°C, grid pattern, the nozzle speed is 40 mm/s (for infill 50%) and the nozzle temperature is 285°C, grid pattern, the speed of the nozzle has no effect (for infill 100%). The results of the crack study showed that the workpiece is characterized by brittle fractures due to porosity in the workpiece and separation between the fibers and the matrix polymer.

*Keywords: Carbon fiber-reinforced nylon (12) filaments, Fused deposition modeling, design of experiments, Full factorial experiment*

# Mechanical properties of Dual phase steel SCM 415

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**ABSTRACT-** The purpose of this research is to study the hardness property and microstructure of dual phase steels SCM 415 produced by intercritical annealing treatment. The experimental results showed that dual phase steels hardness property has slightly increased after putting under intercritical annealing treatment due to phase transformation from ferrite to martensite that is affect with properties of hardness. The microstructure of dual phase steels was analyzed through optical microscope. It has been found that increasing the temperature during intercritical annealing treatment results in a phase transformation from ferrite-pearlite to ferrite-martensite. These changes affect the phase volume fraction and result in a decrease in the ferrite ratio, as well as an increase in the martensite ratio in the final product.

*Keywords: Dual phase steels, Intercritical annealing treatment, SCM 415*

# Heat treatment and mechanical properties of aluminium alloys 2055



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**ABSTRACT-** The purpose of this research was to study the enhanced mechanical properties of aluminium-lithium alloy 2055 by precipitation hardening. The experiment, ageing was performed at 155 °C for a period of 0.5, 1, 2, 4, 6, 9, 12, 15, 24, 48 and 72 hours, and at 175 °C for a period 1, 6, 9, 12, 24, 48 and 72 hours. The tensile test results showed that ageing at different temperature, mentioned is temperature at 155 °C and 175 °C during a period of 48 hours revealed the yield strength at 155 °C was 307 MPa, which was lower than ageing at 175 °C which was 355 MPa. Ageing with different durations, the results showed that ageing at 155 °C for 72 hours revealed the highest mechanical properties, the yield strength and tensile strength were 359 MPa and 525.73 MPa, respectively, and ageing at 175 °C for 48 hours, which is considered as the most suitable ageing time, the yield strength and tensile strength were 355 MPa and 443.39 MPa, respectively. Therefore, ageing in various temperatures and time ranges has affected on different mechanical properties.

*Keywords: Aluminium alloys 2055, Precipitation hardening, Ageing*

# Effects of thermal loading on iron nitride layer on nitrocarburized S15C and SPCC carbon steels



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**ABSTRACT-** The objective of this research is to study the quality and quantity of nitride layer on low carbon steel S15C and cold-rolled steel SPCC that have undergone different tempering processes at different temperatures and times. The aim is to determine the appropriate tempering conditions after nitrocarburizing using XRD technique to analyze the chemical composition of the nitride layer at different temperature and time intervals. The results show that the chemical composition of the nitride layer on low carbon steel S15C and cold-rolled steel SPCC changes after tempering at higher temperatures and for longer times. However, if the temperature and time are increased over limit, the nitride layer will start to dissolve. Therefore, the appropriate tempering conditions must be determined to achieve the best results for low carbon steel S15C and cold-rolled steel SPCC.

*Keywords: Nitrocarburizing, Tempering, Low carbon steel*

# Mathematical Modeling of Migration from Bioplastic Films for Food Packaging



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**ABSTRACT-** Bioplastics have attracted a lot of attention in the packaging industry. TiO<sub>2</sub> is commonly used as a nanofiller because it can naturally degrade and is safe to use in food contact material under limited conditions. In this research, migration testing was manipulated according to Commission Regulation (EU) No. 10/2011 and No. 2020/1245 (Amendment). Three types of films: PLA/PBAT, PLA/PBAT/1%TiO<sub>2</sub>, and PLA/PBAT/3%TiO<sub>2</sub> were extracted under standard testing conditions for overall migration 0 (OM0) at 40 °C for 30 minutes to simulate cold storage or room temperature up to 30 minutes, and overall migration 1 (OM1) at 20 °C for 10 days to simulate refrigerated storage or freezing. The samples were extracted in food simulant B (3% acetic acid) at 40 °C for 5, 10, 15, and 30 minutes at 20 °C for 1, 2, 3, 5, 7, and 10 days to formulate a mathematical model for analyzing the overall migration activity under the OM0 and OM1 test conditions. The results demonstrated that all of the samples extracted under OM0 had an overall migration under an acceptable limit. However, under OM1, only 2 samples; PLA/PBAT and PLA/PBAT/1%TiO<sub>2</sub> complied with the regulation. The results showed that the bioplastic film with a higher amount of TiO<sub>2</sub> was likely to have more migration. These findings suggested that bioplastic films with TiO<sub>2</sub> additions could be used as food contact materials under OM0 conditions.

*Keywords: Food contact material, Packaging film, Poly(butylene adipate-co-terephthalate), Poly(lactic acid), Titanium dioxide*

# Properties and Overall Migration of Recycled Polyethylene Terephthalate into Food



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**ABSTRACT-** The plastic used for food packaging is popular currently which creates waste and affects the environment. Plastic is being recycled to manage waste. The recycled plastic used in food contact is recycled poly(ethylene terephthalate) (rPET). The suitability of rPET as a food contact material must be considered. This research aim was to analyze the overall migration of rPET and other properties; glossiness, thermogravimetric analysis (TGA) and oxygen transmission rate (OTR). Six samples of rPET from the consecutive extrusion process (R1-R6) were analyzed and compared with virgin PET (vPET) (R0). The overall migration test was conducted under the standard testing condition overall migration 2 (40 °C for 10 days) which simulates any long-term storage at room temperature or below, including heating up to 70 °C for up to 2 hours, or heating up to 100 °C for up to 15 minutes. The samples were extracted with food simulant A (10% ethanol (V/V)) which was assigned for foods that have a hydrophilic character and are able to extract hydrophilic substances with pH over 4.5. The result showed that the more cycles of the recycling process, the higher the overall migration. The overall migration results were under 10 mg/dm<sup>2</sup> which was compiled with Commission Regulation (EU) No 10/2011. From the gloss measurement, it was found that when PET was recycled for the 1<sup>st</sup> time, the gloss significantly increased and the gloss of rPET decreases with the number of recycling process. PET recycling can extend the life cycle of PET creating a sustainable way of using the unrennewable resource.

*Keywords: Plastic packaging, Recycling, Food contact materials (FCM)*

# The development of water resistance papers by multilayer coating of biopolymer–clay-based composites



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**ABSTRACT-** This study aimed to analyze the water resistance and oxygen-barrier improvement of duplex paperboard coating with kaolin and montmorillonite clay (MMT) multilayered with biopolymer polylactic acid (PLA) top layer using rod coating method. Average particle sizes of Kaolin and MMT were at 10  $\mu\text{m}$ . Kaolin coating formulations were prepared at the concentration of 20% and 25% (w/v) whereas MMT were prepared at 5% and 10%(w/v). Oxidized starch, 15% (w/v), with tween60 was used in all coating treatments as the main binder. Coating thickness for the first layer of clay and the second layer of PLA at the coating machine were set at 5  $\mu\text{m}$  and 10  $\mu\text{m}$  respectively. After coating, thickness of the coated samples was slightly increased since the coating substances absorbed into the based paperboard. According to the results, MMT show significant improvement on water contact angle both at a single layer coating and with a double layer coating with PLA (from 93 to 98 degree) compared to the uncoated sample (79 degree). Water absorption of the coated sample with MMT also found to be as low as 0.01  $\text{g}/\text{m}^2$ . SEM images proved that MMT clay coating had a smoother surface than kaolin's and this could due to its lower concentration. Although kaolin/PLA and MMT/PLA showed a significant reduction in OTR, but multilayer coating with kaolin and PLA gave the lowest oxygen transmission rate (OTR). For the first layer coating, stiffness values of the coated samples were significantly increased especially with MMT coating. According to this research, the stiffness was not further improved with an additional PLA double layer coating.

*Keywords: Paperboard, Kaolin, Montmorillonite, Polylactic acid*

# Effect of alloying elements on intermetallic phases in various modified cast nickel based superalloys



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**ABSTRACT-** The aim of this research work is to investigate and improve the microstructure of modified cast Ni-based superalloy IN-718 with previous cobalt addition by adding 2 percent by weight aluminum and 3 percent by weight nickel. The heat treatment processes are solutioning at 1200 °C for 2 hours then air cooled, precipitation aging at 720 °C for 8 hours then furnace cooled and 640 °C for 8 hours then air cooled, respectively. The microstructures of the samples were analyzed by OM and SEM to obtain the average of area fraction and size of gamma prime particle. The results showed that the appropriate microstructure for using at high temperatures could be obtained by the addition of 2 percent by weight aluminum and 3 percent by weight nickel followed by higher temperature heat treatment conditions. The 1,200 °C solutioning temperature obtained from DTA analysis revealed that the more dissolved gamma prime particles during solutioning and the better precipitated ability during precipitation than that of 1,100 °C solutioning temperature was confirmed. The microstructure obtained by SEM showed the decreasing of gamma prime size and the increasing of average of gamma prime area fraction.

*Keywords: Superalloy, Ni-based superalloy, IN-718, Gamma prime*

# Antimicrobial study of medical gloves with bio-additives



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**ABSTRACT**-Infections with pathogenic bacteria through the human skin have capability to occur even though protecting with wearing rubber gloves. General, rubber glove do not have direct efficiency to antibacterial activity but using rubber glove to prevent the skin directly contacting to bacteria. Staphylococcus aureus is a common bacterium found on the skin. When the skin contacted Staphylococcus aureus, it caused to skin infection such as nausea, vomiting, or diarrhea. From this study, tannin and curcumin have antibacterial efficiency. Both tannin and curcumin can be extracted from the natural plants and herbs. For this reason, we studied to extract tannins from raw banana peels and curcumin from turmeric rhizomes because banana peels and turmeric rhizomes contain tannin and curcumin, respectively. Both these plants and herbs are nature raw materials which are easy to find and increase valued. Starting extraction both tannin and curcumin from banana peels and turmeric rhizome with water and ethanol acted as solvents, respectively. The proportions of between weights of the banana and turmeric rhizomes (g) to volume of solvents (ml) were 1:10, 1.5:10 and 2:10. The obtained extracted agents were analyzed by using X-ray diffraction (XRD) and Fourier transform infrared spectroscopy (FTIR) to compare with standard peak patterns. The extracted agents were mixed with the natural rubber latex compound 3500 ml to prepare medical glove films in total seven formular such as the formular without adding any fillers and formular adding with 1, 1.5 and 2 wt% tannin and curcumin. To compare the antibacterial efficiency on the amount of banana peel and turmeric rhizomes was used each formula. The quality of rubber glove films was tested the water leakage by adding water. The characterizations of microstructures, mechanical properties, and antibacterial efficiency Staphylococcus aureus were analyzed by using scanning electron microscope (SEM), a universal testing machine (UTM), and inhibition zone testing method, respectively. The summarize was adding tannin and curcumin good for inhibition this infection.

*Keywords: Banana peels, Turmeric rhizome, Antibacterial*

# Preparation of polyvinyl alcohol by freeze-thaw to study the hydrogel structure



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**ABSTRACT-** A method of preparation of strong poly(vinyl alcohol) (PVA) hydrogels. Aqueous solutions containing 10-15 wt% PVA were frozen at -20°C for 1h, 4h, 24 h. They were subsequently thawed at room temperature for up to 24 h. This process was repeated three more times and the weight change and degree of swelling were measured after each freezing-thawing cycle. Strong thermoreversible hydrogels exhibiting mechanical integrity were obtained with 15 wt% solutions frozen at -20°C for 24 h and thawed at room temperature for any time period. The process of reinforcement of these thermoreversible hydrogels was a densification of the macromolecular structure. The densification process was more prominent for gels that had been exposed to up to three freezing-thawing cycles. To this end, based on PVA and H<sub>3</sub>PO<sub>4</sub> with different molecular weights of PVA for various PVA/H<sub>3</sub>PO<sub>4</sub> ratios, was developed. The results show the dependence of ionic conductivity on molecular weight and also charge carrier concentration. The instrument used to measure the value is Lcr meter. Compressive creep studies indicated using the tool Shore Hardness Tester. It measures the hardness of a material in terms of its flexibility. In the resistance of pressure exerted into the material. This type of durometer consists of an indenter, indenter plate and spring. The distance of the indenter and platen is related to the spring.

*Keywords: Hydrogel, Freezing-thawing, Densification*

MPCT\_19

# Selections of materials, Engineering Design, Analysis and Prototyping of dog sterilization clip from biodegradable plastic



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**ABSTRACT-** The idea of this research project is to develop a dog sterilization clip. with the aim of developing a clamp for sterilizing dogs engineering analysis and the production of prototypes from biodegradable plastic materials with 3D printers. The original structure was redesigned to develop new models and redesigned Scale-down and Shape-change to suit the properties of the material. As a result of the design, it was found that the New Model was smaller than the original prototype, changing the form of the spring. It has a non-resistance groove to prevent the attachment of other organs. From the engineering tests of the workpiece, it was found that for the New Model, the workpiece requires very little force to make the workpiece come in contact with the lower locking part. Because the workpiece has been modified in the spring to reduce the pressure. As for the resistance force acting on the lock area, it was found that Can endure at safety factor 2.1 is 21 N, and can withstand a maximum pressure of 5 psi after the workpiece is tested for actual use. It was found to be consistent with the results of engineering analysis. And the workpiece can bear a maximum pressure of 15 psi. Therefore, the New Model developed from the new design can be used as a clamp to help close the wound after sterilization surgery.

*Keywords: 3D printing, Simulation, Biodegradable plastic materials*



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## Modelling, Prototyping, & Simulation (MPS)

MPS\_01

# Finite element analysis and strength assessment of a three-dimensional frame structure



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**ABSTRACT-** Finite element analysis is a calculation method capable of giving estimates of the stress and strain in engineering structures by using a software. The calculations are generally performed by defining nodes and elements in a simulated structure. This project has created and studied a ‘true’ structural prototype as a comparison to results obtained from the finite element analysis. The developed structure consists of 4 poles, a central load from the center of the structures, 9 connecting points (nodes), and 8 springs. A mass of 5 to 8 kg, in 0.5 kg increments, is placed as the loading mechanism. The results of the experiment demonstrated a 11.81 percent discrepancy between the spring elongation measurements and the elongations obtained from stiffness tensors calculated using MATLAB. This discrepancy might be due to (1) a non-linear behavior of the tension spring, (2) reading errors of the experimenters, (3) the friction between the spring and the wooden frame, or all of three issues.

*Keywords: Finite element, Stiffness method, Loading structure*

# Investigation on component of palm fiber obtaining from Thailand



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**ABSTRACT-** The objective of this research was to investigate on component of palm fiber obtaining from Thailand. Firstly, natural fiber was masticated by grinding machine. The determination of solubility in alcohol-benzene, alcohol, and hot water was evaluated. Whereas, the determination of cellulose content, lignin content, and ash content in the same sample was revealed. In addition, the user's satisfaction analysis in bio-based material contained natural rubber and natural fiber was studied. There is the simple random sampling in Bangkok community and the statistical analysis consisted of frequency distribution, percentage, average, and standard deviation. In addition, the one-way analysis of variance (ANOVA) was used to compare the results.

*Keywords: Palm fiber, Natural fiber, Natural rubber*

# Take-away packaging design for dry noodles



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**ABSTRACT-** Thailand is not only a distinctive feature of a variety of food. There are also restaurants in various locations or street food to reach consumers for greater convenience. For example, Pad Thai is widely popular with both Thais and foreigners in terms of deliciousness and convenience.

Therefore, the packaging must consider the convenience of consumers, cleanliness, and the environment from the waste that may increase.

Therefore, the objective of this research is to study design guidelines to survey consumer satisfaction towards take-out packaging of dry noodles and develop them to meet the needs of consumers by collecting and analyzing data on dry noodles to develop to suit the packaging presented and observe problems that may arise from the use of the packaging to design the structure and graphic patterns on the packaging. There are 3 different types: 1. boat, 2. Thai children, and 3. lotus, all of them are created with an emphasis on sustainable design and allow consumers to survey their opinions through a questionnaire for consumers. Both online and in the field, 200 people evaluated their satisfaction and expressed their opinion about the packaging by evaluating a 5-level estimation scale ranging from the least to the most, respectively, evaluating all three aspects, namely the structure of the packaging, graphic, and the impact on the environment. Then use the results and suggestions that have been developed further.

*Keywords: Packaging design, Food Packaging, Street food*

# Retail Ready Packaging design for Snack dog product

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**ABSTRACT-** General dog snack packaging available in the market have similar characteristics and forms, such as the structure of the packaging and selected color. This causes the brand to be unattractive or unique. Makes consumers not motivated to choose to buy In addition, it may be necessary to increase the convenience in choosing products for consumers. The raising of dogs in Thailand tends to increase every year, so the concept of retail ready packaging was developed to promote sales. Facilitate the convenience of use to the dealer and to the consumer. The research will be on the design of retail ready display packaging which has 3 structures defined, namely, the first concept is a rectangle or tray shape with display, the second concept is a front and top side opening, and the third concept is top side opening , which brings all 3 formats to be developed in the structure of Mock up and Prototype, including graphics. Then used to create a questionnaire to evaluate the results of satisfaction surveys and consumer suggestions towards retail ready display packaging in all 3 formats. The topic of assessment are divided into five areas: Easy to Identity, Easy to Open, Easy to Shelf, Easy to Shop and Easy to Dispose via online and offline. Finally, the work that has been evaluated that consumers are most interested in from 135 respondents(125 online respondents and 10 offline respondents) is the third concept, forming a top side opening at 57 people (42.2 %) to improve and revise into works that meet the needs of consumers.

*Keywords: Retail ready packaging, Structure, Dog snack*

# Investigation on component of coir fiber obtaining from Thailand



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**ABSTRACT-** Over the years, the fiber-reinforced composite materials have attracted a lot of attention. This is because it produces composites with better mechanical properties compared to materials with non-fibrous fillers. biodegradable environmentally friendly and does not destroy the ecosystem It can also be recycled. It has a low cost which is beneficial to the economy of the industry.

At the same time, the problem of waste that occurs after farming continues to occur. in order to add value and reduce production costs Therefore choose to use natural fibers that are waste from the community's agriculture. Developed and improved for better properties to be formed into floor mats that can be used and added value to natural fibers. and increase income for farmers.

Natural fiber composites have become a popular new material. due to high strength found naturally environmentally friendly It is also recyclable. and has low raw material costs Therefore, this research was to study the development and improvement of natural fiber fillers using community-sourced coir fibers. to be used as a floor mat After that, it will be tested for qualification and consumer satisfaction test. It also reduces the cost of production as well as the reduction of garbage or waste from agriculture to create benefits. and can increase income for farmers by testing the fiber properties Solubility in alcohol-benzene Solubility in alcohol and the determination of lignin, holocellulose, alpha cellulose, pantosan and ash for the development and improvement of natural fibers to be used in making composite materials efficiently.

*Keywords: Natural fiber, Coir fiber, Investigation*

# Engineering Design and Materials Selection for Development of dog sterilization clip using Polymeric Materials



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**ABSTRACT-** Sterilization of dogs has been used in dog population control. For female dogs, the difficulty of time and complex procedure results in the process. Therefore, this project has developed a dog sterilization clip for dog sterilization to a new model that has 2 characteristics: spring and spindle. which can help reduce clutter The objective is to design, do an engineering analysis, and produce the prototype from biocompatible plastic materials, using a finite element analysis through the Fusion 360 program and printing the prototype with a 3D printer. And then, the project continued with the selection of common and low-price plastic materials to improve the surface property to its biocompatibility and used as a replacement material. The material selection results showed that HDPE tends to give a better alternative than other materials for spring models that require for flexibility, while other plastic materials can be used for spindle model. When using the new model to simulate real situations, it was found that the teeth and the hook area can be used for real which is consistent with the engineering analysis results indicating the results are reliable. The safety factor of the workpiece when replacing the choice of plastic material in the engineering analysis found that the value passed the criterion. Therefore, the new model developed from the new design can reduce clutter and has the potential to be developed for use as a clamp for the sterilization of dogs in the future.

*Keywords: Sterilization clip, Finite element analysis, Materials selection*

# Analysis and engineering design of smart poles using glass fiber composites



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**ABSTRACT-** The purpose of this research is to analyze and design a composite utility pole reinforced with 9-meter long E-glass fibers, capable of withstanding a transverse load of 3,000 newtons at the top of the pole. The study material will be a glass-fiber reinforced polymer with E-glass fibers as a reinforcement and polyester as a matrix. The design considered the filament winding process for manufacturing. The design variables of the utility pole included winding angles, a number of layers, diameters at the base of the pole, and sizes of the reinforcing equipment that would be drilled. The analysis used theoretical calculations and finite element methods (FEM) to model various shapes of the utility pole and to determine and identify any damage resulting from the design of the pole under various conditions. The proposed utility pole design had a diameter at the top and bottom that met the specified requirements, with a winding angle of  $\pm 53$  degrees with respect to the axis of the pole and a 14-layer winding. The analysis and design results show that the composite utility pole reinforced with E-glass fibers can meet the strength requirements for moment resistance as desired.

*Keywords: Utility poles, Glass-fiber Reinforced polymer, Finite element analysis*

# Simulation of migration model for food contact materials



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**ABSTRACT-** Migration testing for food contact material is important to ensure that the materials meet the standard regulation (EU, 2011). However, the time consuming and high cost are required. The numerical simulation of migration model can be helpful to minimize these issues. The aim of this research is to simulate the migration through food contact material (FCM) into food simulant with the transient mode. The effects of operating conditions such as type of plastics, food simulants and temperature on the concentration of migrant were studied. The configuration of migration system was virtually developed using COMSOL Multiphysics software. The mesh was generated inside the migration configuration. The transport equation of migrant, Fick's 2<sup>nd</sup> law, with the appropriate boundary condition was solved by numerical method. Prior to simulating the result, the grid independence was tested to obtain the optimum grid configuration. The contour of migrant concentration showed the different value along with the thickness of plastic and the distance of food simulant. As the contact time increased, the concentration of the migrant in plastic decreased but it increased in food simulant with time. The simulation of the migration model can be helpful for prediction of the migration value.

*Keywords: Migration model, Food contact material, Numerical simulation*

# Shelf-life extension bioplastic packaging prototype from thermoplastic starch/PBAT blended sodium and calcium propionate salt: Case study in cheese



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**ABSTRACT-** Blending of thermoplastic starch (TPS) and polybutylene adipate-co-terephthalate (PBAT) potentially produces flexible biodegradable films for packaging of food products. Incorporating sodium and calcium propionate which are commercial antimicrobial agents possibly produces shelf life extension packaging for food products. This research aimed to develop packaging prototypes based on TPS/PBAT blends containing sodium and calcium propionate (0, 1, 3, 5 and 7%wt.) via blown-film extrusion as shelf-life extension biodegradable packaging. The bioplastic prototypes were also applied as cheese packaging and the quality changes in cheese were investigated. Adding propionates decreased tensile strength but increase elongation at break of films possibly due to plasticization. High water affinity of sodium propionate increased wettability of the film surface as reduction of water contact angle, while water vapor permeability was increased. Conversely, dispersion of calcium salt slightly reduced water vapor permeability of the TPS/PBAT films. Higher calcium contents gave opaque films. The film prototypes containing propionates were used for cheddar cheese packaging which showed a delayed of fungal growth by 2 time at room temperature. Moreover, 2 fungal strains (*Penicillium* spp. and *Aspergillus niger*) were effectively inhibited by biodegradable films, loading propionate from 5%. Accordingly, incorporations of propionate salts (both sodium and calcium) produced shelf-life extension active packaging that preserves quality of packaged cheese. The prototypes had high potential to be further developed into commercial levels for sustainable packaging in food industry.

*Keywords: Propionate salt, Antifungal, Food packaging*

# Coating of Zinc-Copper on Glass Substrate via Microwave Plasma-Assisted Thermal Evaporation



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**ABSTRACT-** The Coating is one of the essential processes used to fabricate coating layers to improve mechanical, thermal, electrical, or other properties. Coating can be done by cold plasma techniques using a plasma torch with axial injection at atmospheric pressure. The main objective of this experiment is to deposit a zinc or copper coating on the glass surface from a thermal process, which is an application of microwave plasma thermal sublimation. This process has the following advantages: clean and environmentally friendly process. The experimental conditions were conducted by mixing 0.075 g of zinc and 0.075 g of copper on glass surfaces with dimensions of 2.5 x 2.5 cm. for 5 minutes plasma coating technique. The results showed that zinc alone coated on glass surfaces well without the use of a catalyst. However, copper alone did not coat on the glass surface. Nevertheless, the combination of copper and zinc could coat on the glass surface

*Keywords: Microwave, Zinc, Copper*

# Particles Embedded in Copper Electrodeposits using Sonicator-assisted Process



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**ABSTRACT-** The purpose of this research is to improve embedded carbon black nanoparticles on copper coating layer by using sonicating technique and to study the microstructure of coating layer, distributed carbon black nanoparticles, adhesive of coating layer and chemical compositions of the coating layer. In experiments we used the direct current (DC) at current density of 10 mA/cm<sup>2</sup> to investigate the effect of the intermittent sonicated solution ( $T_{on}/T_{off}$ ; 10s/50, 20s/40s, 30s/30s) for the electrodeposition. The electrolyte solution contains 200ml deionization water, 25g copper sulfate (CuSO<sub>4</sub>·5H<sub>2</sub>O), 39ml Sulfuric Acid (H<sub>2</sub>SO<sub>4</sub>), 30μL Triton X-100, 1.2g carbon black nanoparticles and 0.22g hydroquinone. It was found that using direct current with  $T_{on}$  30 seconds and  $T_{off}$  30 seconds of sonicator results in uniform particles distribution than that of  $T_{on}$  10 seconds,  $T_{off}$  50 seconds and  $T_{on}$  20 seconds,  $T_{off}$  40 seconds.

*Keywords: Electrodeposition, Direct current, Sonicator*

# Binary Alloys Coating By Microwave - Assisted Process

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**ABSTRACT**-This research aims to study aluminum powder coating on copper sheets by using PECVD coating process via a microwave oven which was modified to generate plasma source from nichrome coils. For outstanding feature of this coating process, the working temperature is lower than other CVD method which allow the low boiling point materials to be coated on the substrate. In addition, this reason leads to lower energy consumption and being environmentally friendly. The coating conditions included the amount of aluminum powder at 0.075 g and 0.15 g for 3, 5, 7 and 9 minutes on 2 x 2 square centimeter copper sheets, respectively. Subsequently, the microstructure of the coating layer was analyzed by scanning electron microscopy (SEM) using Back – Scattered Electron (BSE) mode and the chemical composition was analyzed by X-ray Fluorescence (XRF) and Energy Dispersive X-ray Spectroscopy (EDS) techniques.

Based on the result of chemical composition, aluminium was found on the coated layers of the workpiece in all conditions. This coated layer consistently appeared on the coated surface in flat and smooth configuration. It can be concluded that a microwave oven can be used for coating aluminum powder on copper sheet substrates by PECVD coating method.

*Keywords: Microwave, Plasma, PECVD*

# Materials Separation of UHT Milk Packages using Hydrothermal process



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**ABSTRACT-** This research project aims to separate the aluminum foil from the paper by using a hydrothermal process, water, temperature, and pressure that causes the deformation of the paper to separate from the aluminum foil. For illustration, water was used as an intermediary in the decomposition process with heat and pressure to increase the efficiency of the experiment. The performance of all conditions was compared at different temperatures and pressures. The experimental factors were 32.5 liters of water and 250 grams of 3 x 3 centimeters UHT milk cartons. The comparison was made at room temperature, 100, 130, and 160 °C and at pressures of 1, 3, and 5 bars. Each of the experimental conditions was boiled for 30 minutes and then dried at 100 °C for 4 hours using a hopper dryer. Based on the result, boiling at 130 °C with a pressure of 3 bars gave the best result which the aluminium foil was perfectly separated from the paper. In summary, higher temperature and pressure resulted in higher efficiency of paper separation than the experiment with lower temperature and pressure during the same experimental period.

*Keywords: Aluminum foil, Hydrothermal process, Temperature and pressure*

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