PMIS

KU KASETSART UNIVERSITY

FACULTY OF AGRO-INDUSTRY
DEPARTMENT OF PACKAGING AND MATERIALS TECHNOLOGY

ABSTRACT BOOK

The 9th Packaging and Materials Innovation Symposium

PMIS 2024

Rethinking

Packaging and Materials for a Sustainable Future

MARCH 14th

Preface

Welcome to the 9th Packaging and Materials Innovation Symposium 2024 (PMIS2024), held under the theme of "Rethinking packaging and materials for a sustainable future". This symposium is 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, scheduled for the 14th March 2024.

We take great pleasure in presenting this concise Book of Abstracts, showcasing the work of our senior BS students. The PMIS symposium provides a pivotal platform for these individuals to disseminate their research, discoveries, and academic achievements. Beyond academia, it offers students a unique opportunity to exchange technical knowledge, enhance presentation skills, and gain insights into industrial manufacturing, fostering innovation.

We are honored to announce the participation of distinguished keynote speakers in this PMIS symposium. Their profound expertise and insights promise to enrich our collective understanding of key issues within Intelligent and Smart Packaging Technologies, and Material & Design Innovation. We extend our heartfelt appreciation to these speakers for their invaluable time, wisdom, and substantial contributions to the success of this event.

Our sincere gratitude is extended to our sponsors, COSLUXE Co., Ltd., ARCHANAWAT Co., Ltd., Berli Jucker Public Co., Ltd., and FUJI SEAL PACKAGING (THAILAND) Co., Ltd., for their generous support that transforms the vision of this symposium into reality. Their commitment to fostering education and research empowers us to provide a dynamic platform for senior BS students to share research findings and engage in meaningful academic discourse.

A special acknowledgment goes to the dedicated faculty mentors who have served as guiding lights in shaping the intellectual growth and research skills of our graduating class.

As you peruse this Book of Abstracts, we invite you to actively engage with the diverse range of research projects presented by our senior BS students. May the symposium serve as a catalyst for collaboration, inspiration, and the continued pursuit of knowledge.

Thank you for being an integral part of this momentous occasion!

Piyawanee Jariyasakoolroj
Organizing Committee of the 9th PMIS 2024

Welcome Message
for 9th PMIS 2024

I am genuinely delighted to warmly welcome all guests, esteemed speakers, and student participants to The 9th Packaging and Materials Innovation Student Symposium (PMIS) 2024. This event is jointly organized by the Department of Material Engineering (MAT-E) and the Department of Packaging & Materials Technology (PKMT). This year, PKMT takes great pride in hosting, aiming to unite young researchers from both departments in multidisciplinary forums and discussions. On this special occasion, we are thrilled to announce that our collaborative efforts have expanded to include the Department of Textile Science, and we hope to engage more departments within our university, fostering strong relationships and facilitating fruitful knowledge exchanges.

The primary purpose of this symposium is to provide an excellent platform for knowledge sharing and idea exchange in the fields of engineering, science, and technology, ultimately contributing to a better quality of life and sustainable future. We are privileged to have two keynote speakers, Professor Dr. Panuwat Suppakul, who will share insights into smart packaging technology, and Dr.Dararat Mekkriengkrai who will impart valuable experiences from the material industry. These sessions will greatly benefit our soon-to-graduate students as they prepare to enter the professional world.

I am confident that this event will serve as a vital platform for building strong networks among young researchers, academic staff, and industry professionals. Lastly, we extend our heartfelt appreciation to the renowed companies—Cosluxe Co., Fuji Seal Packaging (Thailand) Co., Archanawat Co., and Berlin Jucker Public Co.—who have generously sponsored the student awards for this event.

I wish you all a memorable experience at this symposium.

Associate Professor Dr. Lerpong Jarupan
Head of the Department of Packaging and Materials Technology
Faculty of Agro-Industry, Kasetsart University

Welcome Message
for 9th PMIS 2024

At Kasetsart University, we are committed to excellence in education and research. Over the past eight successful PMIS events, we have proudly co-organized this symposium, nurturing the tradition of knowledge sharing to advance materials and packaging research.

One of the key objectives of the PMIS symposium is to provide a stage for our undergraduate students from both departments to showcase their senior projects and immerse themselves in the conference atmosphere. Their participation not only enriches the symposium with fresh perspectives but also prepares them for future endeavors in their respective fields.

This year's symposium theme, "Rethinking Packaging and Materials for a Sustainable Future," highlights our shared responsibility to explore innovative solutions that minimize environmental impact while meeting societal needs. Through oral presentations and informal discussions, our aim is to inspire students with innovative insights to address today's environmental challenges.

I extend my heartfelt gratitude to all keynote speakers, presenters, and attendees for their invaluable contributions to this symposium. Your enthusiasm enriches our collective learning experience. Special thanks to the organizing committee from both departments for your dedicated effort in ensuring the success of the 9th PMIS 2024.

Welcome to the 9th PMIS 2024– may it be a memorable experience and a catalyst for fostering future generations of successful engineers and scientists in the field of materials science and packaging technology.

Associate Professor Dr. Ratchatee Techapiesancharoenkij
Head of the Department of Materials Engineering
Faculty of Engineering, Kasetsart University

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Overall Program

The 9th Packaging and Materials Innovation Symposium 2024 (PMIS 2024)

"Rethinking Packaging and Materials for A Sustainability Future"

Department of Packaging and Materials Technology, Kasetsart University

14 March 2024

08:30 – 09:00	**Registration** Room 0410 Chuchart Kampoo Building, Faculty of Engineering, Kasetsart University			
09:00 – 09:20	**Welcome and Introduce to PMIS 2024** **Assoc. Prof. Dr. Anuvat Jangchud** Dean of The Faculty of Agro-Industry, Kasetsart University **Prof. Dr. Wanchai Yodsudjai** Dean of The Faculty of Engineering, Kasetsart University **Assoc. Prof. Dr. Lerpong Jarupan** Head of Department of Packaging and Materials Technology, Kasetsart University Room 0410 Chuchart Kampoo Building, Faculty of Engineering, Kasetsart University			
09:25 – 09:55	**Smart Packaging for Food Security and Sustainability** **Keynote speaker I: Prof. Dr. Panuwat Suppakul** Department of Packaging and Materials Technology, Kasetsart University			
10:00 – 10:30	**Innovative Material and Design Process** **Keynote speaker II: Dr. Dararat Mekkriengkrai** Thailand Creative & Design Center (TCDC), Creative Economy Agency (CEA)			
10:30-10:45	**Break**			
	MAS - 1	**ASM**	**MPCT - 1**	**ETA**
	Room 0410	**Room 0403**	**Room 0406**	**Room 0203**
10:45-11:10	MAS12-P01	ASM01-M08	MPCT01-M04	ETA05-P08
11:10-11:35	MAS14-P12	ASM03-M12	MPTC04-M10	ETA10-P26
11:35-12:00	MAS15-P14	ASM07-M29	MPCT07-M16	ETA07-P20
	MAS - 2	**MPS**	**MPCT - 2**	**Sessions**
	Room 0405	**Room 0313**	**Room 0407**	**Room 0219**
10:45-11:10	MAS01-M01	MPS05-P04	MPCT12-P03	MAS07-M22
11:10-11:35	MAS03-M03	MPS06-P05	MPCT15-P16	MAS09-M25
11:35-12:00	MAS04-M18	MPS08-P10	MPCT17-P18	MPCT10-M35

Overall Program

The 9th Packaging and Materials Innovation Symposium 2024 (PMIS 2024)

"Rethinking Packaging and Materials for A Sustainability Future"

Department of Packaging and Materials Technology, Kasetsart University

14 March 2024

12:00-13:00	Lunch			
	MAS - 1	ASM	MPCT - 1	ETA
	Room 0410	Room 0403	Room 0406	Room 0203
13:00-13:25	MAS06-M21	ASM09-P21	MPCT11-P02	ETA01-M07
13:25-13:50	MAS08-M24	ASM08-P09	MPCT13-P13	ETA03-M32
13:50-14:15	MAS10-M27	ASM10-P22	MPCT14-P15	ETA06-P11
14:15-14:40	MAS17-P23	ASM02-M09	MPCT16-P17	ETA09-P25
14:40-15:05	MAS19-T01	ASM04-M13	MPCT05-M11	ETA02-M15
15:05-15:30	MAS20-T02	ASM05-M17	MPCT06-M14	ETA04-M33
	MAS - 2	MPS	MPCT - 2	Sessions
	Room 0405	Room 0313	Room 0407	Room 0219
13:00-13:25	MAS13-P07	MPS03-M34	MPCT02-M05	ASM06-M19
13:25-13:50	MAS18-P28	MPS01-M26	MPCT08-M23	ETA08-P24
13:50-14:15	MAS16-P19	MPS02-M31	MPCT03-M06	MPS09-T03
14:15-14:40	MAS02-M02	MPS04-M36	MPCT09-M30	MPCT20-T05
14:40-15:05	MAS11-M28	MPS07-P06	MPCT19-T04	-
15:05-15:30	MAS05-M20	-	MPCT18-P27	-
15:30-16:30	Break			
16:30-17:00	Awarding and Closing Remark			

PMIS 2024

KEYNOTE SPEAKER

Rethinking Packaging and Materials for a Sustainable Future

Prof. Dr. Panuwat Suppakul

Academic Position Full Professor

Affiliation Department of Packaging and Materials Technology
Faculty of Agro-Industry, Kasetsart University

Educational Background

Ph.D. (Packaging Technology) 2004 Victoria University, Australia
M.Sc.Tech. (Engineering Materials) 2000 The University of New South Wales, Australia
M.Sc. (Agro-Industrial Product Development) 1996 Kasetsart University, Thailand
B.Sc. (Agro-Industrial Product Development), 2nd Hons. 1993 Kasetsart University, Thailand

Expertise Active and Intelligent Packaging Technology, Smart Packaging Technology

Publications Textbooks 2, Book Chapters 9, Feature Articles 2, Review Articles 3,
Research Articles 30, US Patent 1, Thai Patent 2, Thai Petty Patent 1

Committee Academic Positions, Royal Thai Government Scholarship,
Peer Reviewer Review and Research Articles for more than 25 Journals,
Peer Reviewer Research Proposal for FCT, Portugal; CONICYT, Chile; ERC,
European Union (EU), KURDI, Thailand; NSTDA, Thailand; TRF, Thailand

Royal Decorations and Medals

2023 Knight Grand Cordon (Special Class) of the Most Noble Order of the Crown of Thailand
2022 Chakrabarti Mala Medal - Medal for Long Service and Good Conduct (Civil-25 Years)
2020 Knight Grand Cross (First Class) of the Most Exalted Order of the White Elephant
2015 Knight Grand Cross (First Class) of the Most Noble Order of the Crown of Thailand

Award

2017 Outstanding Government Service Officer 2016 Award, Ministry of Education, Bangkok, Thailand
2017 Outstanding Old Student 2017 Award, Samsenwittayalai School Alumni Association, Samsenwittayalai School, Bangkok, Thailand
2016 Outstanding Academic Officer and Researcher (Research and Innovation, Natural Science) Age Group of Higher 40 Years, Kasetsart University, Bangkok, Thailand

Dr. Dararat Mekkriengkrai

Educational Background

Ph.D. (Polymer Science and Technology) 2005 Mahidol University, Thailand

M.Sc. (Polymer Science) 2000 Petroleum and Petrochemical College of Chulalongkorn University, Thailand

B.Sc. (Biochemistry), 2nd Hons. 1998 Khon Kaen University, Thailand

Experience

2018-PRESENT **CREATIVE ECONOMY AGENCY (CEA)**

2019-PRESENT **Knowledge Service Specialist, Creative Knowledge Department**

- Consulting on projects and research support of MDIC access clients as well as TCDC Program and activities
- Responsible for Material ConneXion Bangkok management and activities
- Management and development for all online material database corresponding to Material ConneXion Bangkok and TCDC
- Assist the Director in new projects from TCDC concerning to materials and developers

2018-2019 **Material & Innovative Specialist, Creative & Innovation Department**

05.2005-2018 **THAILAND CREATIVE & DESIGN CENTER (TCDC)**

12.2016-2018 **Material Specialist, Creative & Innovation Department**

- Consulting on projects and research support of MDIC access clients
- Responsible for Material ConneXion Bangkok management and activities
- Management of Material Tabula and other materials & design innovation showcase in MDIC
- Management and development for all online material database corresponding to Material ConneXion Bangkok and TCDC
- Material Sourcing for Thai innovative and green materials including AEC materials
- Responsible for all content providing to exhibitions, publications, articles and PR including material information
- Responsible for innovation matching program in MDIC
- Assist the Director in new projects from TCDC concerning to materials and developers
- Lecture on materials and technology to members, universities and companies

05.2013-12.2016 **Material Specialist, Material ConneXion Bangkok**

- Consulting on projects and research support of library access clients
- Management of Material Tabula and Library maintenance
- Management and development for all online material database corresponding to Material ConneXion Bangkok and TCDC
- Responsible for all content providing to exhibitions, publications, articles and PR including material information.
- Material Sourcing for Thai innovative and green materials including AEC materials.
- Assist the Library Director in new projects from TCDC concerning to materials and developers
- Lecture on materials and technology to members, universities and companies

08.2005-04.2013 **Material Researcher**

- Research Support of Library Access clients on the selection and use of products from the physical samples archive
- Consulting on projects by researching into new materials developments and sourcing of specific materials data to Material Specifiers
- Organization of Material Tabula and Library maintenance
- Management and development for all online web and material database corresponding to Material ConneXion Bangkok and TCDC
- Responsible for all content providing to exhibitions, publications, articles, PR, etc.
- Assist the Library Director in new projects from TCDC concerning to materials and developers

05.2001 **Training on RNA extraction and protein characterization, Osaka University**

11.2000-04.2001 **Research on biosynthesis of natural rubber, Mahidol University**

PMIS 2024

MAS

Materials for Sustainability

Rethinking Packaging and Materials for a Sustainable Future

MAS01-M01

Effect of Polyethylene Glycol (PEG) on Properties and Deterioration of Polylactic Acid (PLA)

Wasinee Sirifongnukul[1], Amornrat Rojthinnakorn[1], and Amornrat Lertworasirikul[1,*]

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[*]*corresponding author: fengarl@ku.ac.th*

Polylactic acid (PLA), a thermoplastic, has attracted considerable interest because it is derived from renewable resources, has a minimal environmental impact, and is biodegradable. Nevertheless, its notable brittleness and slow degradation pose significant hurdles for expanding its applications. Polyethylene glycol (PEG) is known to be a biodegradable and non-toxic polymer that could enhance the flexibility of PLA. The degradation time of low molecular weight PEG is faster than that of PLA, enabling the blending of PLA with low molecular weight PEG as a means to customize PLA's degradation rate. In this study, PLA was blended with PEG content ranging from 10% to 40% using a twin-screw extruder, followed by film formation via compression molding. The impact of PEG on the physical, mechanical properties and melt flow rate, as well as the degradation behavior of PLA, was investigated. Degradation of PLA/PEG in water was assessed by measuring weight loss. Changes in structure, morphology, clarity, crystallinity, and mechanical properties were analyzed using FTIR, SEM, UV-Vis, DSC, and UTM techniques, respectively.

Keywords: Polylactic acid, Polyethylene glycol, Degradation

MAS02-M02

Utilization of Biochar as an Admixture and a Supplementary Cementitious Material in the Sustainable Cement Composites.

Natnicha Soenvanichakul[1], Peuksapaporn Glansomjit[1], Pattamaporn Kiangkaew[1], Parinya Chakartnarodom[1,*], and Wichit Prakaypan[2]

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Global warming is a major concern, and one of the contributing factors is the increasing expansion of industrial factories, particularly cement production. The aim of this research works is to examine and identify the utilization of biochar - a material derived from macadamia nut shells - as a supplement and admixture in sustainable cement composites. This approach aims to reduce cement consumption, repurpose agricultural waste, minimize waste production, and increase the value of products. The study involves producing mortar samples with biochar powder replacing cement at percentages of 3, 5, 10, and 15 by weight mortar. The biochar powder used is finely ground to pass through a 200-mesh sieve. The samples were then tested to study the heat of hydration reaction properties of cement and biochar, as well as the compressive strength and density of the mortar. Results indicate that the compressive strength decreases with increasing biochar content, except for samples with 5% biochar replacement, which exhibit comparable strength to the control. These findings pave the way for the development of sustainable cementitious products that incorporate biochar, such as Loft, contributing to sustainable construction materials.

Keywords: Cement, Biochar, Sustainable cementitious materials

MAS03-M03

Effect of Eco-friendly Binary binder System of Fly Ash on Properties of Cement Composite

Jidapa Luemsumran[1], Laksamee Choauputtan[1], Kanteera Raysin[1], Parinya Chakartnarodom[1,*], and Wichit Prakaypan[2]

[1]Department of Materials Engineering, Faculty of Engineering, Kasetsart University, Bangkok 10900, Thailand
[2]Suncement process 269/1 No.8 Ban Lueak, Photharam, Ratchaburi, 70120, Thailand
[*]corresponding author: fengpryc@ku.ac.th

This research aims to investigate the utilization of municipal solid waste (MSW) fly ash as a component in precast concrete panels. The raw materials include Type 1 Portland cement, sand, aggregates, alumino-silicate compound, and fly ash derived from incinerated waste. Seven cement formulas were developed and tested by adjusting the proportions for comparative analysis to achieve optimal properties. The preparation process involved varying cement percentages (5%, 10%, 20%, and 30% by weight), fine sand (5% by weight), alumino-silicate compound (2% by weight of cement) and incorporating fly ash at 10%, 20%, and 30% by weight. The mixture was then combined with water and molded into cubic specimens measuring 15x15x15 cm^3. After curing for 1, 3, 7, and 28 days, the specimens were analyzed for microstructure using a Scanning Electron Microscope (SEM) to assess physical and surface properties. The compressive strength of the concrete was tested using a Compression Testing Machine. The research findings indicate that incorporating 2% alumino-silicate compound and fly ash from incinerated waste can enhance hydration reactions, resulting in improved microstructure and increased density of the precast concrete. The compressive strength reached a maximum of 317.1 Ksc at 1 day and 525.1 Ksc at 28 days, meeting the Thailand industrial standard C828 standard for precast concrete properties.

Keywords: Municipal solid waste (MSW) fly ash, Fly ash, Alumino-silicate

MAS04-M18

Vanillin Derived Benzoxazines: Synthesis, Polymerisation Behaviours, Anticorrosion Study, and Flammability Test

Phatjira Santakul[1], Kasidech Thanavijitphan[1], Jenjira Bunma[1], Natapol Suetrong[1], and Worawat Wattanathana[1,*]

[1]Department of Materials Engineering, Faculty of Engineering, Kasetsart University, Bangkok 10900, Thailand
[*]corresponding author: fengwwwa@ku.ac.th

In this research work, bio-derived benzoxazine monomers were synthesized by a one-pot Mannich reaction of 3 components, namely vanillin, paraformaldehyde, and primary amines, with a molar ratio of 1:2:1. The primary amines used for the synthesis were methylamine (V-m), ethylamine (V-e), 1-propylamine (V-p), 1-butylamine (V-b), aniline (V-a), and cyclohexylamine (V-c). The structures of all the synthesized vanillin-based benzoxazine monomers are confirmed by ^{1}H-NMR, ^{13}C-NMR, and FTIR spectroscopies. Besides, the single crystal X-ray diffraction was used to examine the crystal structure and bond parameters of vanillin-methylamine-based benzoxazine (V-m). The ring-opening polymerization (ROP) of the benzoxazines was triggered by heat treatment at different conditions, e.g., 120, 140, and 160 °C for 1 h. The polymerization behaviors were monitored by differential scanning calorimetry (DSC), thermogravimetric and differential thermal analyses (TG/DTA), and *ex*-situ FTIR. The results showed that the extent of the ROP increased with temperature. The anticorrosion performance of the benzoxazines was examined by potentiodynamic polarization as well as electrochemical impedance spectroscopy. Moreover, the preliminary study on flammability was also carried out.

Keywords: Vanillin, Benzoxazine, Flammability Test

MAS05-M20

Development of Copper-Azo Dye Complex and Polyvinyl Alcohol Composite for Feasibility Study on Solar Cell Application

Weerapat Warasin[1], Supakan Supsorn[1], Natapol Suetrong[1], and Worawat Wattanathana[1,*]

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This study investigated the development of the film used as a coating for light-receiving glass. Herein, the Cu^{2+}-eriochrome black T (EBT) complex and PVA composite system (Cu-EBT-PVA) was of interest to developing a photovoltaic glass for solar cell applications. The experiment was done by coating the Cu-EBT-PVA solution on substances, namely glass slides and FTO glasses, using a spin coating machine. The experimental conditions were set by using a centrifugal speed in the range of 900-2100 rpm with the centrifugal speed increment of 400 rpm. It was found that at a rotational speed of 900 rpm, the film coated on the glass was the thickest, and the film thickness decreased as the rotational speed increased. When tested with UV-visible and PL techniques to see the absorbance and emission peaks, it was observed that the glass coating film with the highest thickness exhibited the most intense absorption and emission signals. This result suggested the improved properties of light-receiving glasses used in solar cells. The Cu-EBT-PVA coated FTO glass had the property of being able to work well at high temperatures with little change in electrical conductivity. The substance coated on FTO glass results in good thermal stability of the glass. Resistant to high-temperature substrates and resistant to both abrasion and scratches. The study on the resistance changes with the light intensity of the Cu-EBT-PVA coated FTO glass was also studied.

Keywords: Composite, Photovoltaic, Coating

MAS06-M21

Fabrication and Characterization of Vegan Leather from Mangosteen

Raksathit Ekabutr[1], Apinan Ngamsapsirikun[1], Natapol Suetrong[1], and Worawat Wattanathana[1,*]

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These research objectives were 1) To fabricate alternative materials for producing vegan leather to substitute the use of animal leather and 2) To develop materials for vegan leather with antimicrobial properties. Since the vegan leathers produced nowadays are usually subjected to deterioration by fungal growth, herein, this work selected the mangosteen peel to add to the vegan leather to improve the antimicrobial properties. The fabrication steps for making vegan leathers are as follows: 1) mix finely ground mangosteen peels with distilled water, 2) the mixture was subjected to heating process, 3) add a binding agent to the mixture and stir well, and 4) cast the mixture of the mold to get the desired shapes and sizes. Different proportions of mangosteen peels, distilled water, and binding agents were optimized so that more than 50 trials were prepared. Several analyses, e.g., optical microscopy, spectroscopic analysis, and X-ray diffraction, were done to investigate the properties in order to find the most suitable conditions. The growth of fungi on the prepared vegan leathers were compared with the commercial vegan leather from the community enterprise.

Keywords: Vegan leather, Mangosteen peel, Antimicrobial property

MAS07-M22

Materials for Bulletproof Armor Made from Fish Scales

Pornanun Pongjit[1], Worakan Sriprasert[1], Sunyakrit Buranasate[1], Napawut Thanapunyanun[1], and Worawat Wattanathana[1,*]

[1]Department of Materials Engineering, Faculty of Engineering, Kasetsart University, Bangkok 10900, Thailand
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In this research, the composites of fish scales to be used as the simulated materials for bulletproof armor were fabricated by mixing two types of epoxy resin (A and B) and tilapia scales with different proportions, e.g., 20: 80, 40:60, 60:40, and 80:20 percentage weight by weight. The mixture of the epoxy resins and fish scales were put into a mold with a width of 17 cm, a length of 17 cm, and a thickness of 0.3 cm and then compressed into composite sheets using different conditions, i.e., different processing temperatures and times. The best condition was found to 140 °C and the heating period of 15 min. After that the composite sheets were cut according to the standard testing method into the desired shapes and dimensions. Mechanical properties in terms of tensile strength, impact strength, and bending strength were examined.

Keywords: Fish scales, Epoxy composites, Mechanical properties

MAS08-M24

Feasibility Study of Recycled Plastic Bottle Cap for 3D Printing Filament

Sumet Phuekkaew[1], Sorawee Karnboon[1], and Somjate Patcharaphun[1,*]

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The feasibility of using the High Density Polyethylene (HDPE) bottle cap as a recycled plastic for the production of 3D printing filament is studied in this work. The influence of test temperature filler type and content on the rheological properties i.e. Melt Flow Rate (MFR) and extrudate swell ratio (B) are investigated. The test results of recycled HDPE are also compared to those obtained from virgin grade HDPE. The single screw extruder is employed to produce the 3D filament. Several settings of process parameters including die temperature, screw rotation speed, and haul-off speed are adjusted to gain 3D filament with an average diameter of 1.75 mm. The 3D filament produced from recycled HDPE is then extruded through a nozzle of the 3D printer concerning the preset printing parameters such as feed rate and nozzle temperature. The 20x20x20 cube is printed and the percentage of shrinkage is analyzed by using a computer program (ImageJ). The rheological testing results indicate that the increasing melt temperature increases the MFR, while no significant change of swelling ratio is found. It can be seen that the MFR of virgin HDPE is higher than recycled HDPE, whereas the swelling ratio is lower compared to that of recycled HDPE. The increasing MFR and unchanged swelling ratio are found with the increase in filler content. The virgin and recycled HDPE have higher shrinkage than those of PLA and ABS. The increase of filler content in HDPE (from 3 to 7 wt%) tends to increase the shrinkage of HDPE cubes. It is due to the addition of filler, which can typically act as nucleation sites and accelerate the crystallization rate consequently increasing the shrinkage of part. In the case of the 15 wt% amount of filler, it is interesting to note that the %shrinkage of HDPE is particularly decreased which is related to the diluent effect. Therefore, the primary results of this work show a high feasibility of using recycled HDPE bottle caps as a 3D filament to reclaim plastic wastes and to reduce environmental problems.

Keywords: Recycle HDPE, 3D printer, Percentage of shrinkages

MAS09-M25

Floor Mat Produced from Tire Crumb Rubber and Polystyrene Wastes

Thanida Pholwongtrakul[1], Wiboonpong Boriburana[1], Sarisa Prasertlum[1], and Somjate Patcharaphun[1],*

[1]Department of Materials Engineering, Faculty of Engineering, Kasetsart University, Bangkok 10900, Thailand
[*]corresponding author: fengsjpc@ku.ac.th

The objective of this work is to study the feasibility of using the disposal polystyrene packaging plastics and foam (Expanded Polystyrene, EPS) as a binding agent for the floor mats produced from recycled tire crumb rubber to replace commercial-grade Polyurethane (PU). The influence of tire crumb rubber/aggregate ratio, binder content, and product thickness on compressive strength, impact resistance, and water permeability are our main interesting factors. The computer program Autodesk Fusion 360 is employed to design and analyze the strength of floor mats and the comparison between the numerical and experimental results is carried out. Moreover, the various designs of rib patterns are examined for the size of 400x400x25 mm. The preliminary results show that the optimum efficiency for a 25 mm thickness tire crumb rubber floor mat can be obtained by using a crumb rubber/aggregate ratio of 75/25 mixed with 5.0 vol% binder. It is interesting to note that an increasing bulk density of floor mat significantly increases compressive strength and impact resistance. In consideration of the water permeability, all the tire crumb rubber mat floors produced in this work are water-permeable. Good agreements between numerical and experimental results are found in that the increasing thickness of floor mat tends to decrease compressive strength, whereas the particular increase of compressive strength can be reached by increasing bulk density. The simulation results also indicate that the rib pattern of the honeycomb and circle give a better reinforcing efficiency compared to that of the linear pattern. For design purposes, it can be suggested that the wall thickness of the mat floor (T), rib height (H), and rib width (W) depend on the rib pattern, size, and thickness of the product. The success of this work proclaims a high feasibility of utilizing polystyrene waste as a binding material to reclaim plastic wastes and tire rubbers and to reduce environmental problems.

Keywords: Polystyrene waste, Tire crumb rubber, Mechanical properties

MAS10-M27

Synthesis of Activated Carbons from Corn Cob as an Adsorbent for Removal of Dyes in Water

Atthanon Choomthi[1], Nonthapat Kosacarn[1], Chanatip Sungprasit[1,2], Kasidit Janbooranapinij[1,2],and Gasidit Panomsuwan[1,2,*]

[1]Department of Materials Engineering, Faculty of Engineering, Kasetsart University, Bangkok 10900, Thailand
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Synthetic dyes, extensively discharged by various industries such as textiles, clothing, paper, food, and plastic, pose a significant threat to the environment, contributing to pollution. They are highly toxic and potentially carcinogenic, causing adverse effects on both animal and human health. Effective removal of synthetic dyes requires materials with excellent adsorption properties. Among several materials, activated carbons (ACs) have received significant attention due to their large surface area and high porosity. In this work, ACs were derived from waste corn cob via carbonization at 450 ºC followed by chemical activation using zinc chloride (ZnCl2) at 600 ºC in various proportions, including 1:2, 1:3, and 1:4. X-ray diffraction (XRD) and Fourier transform infrared spectroscopy (FTIR) results revealed that the ACs exhibited an amorphous carbon phase without any impurity phases and had similar chemical functional groups (i.e., C=C and C–O–C), with regardless of ZnCl2 content. The morphology of the ACs displayed the development of a porous structure and a ruptured surface compared to raw corn cob and non-activated samples. The specific surface area of ACs gradually increased from 528 to 582 m2/g as the ZnCl2 content increased, which was much larger than that of the non-activated one (1 m2/g). The porosity of ACs was mainly contributed by micropores, with a small proportion of meso–macropores. Furthermore, the adsorption of synthetic dyes, including methylene blue and methyl orange, using ACs was assessed via UV-Vis spectroscopy. Among all samples, the AC (1:4) exhibited the highest adsorption capacity due to its highest specific surface area and greater porosity. The results obtained in this work provide valuable information on the conversion of waste corn cob into ACs for the removal of synthetic dyes in water.

Keywords: Activated carbons, Corn cob, Synthetic dyes, Adsorbents

MAS11-M28

Synthesis of Steam-Activated Carbons from Coconut Coir Dust as Electrode Materials for Supercapacitors

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Coconut coir dust (CCD) is a byproduct generated during the separation process of coconut coir fiber from coconut husk. Due to its high carbon content and relatively low ash content, utilizing CCD as a precursor for carbon production is an attractive option. In this work, activated carbons (ACs) were synthesized from CCD through carbonization at 500, 600, and 700 ºC, followed by steam activation at 900 ºC. The morphology of ACs exhibited a rougher and more ruptured surface after steam activation. All ACs displayed an amorphous carbon phase with a small presence of impurities. Upon activation, the chemical functional groups disappeared, confirming the conversion of lignocellulosic structure into a carbon material. The specific surface area of ACs derived from carbonized samples at 500, 600, and 700 ºC was 802, 779, and 889 m^2/g, respectively. This surface area was contributed by micropores (57–67%) and meso-macropores (33–43%), indicating that the pre-carbonization temperature influenced the adjustment of porosity and surface area of the ACs. The potential application of ACs derived from CCD as supercapacitor electrodes was evaluated using a three-electrode system by cyclic voltammetry (CV) and galvanostatic charge-discharge (GCD) in 6 M KOH electrolyte. All ACs exhibited a quasi-rectangular CV curve with no redox peaks and nearly linear triangular GCD curves, indicating the electrical-double layer capacitor (EDLC) behavior. The AC (carbonized at 700 ºC) had the highest specific capacitance (~90 F/g at 1 A/g), attributed to its highest surface area. Furthermore, it was chosen for fabricating a coin-cell supercapacitor (two-electrode system) for practical applications. The coin cell was tested through 10,000 charge-discharge cycles to confirm its potential for long-term use. The results of this study highlight the potential of ACs derived from CCD as electrode materials for supercapacitor applications.

Keywords: Activated carbons, Coconut coir dust, Supercapacitors

MAS12-P01

Production Improvement of 2,5 Furandicarboxylic Acid from Catalytic Oxidation of5-hydroxymethyl furfural for Sustainable Packaging

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Growing public concern over plastic waste accumulation has driven increased interest in bioplastics, particularly Polyethylene furanoate (PEF), a next-generation polymer offering a sustainable alternative to the widely used polyethylene terephthalate (PET) with superior gas barrier properties. 2,5-Furandicarboxylic acid (FDCA) is the crucial monomer for PEF production, but its efficient synthesis remains a challenge due to limitations of conventional reactors, such as high pressure, long reaction times, and low productivity. The objective of this research is to improve the process for synthesis of FDCA monomer from oxidation of HMF in a flow packed bed reactor using Ru/C as a catalyst. The effect of various parameters, including solvent, HMF concentration, molar ratio of HMF/H_2O_2, volumetric flow rate of H_2O_2 and reaction temperature on product yield are studied. The product was quantitatively analyzed using HPLC technique under optimized conditions. The result showed that ultrapure water yielded the highest FDCA product compared to 1,4-Dioxane and DMSO solvents. Increased concentrations of both HMF and H_2O_2 resulted in a lower yield of FDCA. As temperature increased, yield of FDCA increased due to better reaction kinetic rate according to Arrhenius equation. The optimal reaction conditions were achieved with a flow rate of 0.03 mL/min for both HMF and H_2O_2, HMF/H_2O_2 molar ratio of 1:8, temperature of 90 °C, and ultrapure water as the solvent, yielding an FDCA yield of 90.7%. These findings offer valuable insights for the optimized synthesis of FDCA, paving the way for its utilization in PEF bioplastic for sustainable packaging solutions.

Keywords: 2,5-Furandicarboxylic acid (FDCA), Polyethylene Furanoate (PEF), Sustainable packaging

MAS13-P07

Effect of Citric Acid on Properties of Starch Coating for Paper Packaging

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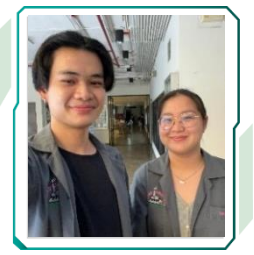
Paper packaging is one of biodegradable materials which has been demanded increasingly. It has porous structure and great hydrophilicity, leading to high water absorption. Poor gas and water vapor barrier properties are also its limitation. To overcome these constraints, a crosslinked starch-based solution, which has excellent biodegradability and low cost of production, can be coated on paper packaging. This research aimed to study the effect of crosslinking, produced by the addition of citric acid (CA), on the physical, mechanical, barrier, and antifungal properties of starch (NS) and Zinc oxide nanoparticle/starch (NS/ZnO) coatings. In this experiment the starch was optimally gelatinized at the 90 °C for 20 min before adding various concentrations of CA, After the addition of CA, the solution was adjusted to pH 6. The result shows that an increase in CA concentration led to higher Young's modulus, lower air permeability, and lower water absorption. This was due to an increase in the degree of crosslinking between CA and starch molecules which also affected water vapor permeability. After that, ZnO was added into a crosslinked starch solution (NS/CA) as an antimicrobial agent. The result shows that Young's modulus and air permeability were relatively similar to those of NS/CA. However, water absorption tended to increase after adding ZnO. This may be due to the hydrophilicity of ZnO. The effect of starch crosslinking on antifungal properties of ZnO was also investigated.

Keywords: Cross-linked starch, Paper-based packaging, Antifungal property

MAS14-P12



Development of Natural Ingredient-Based Edible Inks for Food Decoration

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Instagram and TikTok have fostered the "foodie" trend, which involves a growing interest in food and dining. Food businesses are using social media marketing to gain new customers. Thus, food decoration has become important since it allows for customization and visual appeal, improving the dining experience. With this growing demand, research on edible ink for food decoration, particularly regarding the development of sustainable inks, is becoming increasingly pertinent. This study presents an investigation into the development of water-based edible ink utilizing colorants derived from natural extracts. Food-grade additives were utilized to formulate the ink, and the resulting formulation was optimized for key printing characteristics, including color inalterability, stroke sharpness, and lightfastness. The investigation revealed the potential of blue extract from *Clitoria ternatea L.* (butterfly pea) and red extract from *Hibiscus sabdariffa L.* (roselle) as sustainable ink colorants. Through careful selection and optimization of additive ratios, both ink formulations were successfully developed, utilizing 0.5% glucose as pigment carrier, 0.15% carboxymethyl cellulose as binder, and 0.3% xanthan gum as thickener. Evaluation of the developed inks revealed satisfactory color quality when applied to paper using various techniques such as writing, drawing, and rod coating. Notably, lightfastness testing under controlled conditions (0.68 W/m²/nm at 60°C for 24 hours) demonstrated promising results, indicating the inks' ability to retain color intensity under UV light exposure. This study contributes to the development of sustainable and effective edible inks for food decoration, showcasing the potential of natural extracts as colorants and highlighting their promising lightfastness properties.

Keywords: Ink Formulation, Stroke Sharpness, Light fastness

MAS15-P14

Natural Polymer coating Paper for Water and Oil Resistance Improvement

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Paper packaging for food takeaway becoming more popular since paper itself is recyclable, compostable and can be produced form renewable resources. However, most of paper packaging are laminated or coated with nonbiodegradable or chemically modified plastics which are prohibited under Single Use Plastic Directive (SUPD). This research aims to investigate the possibility of using carbohydrate or protein coating formulations for food paper packaging to improve water and oil resistance. Selected paperboard substrate was 240 g/m^2 and the coating solutions were modified tapioca starches (Flavotec®N286) at 15%,20% and 25% (w/v) and casein sodium salt at 1%, 3% and 5% (w/v). Silicone oil 1000 (Polydimethylsiloxane, PDMS) which was commonly used for paper coating as released liner was also selected to benchmark. Automatic Film Applicator, Model BEVS1818). After coating, Cobb's Test (TAPPI T441 om-13) for water and oil absorption and Kit Test (TAPPI T559) for oil repellency as well as physical properties, surface analysis (Scanning Electron Microscope, SEM) and thermal stability (TGA) of the coated samples were investigated. The results showed that coating with modified tapioca starches (25%, w/v) significantly reduced water and oil absorption and showed excellence oil repellency compared to the uncoated paper as well as protein and PDMS coating due to its stability under oil/water-based liquid. The lowest water and oil absorption ($Cobb_{60}$) were 18.42±6.03 g/m^2 (Uncoated paper, 26.77±3.60 g/m^2) and 14.62±6.79 g/m^2 (Uncoated paper, 228.3±21.35 g/m^2) respectively. Kit No. ranked highest at 12 (Uncoated paper, Kit No. =0). For casein, only 3 % (w/v) slightly improved water and oil resistance (Kit value =6) whereas higher concentration at 5 % (w/v) could not improve water resistance since more hydroxyl groups are hydrophilic.

Keywords: Paper Packaging, Natural Polymer, Coating, Food, Water, Oil resistance

MAS16-P19

Controlled Release of Active Agents with Lignin Nanoparticles from Poly(butylene succinate)

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Blown-film extrusion was utilized to create biodegradable poly(butylene succinate) blend films containing spherical lignin nanoparticles (LN) and natural agents, such as vanillin, trans-cinnamaldehyde, citral, and thymol, for applications in food packaging. The films underwent characterization for remaining contents, morphology, thermal, mechanical, barrier properties, UV-shielding ability, and release into the headspace or diffusion coefficients. The size of the LN particles ranged from 40-300 nm, with an average of 120±18 nm. The composite films with LN exhibited a brownish color, while neat PBS displayed a white milky appearance. Solvent extraction results indicated that the composite films had a greater remaining content of each active agent. The FTIR and SEM analyses revealed good interactions among LN, natural agents, and the PBS matrix, as well as high homogeneity of the resultant PBS composite films. The plasticization effects led to improved compatibility and smoothness. In comparison to neat PBS, the PBS/LN/natural agents composite films exhibited improved tensile modulus, higher oxygen and water vapor permeability, and excellent UV-shielding ability. Mathematical models were appropriately employed to describe the release behavior of the natural agents into the headspace, with the diffusion mainly dependent on the remaining concentration. According to the diffusion coefficient, the active films had a slow and steady constant release into the food headspace. PBS blend films with lignin nanoparticles and natural agents resulted in functional active packaging.

Keywords: Poly(butylene succinate), Controlled release, Natural agents

MAS17-P23

Edible and Water-Soluble Films Based on Starch/Gelatin Blends

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This research aims to develop edible and water-soluble films made from cassava starch/gelatin blends using a blown film extrusion process. Cinnamaldehyde was added to the films as an antioxidant. In addition, ginger starch, which is a by-product of ginger juice production, was also used to partially replace cassava starch in film production to create its value. Four types of films, including cassava starch/gelatin (C), cassava starch/ gelatin/cinnamaldehyde 0.5% (CC0.5), cassava starch/gelatin/ cinnamaldehyde 1% (CC1), and cassava starch/ginger starch/gelatin (CG) were prepared. Water solubility, water contact angle, oxygen and water vapor barrier properties, as well as tensile and impact properties of the formed films were then analyzed. The addition of cinnamaldehyde caused color change (more yellowish) and poorer oxygen barrier property of the films. CC0.5 film had better mechanical properties than CC1 film and also showed higher tensile strength, Young's modulus, and water contact angle than C film. CG film presented better water solubility, but poorer mechanical properties, and oxygen and water vapor barrier properties than C film. In addition, CG film showed lower shrinkage than other films. For the application of films as three-sided sealed sachets for instance noodle seasoning oil, CC and CG films had the potential to be used as seasoning oil packages. Nonetheless, CG film was recommended for this application because of its lowest shrinkage during sealing, best water solubility, and most perfect and acceptable sealed sachets.

Keywords: Edible film, Water soluble film, Starch

MAS18 - P28

A Study on the Properties of Materials and Technology for Ready-to-eat Food Packaging

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In recent years, with the change in lifestyle, microwave reheating has become a widespread practice. This study investigates microwaveable food packaging in convenience stores, focusing on microwave reheating chilled food products. Our market survey reveals that most ready-to-eat food packaging (21 out of 26 samples) requires cutting or piercing before microwaving to release steam. Packaging designs that do not need cutting or piercing have features such as a self-venting mechanism. Typical microwave packages expand during heating due to internal pressure from accumulated steam. Post-heating, the internal pressure decreases. Without cutting or piercing the packaging material, the packaging may burst or explode. The self-venting mechanism releases steam through a valve or micro-perforation pattern, preventing packaging explosion during microwave heating. We also conduct tensile tests to evaluate the mechanical properties of the packaging materials. Regulations mandate the use of polypropylene (PP) for microwaveable food packaging in Thailand due to its suitability for microwave reheating. Other polymers, such as PETE (polyethylene terephthalate), HDPE (high-density polyethylene), and LDPE (low-density polyethylene), can only be used at low heat for short durations. However, biodegradable polymers, such as polyhydroxyalkanoates (PHAs), are explored as alternative materials in reducing petroleum consumption and promoting sustainability. PHAs, being heat-resistant, flexible, and comparable to PP, show potential for microwaveable food packaging.

Keywords: Microwave packaging, Packaging innovation, Mechanical properties

MAS19-T01

Synthesis of Zinc Oxide Nanoparticles using Neem Leaf Extract and its Antimicrobial Study on Cotton Fabric

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The objective of this research is to investigate the green synthesis of zinc oxide nanoparticles from neem leaf extract and evaluate their effectiveness in inhibiting three disease-causing bacteria on cotton fabric, namely *Staphylococcus aureus*, *Escherichia coli*, and *Klebsiella pneumoniae*. Firstly, the dried neem leaves were extracted with methanol at room temperature for two days. Then, the different concentrations of neem leaf extract were prepared at concentrations of 5, 10, 15, 20, and 30 per cent and synthesized with 10 mM zinc acetate at 90°C for 2 hours. UV-Vis spectroscopy technique was employed to analyze the absorption wavelengths characteristic of zinc oxide nanoparticles. The minimum inhibitory concentration was investigated by the agar dilution test technique. After that, the zinc oxide nanoparticles were coated on cotton fabric by pad-dry-cure technique. The antibacterial activity and the durability of the zinc oxide-coated cotton fabrics were assessed by the zone of inhibition. It was found that the UV-Vis spectroscopy of the green synthesis of zinc oxide nanoparticles typically fell within the wavelength range of 300 to 380 nanometers. The result of the minimum inhibitory concentration revealed that the five per cent neem leaf extract with zinc oxide nanoparticles solution was capable of inhibiting the growth of all three bacteria. Additionally, the cotton fabric coated with zinc oxide nanoparticles exhibited effectiveness in inhibiting these three disease-causing bacteria. Even after washing, the zinc oxide nanoparticles coated cotton fabric still retained the nanoparticles on its surface and maintained its ability to inhibit.

Keywords: Neem-leaf extract, Zinc-oxide nanoparticles, Antimicrobial activity

MAS20-T02

Designing Stress Relief, Scented Fabric Accessories for Working Professionals

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The objective of this research is to provide preliminary stress therapy, which is a condition that can occur to anyone due to family issues, academic pressure, and work-related stress, especially among the working-age population facing economic uncertainty, pressure to succeed from peers or similar-aged individuals, or workplace stress. If these stressors accumulate significantly, they can lead to depression in many individuals. Therefore, there are various methods of stress therapy available, such as exercise, meditation, or other activities. In this research, the researchers have chosen another method of stress therapy based on folk wisdom. This method involves providing stress therapy to working-age individuals experiencing stress in the Bangkok metropolitan area. It utilizes the scent of microcapsule technology and incorporates it into convenient wearable accessories for daily use. The selection of scents is based on data from surveys of a sample group that indicated relaxation and suitability for use in accessories. Sensory evaluation is conducted using a Sorting Test and a Semantic Differentiation Scale. This information is then used to design accessories made from dyed fabric with pleasant scents using a printing and microcapsule embedding process. Natural adhesives are used instead of synthetic ones to promote environmental friendliness in production.

Keywords: Microencapsulation, Aromatic oils, Accessories

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ASM01-M08

Smart Sensing: Metal Oxide/MWCNT Composites for Detecting Citric Acid in Tom Yum Goong

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This research presented a simple and robust method for assessing citric acid in Tom Yum Goong and established standards for cooking and export. The study investigated the synthesis of ZnO and Fe-doped ZnO via solution combustion for potential use in electrochemical sensors for citric acid detection. Composite powders were created by combining these materials with multi-walled carbon nanotubes (MWCNTs) through hydrothermal treatment. The resulting composites were applied to screen-printed carbon electrodes and tested for citric acid detection in both aqueous solutions and Tom Yum Goong. In comparison to ZnO/MWCNTs, the Fe-doped ZnO/MWCNTs electrodes exhibited superior electrocatalytic performance, demonstrating a robust linear response, acceptable sensitivity 1.38×10^{-4} $mAmM^{-1}mm^{-2}$, low detection limit (0.027 mM), and satisfactory selectivity in the presence of interfering chemicals including nitrate nitrite and glutamate. The study highlighted the positive effects of Fe-doping on ZnO, revealing enhanced electrocatalytic potential and showcasing promising applications, particularly in effectively responding to lime juice in Tom Yum Goong.

Keywords: Citric acid, Electrochemical sensor, Fe–doped ZnO

ASM02-M09

Fabrication of HA/Polymeric Bone Scaffolds through 3D Printing

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This study focused on the development and characterization of 3D-printed bone scaffolds coated with hydroxyapatite, a biocompatible material commonly used to reconstruct damaged bones from osteoporosis or accidents. The fabrication process involved blending hydroxyapatite powder with a liquid photopolymer, followed by UV irradiation. The resulting scaffolds displayed a uniform distribution of fine hydroxyapatite powder on the surface. Subsequent coating with a hydroxyapatite slurry under various coating and sintering conditions was shown to influence the scaffold's compressive strength. Weibull analysis of scaffolds with multiple coating layers demonstrated a high likelihood of survival at 4 MPa, falling within the acceptable range for cancellous bone strength. This comprehensive study highlighted the potential of hydroxyapatite-coated 3D-printed bone scaffolds with favorable microstructure and mechanical strength, making them promising for bone reconstruction applications.

Keywords: Hydroxyapatite, Bone Scaffold, Stereolithography

ASM03-M12

Fabrication of Superhydrophobic SS304 Surfaces via Electrochemical Techniques

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Nowadays people are careful when touching various types of materials as they may encounter diseases by touching those materials. Materials may be used in kitchenware or medical equipment and can be dirty with dust, diseases, or oil residues on top of the material surface. The surface can be improved by making it super hydrophobic with contact angles higher than 150° and have self-cleaning properties. In this research stainless steel grade 304 was chosen as it has been widely used, has high potential to resist corrosion, high temperature resistance, hard to form rust, does not absorb chemicals, good shock absorption. The samples used were cut into pieces measuring 2x4x0.1 centimeters. In the first step it will be etched in myristic acid mixed with concentrated ethanol (0.103-0.441 M) 48 to 216 hours. Then it will be anodized in concentrated sulfuric acid (0.176-1.609M) at 2V and a current of 0.1 - 0.2 ampere per square centimeter for one hour. Results show that before experimentation, the contact angle was approximately 67 to 71° and does not exhibit hydrophobic properties. However, after the experiment with etching and anodization the contact angle of the test pieces changed significantly with increasing concentration of the acid, etching time, and concentration of anodizing chemicals. In this research stainless steel that has been etched with Mystic acid mixed with concentrated ethanol 0.411 M for 216 hours and anodized in a solution of concentrated sulfuric acid 1.609 M resulted in a hydrophobic surface with the highest contact angle of 97.5°. When the surface was analyzed with SEM, it can be seen that the surface porosity has increased making the surface more rough and an oxide film was formed which was less than 200 nanometers thick. This can be further studied to improve the super hydrophobic properties and self-cleaning abilities.

Keywords: Anodizing, Superhydrophobic, SS304

ASM04-M13

Effect of Increasing Roughness on Surface Adhesion Properties of AL1100

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Nowadays aluminum has been used widely in kitchen utensils, packaging, and other equipment and these products need to be very clean. Therefore, to increase the roughness of aluminum surfaces to increase adhesion, inhibit corrosion, and decrease fatigue due to touch and heat transfer, these are the goals of this project. In the experiments, aluminum grade 1100 size 20x40x1 millimeter was used and surface roughness was increased using 3 methods; the first method is by polishing with sandpaper, the second method is with chemical etching, and the third is etching with electrochemistry. 1. When polishing, sandpaper number will increase from 100 to 2000 and the polishing machine set to 150 RPM. 2. For chemical etching it will be done in 1 M Ferric chloride solution for 30 to 60 minutes and the pieces will undergo surface grafting with chemical bonding with ethanol for 30 minutes. 3. For the anodizing process the test pieces will be divided into two groups. The first group will be analyzed in diluted sulfuric acid for 40 to 80 minutes and the second group will be submerged in 4.26 M Mystic acid mixed with 24.7 M methanol for 48 hours and then anodized in diluted sulfuric acid for 40 to 80 minutes. All the pieces were taken to measure the contact angle to observe how the different processes affect the roughness of the surface. Results show that the contact angle of aluminium that has not undergone any process was 92°. Test pieces in experiment 1 had the highest contact angle of 97.7°, method 2 had the highest contact angle of 120.8°, method 3 had the highest contact angle of 111.9°. From these experimental results, the surface modification with chemical etching resulted in the highest contact angle. Therefore, future development should use this process which is the most appropriate.

Keywords: Aluminium Surface Modification, Roughness on surface, Contact Angle

ASM05-M17

Development of Novel Composites between Polymer/Organic Salt and their Thermal, Electrical, and Antimicrobial Properties

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This research aimed to study the fabrications and characteristics of novel films from polybutylene adipate terephthalate (PBAT)/organic salt. The organic salt was cyclohexyl fumarate, which can be easily synthesized by mixing the equimolar ratio of cyclohexylamine and fumaric acid in aqueous ethanol (33%v/v). The characteristics of the prepared organic salt were confirmed by single-crystal X-ray diffraction (SC-XRD), powder X-ray diffraction (PXRD), and Fourier-transform infrared spectroscopy (FTIR). Then, the organic salt was mixed with PBAT to make compound pellets with an organic salt content of 1% (masterbatch) by a twin-screw extrusion process. After that, the composite films with organic salt contents of 0.25, 0.5, and 0.75% were also fabricated by mixing the masterbatch pellets with the pristine PBAT pellet during the film extrusion process. The physical and biological properties of polymer composite materials, in terms of thermal, mechanical, electrical conductivity, and antimicrobial properties (towards different bacteria and fungi), were examined in order to observe the effect of the organic salt addition.

Keywords: Composite films, Organic salt, Physical and biological properties

ASM06-M19

Eugenol-Derived Benzoxazines: Ring-Opening Polymerization, Anticorrosion Performance, and Photoluminescent Property

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The research aims to study the synthesis of benzoxazine monomer coating for corrosion resistance by using eugenol as a bio-precursor. The benzoxazine monomer (Eu-m) was prepared by mixing eugenol, paraformaldehyde, and methylamine with a ratio of 1:2:1 and then heated for 3 hours using the reflux process and further purification. The chemical structure and the purity were confirmed by ^{1}H NMR, ^{13}C NMR, and FTIR spectroscopies. The polymerization triggered by different conditions (120, 140, and 160 °C with a similar duration time of 1 hour) of the Eu-m benzoxazine monomer was performed after the monomer was coated on steel plates. FTIR spectroscopy was also employed to monitor the progress of the ring-opening polymerization by observing the formation and/or the disappearance of certain FTIR peaks. The anti-corrosion performance was examined by potentiodynamic polarization as well as electrochemical impedance spectroscopy techniques. The electrode system was set up in order to conduct the electrochemical test. Besides, the optical properties of the Eu-m monomer were examined by photoluminescent spectroscopy in order to obtain the excitation-emission matrices.

Keywords: Benzoxazine, Eugenol, Corrosion

ASM07-M29

Solution Plasma Synthesis of Gold Nanoparticles Incorporated into Electrospun Polyvinyl Alcohol Nanofibers

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Gold nanoparticles incorporated into polyvinyl alcohol (AuNPs/PVA) nanofibers were successfully prepared using the electrospinning technique. Two key factors for PVA nanofiber preparation were determined: PVA concentration and tip-to-collector distance. In this study, PVA nanofibers were prepared with various PVA concentrations (i.e., 8, 10, 12, 14, 16, and 18 wt%) and tip-to-collector distance (i.e., 10, 12.5, and 15 cm) at an electric potential of 20 kV, flow rate of 0.3 mL/h, and injection time of 3 h. The morphology of the PVA nanofibers was examined using a scanning electron microscope (SEM). With increasing PVA concentrations from 8 to 18 wt%, the average fiber diameter of the PVA nanofibers increased from 49.5±9.5 to 121.1±20.8 nm, while the bead density was reduced from 1.2 to 0 bead/μm^2. Optimal electrospinning conditions, resulting in smooth injection and beadless nanofibers, were determined to be a PVA concentration of 18 wt% and a tip-to-collector distance of 15 cm. These conditions were further used for the preparation of AuNPs/PVA nanofibers. The AuNPs were synthesized by solution plasma sputtering of Au wires into PVA solution without any chemical addition. SEM images and energy-dispersive X-ray spectroscopy (EDS) mapping revealed that the average fiber diameter of the AuNPs/PVA nanofibers was 97.4±16.5 nm, with a beadless and uniform distribution of AuNPs within PVA nanofibers. Incorporating AuNPs into PVA nanofibers resulted in a decrease in the average fiber diameter compared to 18wt% PVA nanofibers. The AuNPs/PVA nanofibers hold potential for further development in various medical applications, such as drug delivery systems and biosensors.

Keywords: Electrospinning, Gold nanoparticles, Polyvinyl alcohol nanofibers

ASM08-P09

Development of Functional Packaging to Improve the Texture of Plant-Based Meat

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Plant-based meat is the future food, with nutrient benefits from plant proteins. The texture and firmness of reformulate structures is important parameter for consumers. This work aims to develop cassava starch-based films containing transglutaminase to improve firmness. Cassava starch and transglutaminase were mixed, and the films were prepared by a solution castings method. The films were analyzed using a Fourier transform Infrared spectrometer (FTIR), scanning electron microscopes (SEM), permeability properties, contact angle, mechanical properties, and food application. Plant-based meat were packed with active films and analyzed for texture attributes. FTIR indicated the interaction of functional group between starch and transglutaminases. Addition of transglutaminases exhibited decrease smoothness surface morphology. The increasing transglutaminase concentration increases water vapor permeability and water contact angle. Tensile strength and Young's modulus of films containing transglutaminase decreased but elongation increased. The films showed low water solubility. Texture analysis indicated an improved hardness with firmer texture of patties plant-based meat packed in films containing transglutaminases. Transglutaminases in the film enhanced the texture of plant-based meat patties due to protein cross linking by transglutaminase. Accordingly, the novel cassava starch film containing transglutaminases enzyme effectively increased firmness of plant-based meat.

Keywords: Cassava Starch; Transglutaminase; Plant based meat

ASM09-P21

Antioxidant Activities of Angkak Extract and Angkak Extract-incorporated Methylcellulose Film

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Red yeast rice, or angkak, is a product derived from the fermentation of the *Monascus purpureus* by using rice or grain as the main raw material. This type of fungus thrives on rice and produces a red pigment. Angkak is commonly used as a natural food coloring and flavoring agent, safe, and often used as a substitute for synthetic colors in the food industry. Additionally, angkak contains various antioxidants, which have been studied for their free radical scavenging activities. The objective of this research is to study the antioxidant activity of angkak extract and evaluate the effectiveness of methylcellulose-based films incorporated with angkak extract. The study revealed that angkak extract exhibited inhibition with IC_{50} values of 3802.59 and 1466.81 micrograms per milliliter when tested using 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging assays and 2,2'-azino-bis (3-ethylbenzthiazoline-6-sulphonic acid) (ABTS) radical cation decolorization assay, respectively. When the angkak extract was incorporated into the methylcellulose-based films at concentrations of 1%, 2%, and 3% by weight, it was observed that the thickness of the films increased while the transparency decreased. This resulted in enhanced antioxidant activity when tested using DPPH and ABTS assays. An increase in the amount of angkak extract in the films led to increase tensile strength at the breaking point and Young's modulus, and decrease elongation at break. When studying light transmission through ultraviolet light with wavelengths between 200 and 800 nanometer, the ability of the films to prevent light transmission was most effective at the highest concentration of angkak extract. This study highlights the encouraging potential of using methylcellulose-based films incorporated with angkak extract as antioxidant films for food packaging to prolong shelf life, enhance food quality, and ensure safety for packaged foods.

Keywords: Angkak, Antioxidant, Active Packaging

ASM10-P22

Antioxidant Activities of Roselle Extract and Roselle Extract-Incorporated Methylcellulose Film

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Free radicals in food contribute to deterioration and a decline in nutritional value. Consequently, the use of antioxidants to mitigate the impact of free radicals is essential. Due to consumer concerns about the potential risks associated with synthetic antioxidants, natural extracts have emerged as a viable alternative. Roselle, a herbal plant with diverse properties, including its use as a food colorant and antioxidant, has gained attention for this purpose. This research investigated the antioxidant effectiveness of a roselle extract and roselle extract-incorporated methylcellulose film. This work aimed at assessing its ability to act as an antioxidant, delaying the deterioration of food. The methods, diphenyl-picryhydrazyl (DPPH) radical scavenging assay and ABTS radical cation decolorization assay, were employed to analyze the antioxidant properties. The results indicated that the IC_{50} values, representing the concentration at which the extract reduced free radicals by 50%, DPPH were 2947.59 micrograms per milliliter and ABTS, the incresed of concentration of roselle led to higher scavenging activity. Physical properties of the films were evaluated after incorporating roselle extract at concentrations of 1%, 2%, and 3%. The study revealed an increase in film thickness, accompanied by a reduction in transparency. The films exhibited increased thickness, impacting clarity but improving the ability to inhibit free radicals. Moreover, the thicker films displayed superior light-blocking properties, with the highest thickness providing the most effective UV blocking with wavelengths between 200 and 800 nanometer. In summary, films enriched with roselle extract showed promising antioxidant and UV-blocking capabilities, making them a good potential choice for food packaging to ensure safety and consumer confidence.

Keywords: Roselle, Antioxidant, Active Packaging

PMIS 2024

MPS

Modelling, Prototyping, & Simulation

Rethinking Packaging and Materials for a Sustainable Future

MPS01-M26

Ring Stiffness analysis of HDPE Double – wall Corrugated Pipe by using Computer Aided Engineering

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The computer program Autodesk Fusion 360 is utilized in order to investigate the ring stiffness (SN) of double-wall corrugated HDPE pipe according to the ISO9969 standard. To gain an eco-friendly product, the post-consumer recycled (PCR) HDPE is employed in the double-wall corrugated pipe. First step, the various internal diameters (ID) of double-wall corrugated pipe are developed by using computer-aided design (CAD). The 3D model of double-wall corrugated pipes is then generated to mesh model for the analysis of ring stiffness. The material data i.e. Young's modulus and yield strength obtained from the tensile test (ASTM D638 Type IV) are required in the simulation. From the experimental results obtained from the double-wall corrugated pipe with a diameter of 100 mm, it can be seen that the SN is approximately 19.82 KN/m^2 which is much higher than the target value (8.0 KN/m^2). It is found that the presence of rib for 300 and 500 mm double-wall corrugated pipes does not significantly enhance the pipe stiffness and the SN values are found between 10.5 to 12.0 KN/m^2, which are still higher than that of target value. The analytical results of SN obtained from the computer program are in agreement with the experiments. However, it should be noted that the predicted SN values obtained from the simulation are much lower than those of the experiment. The possible reason for the discrepancy due to the difference between the testing conditions. The predicted results show that the SN value is 12.24 KN/m^2 when the 40 wt% recycled HDPE is employed into the outer and inner layers of 100 mm corrugated pipe. In the case of 300 and 500 mm double-wall corrugated pipe, the 40 wt% recycled HDPE is only incorporated into the outer layer and the predicted SN values are still higher than 8.0 KN/m^2. From the simulation results, it can be implied that the 40 wt% recycled HDPE can be used for the production of 100, 300, and 500 mm double-wall corrugated pipe in order to minimize the material cost and the depletion of natural resources.

Keywords: Ring stiffness, High density polyethylene, Corrugated pipe

MPS02-M31

Comparison between Physical Corrosion Models and Experimental Corrosion

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Currently, carbon steel plays a crucial role in industries and manufacturing processes due to its excellent properties and strength. However, there are issues related to corrosion, especially in marine environments. Corrosion problems can lead to deterioration of materials and tools used in the manufacturing process, resulting in increased maintenance costs and reduced lifespan of equipment. Therefore, Potentiodynamic polarization testing is employed as a method to assess the risk of corrosion. This method is then compared with computer models. The computer model starts with input data for initial concentration and burnout coefficient of substances in the solution, metal, solution conductivity, and Tafel slopes, which are derived from the Potentiodynamic polarization curves. These curves can also be used to measure corrosion potential (E_{corr}) and corrosion current density (j_{corr}) of the system. Additionally, mass transfer current of Tafel kinetics is incorporated into the model. Corrosion loss experiments of metal loss with metal loss due to corrosion inhibitors are compared directly with simulated results and validated.

Keywords: Corrosion, Kinetic modeling, Electrochemical, Potentiodynamic polarization

MPS03-M34

Modeling of Heat Conduction using COMSOL Multiphysics Program

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Heat transfer analysis of novel building materials, such as Phase change Materials (PCM), is a challenging task due to their unique thermochemical propoties and the complexity of their operation. The aim of this work is to investigate the thermal performance and impact of novel PCM enhanced plasters via the heat transfer analysis of a building wall under summer dominant conditions. For the Implementation of the numerical simulation study, three dimensional (3D) time dependent building wall models, incorporating the PCM-enhanced plasters, have been developed in COMSOL Multiphysics. This study will offer fundamental knowledge and important guidance on the conduction of numerical heat transfer modeling incorporating phase change materials, and it will provide significant conclusions on the design optimization of PCM enhanced building elements for use in summer dominant climatic conditions.

Keywords: PCM, Heat Transfer, Numerical Simulation

MPS04-M36

Modeling of Phase Changes in Materials

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Phase Changes in materials are helpful in engineering, whether in material design, technological advancement, or industrial applications. Understanding these processes aids in improving and studying material properties to ensure suitability for various applications. This research is aimed to examine the phase transformation of materials and the heat transfer processes involved, which are complex and often require mathematical methodologies for problem-solving. In this project, we aim to investigate the phase transformation of metal alloys and utilize the Finite Element Method (FEM) to address problems in the process. The project will start with determining of the area or "domain" to be analyzed, followed by specifying the working conditions of each area. For this project, the conditions will be set as heat transfer. Then we will study the process of the specified conditions and establish the heat transfer equations to derive the results of the analysis. The next step involves solving the system of equations. In this project, simulations will be conducted using the COMSOL Multiphysics software. The results from the simulation indicate that the workpiece undergoes a phase transformation from liquid to solid in regions where cooling occurs first. The trend in phase transformation suggests rapid changes when ΔT decreases. These simulation findings can serve as preliminary data before conducting actual experiments, thus reducing costs. For instance, adding a time function allows for define of properties as desired.

Keywords: Phase Changes, Finite Element Method (FEM), COMSOL Multiphysics

MPS05-P04

Sustainable Packaging Design for Processed Fruit Using the Concept Transformation

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Because environmental issues and solutions are becoming more widely recognized in global society. Consequently, there is a strong search for remedies to reduce these issues. include resolving the significant issue of "packaging" waste. Therefore, the producer had to concentrate on creating "sustainable" packaging (Sustainable Packaging). There are several ways to promote sustainability. Including the economical use of resources for packaging. But when you take into account Thailand's capacity for producing fruit as well as the product's ongoing growing trend. As a result, Processed Thai fruit businesses and entrepreneurs have to think about using sustainable fruit packaging. Thus, the purpose of this project is to use the notion to develop a sustainable Thai fruit packaging prototype. format change used in conjunction with structural and graphical design in packaging created by examining information from a survey of experts and a review of the literature. After using the findings and recommendations, the researcher created a Thai fruit packing prototype. Additionally, 400 customers in Bangkok participated in a satisfaction survey. According to the expert questionnaire answers, the third packing format was the most well-liked. with a standard deviation of 0.71 and a mean of 4.21, the structural design was deemed satisfactory. In the category of sustainable design, the overall mean score was 4.15, with a standard deviation of 0.74. The standard deviation is 0.68 and the mean is 4.18. Its average score for format change is 0.70 overall.

Keywords: Processed Fruit Packaging, Transformation, Packaging Design

MPS06-P05

Designing Innovative and Creative Thai Food Packaging with Augmented Reality Technology

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The Thai food industry is a significant part of the country's economy and tends to grow continuously in the future. This makes packaging an important instrument for enhancing product image and increasing global competitiveness. The aims of this research were: 1) to create a prominently Thai food packaging prototype and provide a positive consumer experience by combining augmented reality technology and design. 2) to investigate the marketing potential of augmented reality technology on Thai food packaging. 3) to study the perceptions and satisfaction of Bangkok consumers towards augmented reality technology on Thai food packaging. For the purpose of this study, we used mixed methods based on literature reviews and questionnaires. Then we used the results and recommendations to develop a prototype of augmented reality technology based on the ADDIE model and tested the satisfaction of 400 consumers in Bangkok using the AIDA Model. As a result, the questionnaire on the development of packaging design concepts and augmented reality technologies from experts revealed the level of satisfaction with the structural design the average is 4.55, and the standard variation of 0.55. In graphic design, the average is 4.38 with the standard deviation of 0.52. In addition, the presentation of the cooking process and the history of the menu with augmented reality technology provided the most satisfactory. The average is 4.63 and 4.37, with standard deviations of 0.5 and 0.78, respectively.

Keywords: Mobile Augmented Reality, Packaging Design, Marketing

MPS07-P06

Sustainable Packaging Design for Dried Thai Fruits Using the Concept of Gamification

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Most of the current packaging, when consumers finish using it, must be discarded immediately and cannot be used for further benefits. For this reason, there is an interest in sustainable packaging design by applying the principle of gamification together with the design of dried fruit packaging to reuse the packaging for the maximum benefit. By research, using the review of literature, then develop the packaging format with the concept of 4 values. Then classify the game according to 4 types of values, including 1.) The value of self-discovery, use the snake ladder game 2.) The value of being special, use the brain training games 3.) The value of the storytelling, use the jumping frog game 4.) The value of knowledge, using the photo hunt game and all 2 packaging structures are 1.) Game table style 2.) The handle format for asking experts and survey opinions to analyze the most appropriate game values. In the results, it was found that the 1st game has an average of 3.71 which is in the criteria for the assessment of the high level of suitability. Followed by the game that received a medium-level assessment score, including the 2nd model has an average of 3.18, the 4th game has an average of 3.12, and the 3rd game has an average of 3.06, respectively. The structure of the 1st box has the highest assessment score. With the advice to adjust more functions to use and the actual production. Therefore, the result can conclude that the snake ladder game is the most appropriate in terms of value and application to dried fruit packaging, which is suitable for the 1St structure that can be folded into a game table. This packaging design should be improved more to continue in actual production and promote the dried fruit business operators in the next application.

Keywords: Sustainable packaging design, Dried fruit, Gamification

MPS08-P10

Antifungal Sheet base on Polylactic Acid-Modified Starch Blend with Cinnamaldehyde for Extending the Shelf Life of Bakery Products

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Active packaging is able to prolong the shelf life of food products. Cinnamaldehyde (CIN) is the main constituent in cinnamon essential oils that has strong antioxidants and antimicrobial properties. This study aimed to investigate the antimicrobial efficiency of poly(lactic acid), PLA/starch based sheets containing cinnamaldehyde to extension the shelf-life of bakery products. PLA blend with different modified starch namely octenyl succinate (OS) and hydroxypropylated (HP) incorporated cinnamaldehyde (0, 1, 3 and 6%). Mechanical properties, water contact angles, water vapor permeability and oxygen permeability of sheet were investigated. Addition of cinnamaldehyde decreased mechanical, water vapor permeability of both PLA/OS and PLA/HP blend sheets. Oxygen permeability of PLA/HP sheets was increased while PLA/OS sheets was decreased with increased cinnamaldehyde concentration. CIN decreased light transmission. Cinnamaldehyde had great antibacterial efficiency against *Staphylococcus aureus, Escherichia coli and Bacillus cereus.* PLA/HP and PLA/OS with 3 and 6% cinnamaldehyde sheet effectively inhibited fungal growth on sliced bread for 4 weeks during storge at room temperature. All sheets containing cinnamaldehyde more able to produce thermoformed trays with maintain stability during storage for 21 days. This study suggests that PLA/starch blend sheet incorporating cinnamaldehyde had potential to inhibit the microbial growth and extend the shelf-life of bakery products.

Keywords: Active packaging, Cinnamaldehyde, Modified starch

MPS09-T03

The Utilization of Waste Materials to Enhance the Value-added Development of Bean Bag Products through Principles of Management and the Application of Technology to Assist in the Design Prototyping and Performance Testing

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This research studies the processing of waste materials to analyze their transformation into uses, such as fabric scraps, sponges from car seats, and underwear sponges. There is an analysis of the factors affecting the use of bean bags in the production of bean bags, to study the development of the style and process of bean bag forming, and to know the satisfaction of the target group. Two types of experiments were used: Experiment 1, seam. This experiment will test the seam regarding the force distribution of sewing by testing both the group of overlapping seams, layer SS (superimposed seam), and the group of overlapping seams, layer LS (lapped seam), to see which type of stitching will have the best support and distribution of force. Using a stitch frequency of 10 SPI, which has an experimental standard, TIS 121, Volume 27-2009 (Tearing/Stearing Strength), Tested by using all fabrics and then sewing with the stitches according to the established pattern, then put it into a tensile testing machine to select the strongest stitch pattern for use in production. And Experiment 2 elongation tested the sponge's recovery. That is a pendulum was placed on a test sample that was cut into a square shape, size 20 x 20 x 20 centimeters, and stuffed with 5 samples of sponge, then timed in 2 periods to see the time spent on the sponge. And there is a comparison with foam beads (EPS) on the market that are used in general bean bags for sale. The results of the experiment concluded that in Experiment 1, the seam with the best strength in the force distribution test was the stacked seam group, the LS layer (lapped seam). And experimental 2, a sponge with good recovery comparable to foam beads on the market; the car seat sponge measures 3x3x3 centimeters, and all experimental results are used to produce a bean bag with a design that uses trends that were popular at the beginning of 2024 in the design of shapes, colors, and patchwork of fabric together. And asking for the satisfaction of 3–5 experts who have expertise in each area.

Keywords: Waste material, Bean bag, Patchwork, Expert satisfaction

PMIS 2024

MPCT

Materials Processing, Characterization & Testing

Rethinking Packaging and Materials for a Sustainable Future

MPCT01-M04

Alumina in Particles Embedded in Copper Electrodeposits Using Sonicator-Assisted Process

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This research aims to improve the surface of low-carbon steel by the electrodeposition of embedding alumina powder onto the copper electrodeposited layer using the sonication technique. The electrodeposition of copper layers on SS400 substrates was performed by direct current (DC) with a current density of 10 mA/cm^2 to investigate the effect of the intermittent sonicated solution at various ratios of T_{on} and T_{off} (T_{on} / T_{off} ; 10s/50, 20s/40s, 30s/30s). The electrolyte solution was prepared using a mixture of 200 mL of deionization water type I, 25 g of copper sulfate ($CuSO_4.5H_2O$), 39 mL of sulfuric acid (H_2SO_4), 30 µL of Triton X-100, 10.2 g of alumina powder (Al_2O_3), and 0.26 g of hydroquinone ($C_6H_{14}(OH)_2$. The electrodeposited layer's microstructure, distribution, adhesion, and chemical composition were characterized. It was found that the condition with a T_{on} of 30 seconds and a T_{off} of 30 seconds in a sonicator resulted in a more uniform particle distribution compared to other ratios of T_{on} and T_{off} .

Keywords: Electrodeposition, Direct Current, Sonicator

MPCT02-M05

Coating of High Entropy Alloys on Low Carbon Steel (SS400) by Pulse Electrodeposition

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This research aims to improve the surface of low carbon steel (SS400) by pulse current electrodeposition of high entropy alloy. The microstructure, elemental distribution, phase composition, and corrosion resistance of CoCrFeNiSn electrodeposited layers were characterized. The CoCrFeNiSn electrodeposited layers were performed at varying duty cycles of 33% (PC33), 50% (PC50), and 67% (PC67) with a current density of 3 mA/cm^2. Typically, the $LiClO_4$ was added to enhance electron transfer in the electrolytes, but due to its high cost, experiments were conducted comparing specimens with and without $LiClO_4$. The electrolyte solutions used in this study were dimethylformamide (DML), acetonitrile (CH_3CN), $CoCl_2$, $CrCl_2$, $FeCl_2$, $NiCl_2$, and $SnCl_2$. It was found that a higher duty cycle led to an increase in particle size. In conclude, the electrodeposited layers in all conditions were successfully synthesized with no significant difference, even though $LiClO_4$ was omitted. Therefore, cost reduction can be achieved by not using $LiClO_4$ in the electrodeposition process.

Keywords: Coating, Pulse Electrodeposition, High Entropy Alloys, Low Carbon Steel

MPCT03-M06

Electrodeposition of Iron Based High Entropy Alloys under Galvanostatic Conditions

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The aim of this research is to enhance the durability and corrosion resistance of the electrodeposited layers of high entropy alloy coatings on SS400 steel iron based. The electrolyte used in the study consisted of a mixture of 100 mL of CH_3CN, 400 mL of DMF, 0.2536 g of $FeCl_2$, 0.2592 g of $NiCl_2•6H_2O$, 0.3792 g of $SnCl_2$, 0.2596 g of $CoCl_2$, 0.3168 g of $CrCl_3$, and 2.128 g of $LiClO_4$. The current densities used for electrodeposition included 2.5 mA/cm^2, 3.1 mA/cm^2, and 3.7 mA/cm^2. Each interval of the current densities was used to coat the specimens at different times as follows 900 seconds, 1800 seconds, and 3600 seconds. After the electrodeposition, the specimens were characterized by SEM, EDX, XRD, and Potentiostat. Based on the results, it was found that the coating layers were composed of CoCrFe and NiSn elements, exhibited all BCC structure investigated from XRD patterns. SEM results showed that the microstructure of electrodeposited layer appeared to be larger with the increase of time intervals within each current densities range. Additionally, the highest E_{corr} was found in electrodeposited layer with condition of 3.7 mA at 1800 seconds, which indicated the best corrosion resistance.

Keywords: *Electrodeposition, Direct Current, High Entropy Alloys*

MPCT04-M10

Mitigation of Alkali Silica Reaction By using Crushed Aggregate Powder as Mineral Admixture

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This study investigated the mitigation of Alkali Silica Reaction (ASR), which is a chemical deterioration of concrete that occurs within the actual concert, using mineral admixture. A reactive aggregate, Rhyolite, and fine powder that passed through no. 100 mesh sieve was used as mineral admixture in this study. The mitigation effect was determined by performing accelerated mortar bar test according to ASTM C1260. We tried an experiment by replacing cement with fine powder at a ratio of 10%, 20%, and 30%. Then we formed a mortar bar according to ASTM 1260 standards. It was found that the addition of finer powder of crushed aggregate could reduce the expansion caused by the alkali silica reaction.

Keywords: Concrete, ASR, Cement

MPCT05-M11

Effect of Thermal Exposure on Stainless Steels

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This investigation studied the effect of prolonged high temperature exposure on the microstructure, mechanical properties, and corrosion resistance of AISI 304 stainless steel. AISI 304 stainless steel samples were exposed to 900 ^{o}C for 0, 8, 24, 72, 168 and 336 hours then microstructural analysis and hardness testing was performed. Corrosion resistance was quantitatively analysed using Double Loop Electrochemical Potentiokinetic Reactivation (DL-EPR) technique. It was found that prolonged exposure negatively affected corrosion resistance of AISI 304 stainless steel.

Keywords: Stainless steel, Corrosion, DL-EPR

MPCT06-M14

Mechanical Properties of Carburized SCM415 Dual-Phase steel

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This study explores SCM415 steel, a specific low alloy and low carbon steel, with the primary goal of improving low carbon steel by enhancing its surface wear resistance and increasing overall strength. The process used carburizing workpieces to increase carbon content at the surface, facilitating a hardening process for enhanced surface hardness. Additionally, a dual-phase treatment is implemented to further fortify the overall strength of the material. During the experiments, samples were exposed to different temperatures (740, 760, 780, 800, 820, 840, and 860°C) and quenching in oil. The results indicate that the optimal temperature range for both surface hardening and dual-phase treatment is between 760-840°C, situated between lines A1 and A3. In this range, a martensite structure forms on the surface, exhibiting high hardness (about 850 HV). The core structure, positioned 1000 micrometers from the edge, demonstrates a dual-phase composition of martensite and ferrite, with hardness values lower than the surface. At 820°C, the hardness value in the core reaches its peak (about 300 HV) due to a well-balanced mixture of carbon content and austenite phases ratio. This underscores the critical role of temperature control in achieving the desired material properties, presenting potential applications for low carbon steel requiring enhanced surface wear resistance and strength.

Keywords: SCM415 steel, Dual-phase, Carburizing

MPCT07-M16

Sintering of Copper Clay under Different Environment for Development of Jewelry Processing Technology

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This research has developed copper clays, which are clay-like composites of copper powders and organic binders. When the ingredients are mixed together, it can be molded into various patterned ornaments. The green part is then strengthened by sintering at high temperature. The sintering process requires usage of energy. Therefore, in this work, the study of sintering under different temperature, time and environment was compared. A general furnace and microwave furnace (adapted from a commercial microwave oven) were used. For the general furnace conditions, the green part was heated at 550°C for 1 hour, then sintered at varying temperatures (800°C and 900°C) for varying times (2 and 4 hours). For microwave furnace condition, the green part was heated at 550°C for 30 mins, then sintered at varying temperatures (800°C and 900°C) for 1 hour. The thicknesses of the samples were varied at 1 mm and 3 mm. For the general furnace conditions, the best sintering condition was 900°C for 4 hours with a sample size of 3 mm. The sample exhibited a densification of 60.2%, the shrinkage percentage of 10.46%, the porosity of 34.15% and hardness of 19.93 Hv. For the microwave furnace conditions, the best sintering condition was 900°C for 1 hour with a sample size of 3 mms. The sample exhibited densification of 57.1%, shrinkage percentage of 8.54%, porosity of 28.11% and hardness of 20.67Hv. It was found that microwave furnace has a better effect than the general furnace due to lower loss of thermal energy. Therefore, a commercial microwave can be applied as a microwave sintering furnace for jewelry clay products, which helps reduce the sintering-production costs.

Keywords: Sintering, Copper Clay, Microwave sintering

MPCT08-M23

Long Term Heating Effects at 900°C on Microstructural Rejuvenation in Various Modified Nickel Base Alloys with Ruthenium and Cobalt Additions

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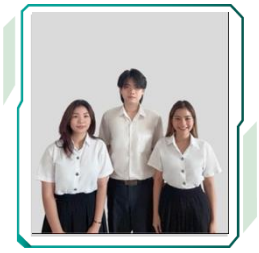
This research work aims to investigate and improve the microstructure of the modified cast Ni-based superalloy MGA-1400, with the addition of Ruthenium (Ru) and Cobalt (Co) in various proportions, to compare the effects of air-cooled versus furnace-cooled heat treatment processes. The heat treatment involved solution treatment at 1200°C for 4 hours, followed by precipitation aging at 845°C for 24 hours, and long-term heating at 900°C for 300 hours. The microstructures of the samples were analyzed using SEM and EDS to determine the average area fraction and size of gamma prime (γ') particles, while hardness was assessed using Micro Vickers hardness tests. The results revealed that, compared to air-cooling, furnace-cooling during the heat treatment process resulted in larger gamma prime (γ') particle sizes and a greater area fraction of gamma prime, due to re-precipitation a phenomenon not observed with air-cooling, which led to smaller gamma prime particle sizes. Moreover, the addition of high amounts of Ruthenium (Ru) resulted in smaller gamma prime sizes and a reduced area fraction of gamma prime. Conversely, incorporating high Cobalt (Co) levels led to larger gamma prime sizes and a greater area fraction of gamma prime.

Keywords: Ni-based superalloy, Gamma prime, Precipitate

MPCT09-M30



The Study of Ceramic Ink for 3D Printing Applications

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The purpose of this research is to study the mechanism of coloration in cobalt aluminate spinel materials obtained from thermal decomposition. There are changes in the starting material of the mixed metal oxide that affect the structure of cobalt aluminate spinel. The change in structure of cobalt aluminate spinel at different calcined temperatures of 800°C, 1000°C and 1200°C has been examined. The properties were thoroughly investigated by combining XRF, XRD and FT-IR techniques. Moreover, the morphology of calcined samples were studied by SEM. The spinel structure of $CoAl_2O_4$ in the Al203 range was found to be crucial in changing the color characteristics of the cobalt. Cobalt aluminate powder showed different colors at different temperatures ranging from 800°C to 1200°C, with color changes ranging from black, dark blue and bright blue. The cobalt aluminates mixed into the ceramic ink and molded by 3D printing methods. This is an important step in controlling the color from the furnace process at each temperature, which affects the strength and stability of the ceramic ink.

Keywords: 3D printing, Cobalt aluminate, Ceramic ink

MPCT10-M35

The Design of a Beam Knife Plate as a Support for Timber Framing

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This work is about beam knife plate types and structural systems of columns attached to beam knife plates. The behavior of timber structures under load has been studied. A structural simulation process has been used to transform building data into a digital file. These include physical properties (such as cross-sectional area dimensions Moment of inertia of the cross-section unit of weight) and mechanical properties (such as modulus of elasticity Poisson's ratio. The purpose of structural analysis is to calculate the internal force between the beam knife plates. The timber framing stability was checked or against weight or force. We have designed a beam knife plate by the solid work program. Data on force between beam knife plate and timber framing was discussed.

Keywords: Beam knife plate, Solid work, Post plate

MPCT11-P02

Enhancing the Synthesis of 5-hydroxymethylfurfural from Fructose for Bio-monomer in Packaging

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5-hydroxymethylfurfural (HMF), a platform chemical derived from renewable feedstocks such as carbohydrates and agricultural waste, represents a significant step towards the establishment of a green chemical industry. Its versatility lies in its ability to be converted into high-value materials, including bio-based monomers like 2,5-furandicarboxylic acid (FDCA), a key component for the next generation of bioplastics (polyethylene furanoate, PEF). In this study, the synthesis of HMF via dehydration of fructose was carried out in thermo-shaking reactor. The effects of solvent, fructose concentration, fructose-to-catalyst ratio and reaction temperature on fructose conversion and product yield are examined. The reaction product was collected at 20-minute intervals and analyzed using HPLC technique equipped with PDA and RI detectors. Dimethyl sulfoxide (DMSO) showed as the most suitable solvent for this reaction. Increasing the initial fructose concentration was found to decrease HMF yield. A 1:1 fructose-to-catalyst ratio resulted in the highest HMF yield. Higher reaction temperature exhibited greater HMF yield due to enhanced reaction kinetics according to Arrhenius equation. The optimal reaction conditions were identified as a 1:1 fructose-to-catalyst ratio, a fructose concentration of 4 g/L, a reaction temperature of 90 °C, and the use of DMSO as the solvent. These findings can serve as a valuable guideline for optimizing the HMF production process, paving the way for its subsequent conversion into FDCA, a key green monomer for sustainable packaging applications.

Keywords: Agricultural waste, Fructose, Hydroxymethylfurfural (HMF)

MPCT12-P03

Migration Behavior of Glycerol and CuONPs from PBAT/TPS Nanocomposite Films for Food Packaging

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Polybutylene Adipate Terephthalate (PBAT) is a promising biodegradable and compostable polymer; however, its high production cost remains a barrier to widespread adoption, despite its excellent biodegradability and mechanical properties. One proposed solution is incorporating low-cost materials like starch into PBAT to form PBAT/TPS blends. Additionally, metal oxides, particularly copper oxide nanoparticles (CuONPs), can be further incorporated into the PBAT/TPS blended films to enhance their antibacterial properties, making them well-suited for food packaging. However, the potential migration of glycerol, a plasticizer in TPS, and CuONPs, an antimicrobial agent, from the polymer matrix into food necessitates an evaluation of their release quantities to ensure consumer safety. The objective of this research is to investigate the migration behavior of glycerol and CuONPs from PBAT/TPS nanocomposite films. The effects of food simulant (3% acetic acid and 10% ethanol), temperature (20 °C and 40 °C), and CuONPs loading (0.05, 0.5, and 1 wt%) on the migration of both components are studied. The amount of glycerol was quantified using HPLC technique, while the amount of CuONPs was quantified using ICP-OES technique. The results showed that the migration of glycerol was higher in 10% ethanol compared to 3% acetic acid. Interestingly, the PBAT/TPS film without CuONPs exhibited a higher glycerol concentration than the film containing CuONPs. Additionally, the migration rate of both glycerol and CuONPs increased with increasing CuONPs loading. These findings can be used to assess the safety of these films for food packaging applications by informing strategies to minimize the migration of potential contaminants into food.

Keywords: Migration kinetics, PBAT/TPS nanocomposite film, Food packaging

MPCT13-P13

Application Test of Biopolymer Inner Layer for Paper Packaging in the Microwave System

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Microwavable paper packaging for food usually need to laminate with heat resistant plastic films such as polypropylene (PP). However, this hinders the recycle process. This research aims to simulate the application tests of Polylactic acid (PLA) coated paperboard in the microwave system. The paperboard 240 g/m^2 was coated with PLA 15% (W/V) by Mini Automatic Film Applicator (BEVS1818). PLA 1, 2 and 3 (PLA1,PLA2,PLA3) layers were coated on the paperboard surface and the heat treatment (180 ºC, 30 sec.) was applied between each layer to create adhered PLA film onto the paper surface. Paper packages of 5x5x4.5 cm (LxWxD) were prepared for application test in the microwave at 800W. Food types selected were water, coconut milk, tomato sauce and Panang Curry soup. Temperature at different positions of the packages were monitored through Data Logger (Graphtect GL240). Heat distribution pictures were captured by infrared camera (Fluke TIS20). The packages were cleaned, and the coated surface was observed using Scanning Electron Microscope. According to the results, food types significantly affect temperature levels in the microwave. Highest temperature was found for coconut milk (first 5 sec.) and then seems to be stable at 100ºC. But for tomato sauce and Panang Curry, the temperature could reach 180ºC within 45 sec. Moreover, corner of the packaging had higher temperatures than the center and the coated surface. Further, temperature at the surface of PLA1 was slightly higher than PLA2 and PLA3 since heat was faster transferred through thinner PLA layer and accumulated at the paper fiber. Some food absorption was found for PLA1. For PLA2 and PLA3, damages found only when tested with tomato sauce and Panang Curry. This might be due to severe food models that accumulating more heat.

Keywords: Paper packaging, Polylactic acid, Microwaveable, Food

MPCT14-P15

Effect of Microwave Heating on Migration and Physical Properties of Single-use Food Container from Bagasse in Acidic Food

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Sugarcane bagasse paper packaging is a sustainable and environmentally friendly alternative to plastic packaging materials. It is made from the by-product of sugarcane processing, which reduces the need for plastic and other non-renewable resources. In this study, the properties of four samples of single-use sugarcane bagasse paper packaging were investigated. The samples were tested for the overall migration using the immersion method in 3% acetic acid at 70 °C for 2 hours (according to the Commission Regulation (EU) No. 10/2011). The samples were also tested for tensile strength, burst strength, microwave stability and thermogravimetric analysis (TGA). The results showed that the physical properties of sugarcane bagasse paper decreased significantly after migration and TGA testing of samples from four sources revealed that the chemicals in the paper began to decompose at temperatures ranging from 340 to 360 °C. The migration results were also simulated for microwave use. Samples C, and D have an overall migration of 26.22±0.61, and 30.17±0.54 mg/dm^2 respectively which exceeds the overall migration limit (10 mg/dm^2), except for samples A, and B has an overall migration of 9.16±0.84, and 8.13±1.19 mg/dm^2. It may affect the senses of consumers such as vision, smell, or taste. This suggests that single-use sugarcane bagasse paper packaging is not suitable for the conditions used in this study. However, further research is needed to improve the properties of sugarcane bagasse paper, such as its resistance to migration, before it can be widely used for food packaging.

Keywords: Bagasse, Migration, Physical properties

MPCT15-P16

Effects of Microwave Heating on Migration and Physical Properties of Single-use Food Container from Bagasse in Fatty Food

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Single-use food containers are very common these days. Many of them are manufactured from natural resources such as bagasse, which is also environmentally friendly due to its biodegradability. This study aims to identify the overall migration (OM), thermogravimetric properties, and physical properties of four types of single-use food containers that are available in the market. The overall migration test was conducted according to the Commission Regulation (EU) No. 10/2011 with a simulant for the lipophilic character of food that contains free fats at the surface. The condition OM3 was applied to simulate the intended food contact condition of hot-fill and/or heating up to 70 - 100 °C for a specific period which is not followed by long-term room temperature or refrigerated storage. The samples came from four sources. Some of the OM results exceeded the overall migration limit of 10 mg/dm². Thermogravimetry analysis (TGA) showed that the compounds in the paper started degrading at temperatures ranging from 340 to 360 ℃. The Consumer acceptability with physical attributes. The resistance to pressure penetration or bursting was measured, the samples after the migration testing showed a reduction of resistance compared to the samples before the migration testing. Tensile strength, the samples after the migration testing showed a maximum force that caused the sample to tear reduced. The stability tests showed the appearance of samples from each source trending in the same direction as the OM results, which may indicate consumer acceptance.

Keywords: Single-use container, Migration, Bagasse

MPCT16-P17

Development of Biaxially Oriented Poly (lactic acid)-Polysorbate Films for Flexible Packaging

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Due to the problem of brittleness and lack of toughness of poly (lactic acid) (PLA) plastic against torsional stress, this research aimed to develop bioplastic films of poly (lactic acid) blended with Polysorbate 60 (Tween60) to form PLA/Tween60 films at ratios of 0%, 2.5%, 5%, and 10% weight by weight of PLA. This was done to increase flexibility and reduce the brittleness of PLA. The composite films were processed into sheets using a twin-screw extruder and subjected to biaxial stretching to enhance their strength and improve film elongation. Differential scanning calorimetry (DSC) graphs indicated that the PLA/Polysorbate60 films exhibited an increased melting temperature (Tm) of 2-3 degrees Celsius with an increasing Polysorbate percentage. Additionally, the percentage of film elongation increased, with a 32.59% increase after biaxial stretching and annealing. The composite PLA/Polysorbate60 films exhibited decreased impact and tensile strength with increasing Polysorbate60 content. Seal strength decreased by 52.10% from 0.4653N/15mm to 0.2424N/15mm. The developed films could be used as packaging materials, providing increased strength to prevent oxygen gas permeation in food packaging and various other product packaging and applications.

Keywords: Poly (lactic acid) film, Polysorbate60, Flexible packaging

MPCT17 – P18

Study on Heat Shrinkage Behavior and Heat Sealability of Poly(lactic acid)/ Polybutylene Succinate Films for Sustainable Packaging

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Currently, the accumulation of plastic waste in the environment is a severe problem. Therefore, the use of biodegradable plastics, specifically poly(lactic acid) (PLA), has been considered crucial due to its ability to biodegrade and be produced from renewable resources. PLA possesses properties such as transparency and high mechanical strength. However, PLA is prone to brittleness and has low thermal stability. This is because the amorphous region in its structure is more than the crystalline region, leading to recrystallization and more shrinkage when exposed to heat. The aim of this research is to enhance the heat stability of PLA by blending it with polybutylene succinate (PBS), a compostable polymer with a high degree of crystallinity and good compatibility. The PLA/PBS blends were prepared using a twin-screw extruder and processed into blown film. The weight ratios of PLA/PBS used were 60/40, 70/30, and 80/20. The thermal properties indicated a reduction in the glass transition temperature (Tg) of PLA/PBS compared to pure PLA, while the crystallization rate increased with higher PBS proportions. The 60/40 blend exhibited the highest degree of crystallization (Xc), resulting in relatively low shrinkage due to the higher amount of crystalline regions compared to PLA, which has a higher shrinkage due to its larger amorphous region. Moreover, the PLA and PLA/PBS blends could be heat-sealed at temperatures between 100-120°C. However, the seal strength could be tested starting from film sealing at 105°C since at 100°C, the seal strength was minimal and not suitable for testing. PLA has a high seal strength, and the heat-sealed area exhibits significant shrinkage. When PBS is added, it causes a reduction in the seal strength. However, the heat-sealed area experiences less shrinkage.

Keywords: Poly(lactic acid), Polybutylene succinate, Heat shrinkage

MPCT18 – P27

Characterization of Microwavable Food Packaging Films : Pre- and Post- Reheating

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The surge in consumption of ready-to-eat foods, often packaged in heat-sealed plastic bags, has significantly heightened environmental concerns stemming from the accumulation of plastic waste. In response, this study investigates the potential of biodegradable plastics as a sustainable alternative. Biodegradable plastics show promise in reducing plastic waste due to their composition of materials that can be easily decomposed compared to conventional plastics. Moreover, bioplastics contribute to the reduction of carbon dioxide emissions associated with traditional plastic production processes. However, the properties of bioplastics are commonly perceived as inferior to those of conventional plastics. Our goal is to pioneer the development of biodegradable packaging films capable of withstanding microwave reheating. Our initial investigations focus on microwaveable solid food products typically stored in refrigerated conditions. To achieve this objective, we evaluate widely used microwaveable plastic sachets, including those tailored for packaging steamed buns and burgers. Our approach includes mechanical, thermal, and barrier property assessments of the packaging materials. We employ analytical techniques including tensile strength testing, water vapor transmission rate (WVTR) analysis, and differential scanning calorimetry (DSC). By evaluating these properties both before and after exposure to microwave heating, our study aims to pinpoint sustainable packaging solutions that not only mitigate the plastic waste problem but also ensure the integrity of food quality.

Keywords: Microwave, Food packaging, Thermal properties

MPCT19 – T04

Development of Slippers from Banana Fiber Nonwoven

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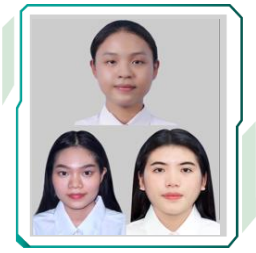
Many banana plants are often discarded after harvesting, leading to significant agricultural waste. This research aims to extract banana fiber from these discarded plants to produce durable and flexible nonwoven sheets suitable for use in slippers. The extraction of banana fiber was carried out under various conditions. Subsequently, the formation of banana fiber nonwoven was studied by blending the extracted banana fiber with polypropylene fiber in different ratios (100:0, 70:30, and 50:50) to achieve various basic weights (200, 300, and 400 g/m^2). The thickness, tensile strength, tear strength, bending properties, and water absorption properties of the banana fiber nonwoven were investigated. Later, slippers made from banana fiber nonwoven were assembled, and the consumer acceptability of the developed slippers was evaluated. The optimal condition for extracting banana fiber was found to be boiling at 90°C for 4 Hours. The thickness of the banana fiber nonwoven ranged from approximately 1.2 to 3.0 mm. Both tensile strength and tear strength of the nonwoven were found to be correlated with its thickness. However, the bending properties of these nonwoven sheets did not exhibit significant differences. Moreover, the water absorption property of the nonwoven sheet was influenced by the ratio of banana fiber to polypropylene fiber. It was also found that the majority of the participants expressed satisfaction with the developed slippers made from banana fiber nonwoven.

Keywords: Banana fiber, Nonwoven, Slippers

MPCT20 – T05



Study on the Properties of Yarn and Woven Fabric Produced by Used Kevlar Gloves

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In the industry, there is a significant amount of wasted Kevlar gloves. Kevlar fiber is known for its high strength and lightweight, making it resistant to impact, pulling force, chemicals, high temperatures, and abrasion. The objective of this research is to study the physical properties of Kevlar yarns from used knit glove, including tensile strength, yarn number, crimp percentage, and CIELab color difference. This research compared yarns from new gloves to those from used gloves that have been cleaned by studying the use of Kevlar yarn from used gloves to form woven fabric with different weaving structures as follow: plain weave (1/1), plain weave (2/2), twill weave (2/2), and satin weave (3/1). Physical properties of the woven fabric structures were tested including tensile strength and tearing strength. The study found that Kevlar yarns from the wrist and palm areas of new gloves, used gloves, and cleaned used gloves have yarn sizes ranging from 59-63 Tex. The color difference values of cleaned Kevlar yarns is 15.51 for the wrist area and 9.02 for the palm area in comparison to new Kevlar yarns, depending on the cleaning process. The crimp percentage of Kevlar used yarns is higher in the wrist area than in the palm area due to the different knitting structures. Studying the properties of used Kevlar yarns aims to apply them in other products and promote sustainable yarn utilization.

Keywords: Kevlar, Recycle, Woven fabric

PMIS 2024

ETA

Emerging Technology & Applications

Rethinking Packaging and Materials for a Sustainable Future

ETA01-M07

CoCrFeNiCu High Entropy Alloy System Cladded on Stainless Steel 304 by Gas Tungsten Arc Cladding Process

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This research aims to improve the surface of SS304 stainless steel by a high entropy alloy cladded layer. The material used in this study was a powder of CoCrFeNiCu high entropy alloy milled from a high speed ball mill for 30 hours. The alloy powder was cladded on stainless steel 304 by gas tungsten arc cladding process. The HEA cladded layer was characterized for microstructure, chemical composition, phase composition, and corrosion resistance. Based on the results, Co, Cr, Fe, Ni, and Cu components were found on the cladded layer which was confirmed by XRD and EDS. The hardness of the cladded layer was higher than the SS304 stainless steel substrate. Moreover, the corrosion potential (E_{corr}) was found at -231 mV vs. SCE. In conclusion, the gas tungsten arc cladding process could be one of the alternative fabrication methods for high entropy alloys with excellent hardness and corrosion resistance.

Keywords: Gas Tungsten Arc Cladding, High Entropy Alloys, CoCrFeNiCu, Stainless Steel, Corrosion Resistance

ETA02-M15

Photocathodic Protection of ZnO/ZnS Multi-layer Thin-Film Coating for Stainless Steel 304

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Currently, metal materials are widely used, but over time and exposure to various environmental factors, they undergo deterioration. One common issue is corrosion. This research aims to study the corrosion prevention of metal, specifically grade 304 stainless steel, using a photocathodic protection method. This involves coating a thin film of N-type semiconductor material, comprising two layers of ZnO and ZnS, onto an ITO glass substrate using the spray pyrolysis technique. The ZnO thin film is sprayed at 400 degrees Celsius for 15 minutes, followed by the growth of nanorod structures using the hydrothermal technique for ZnO in the first layer and ZnS in the second layer at temperatures of 90 degrees Celsius for 12 hours and 7 hours, respectively. Zinc acetate dihydrate is used as the starting material for ZnO, and thioacetamide is used for ZnS. XRD and SEM analysis revealed crystalline structures in the thin film, and the grown nanorods exhibited a hexagonal morphology. Corrosion testing of grade 304 stainless steel coated with the two-layer ZnO and ZnS thin films under dark and UV conditions showed a decrease in corrosion potential, indicating a higher degree of photocathodic behavior. This helps in effectively preventing corrosion.

Keywords: Photocathodic protection, Spray pyrolysis, Hydrothermal

ETA03-M32

Analysis of the Value of Thantawan Industry Public Company Limited

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This specific document is mainly used the value perspective discounts the true value of a company's true value. Thantawan Industry Public Company Limited, stock price of THIP Company Thantawan Industry Public Company Limited, Republic of China, consists of producers and distributors. Airline flight control system of equipment in Stock Exchange of Thailand (SET50) The company is a factory engaged in trading products and materials. Our main products include various types of drinking straws. Ziplock bags for food packaging at various industrial applications, both zip-in and slider zippers can produce such products on the side. The beginning of plastics is different and plastics decompose. Including products that are a center for raw materials, such as packaging to extend the life of fruits and vegetables antimicrobial packaging temperature indicating packaging

According to DCF's analysis, the company's sales revenue is forecast to increase 3.90 % CAGR from 2022 to 2026 based on household trends and driven by GDP growth in the construction sector. After 2026, I assume sales will grow. The company's interest rate is 3.90% per year (continuous growth), which is a conservative rate considering operating results.The company's work in the past 5 years. THIP's target share price is 36.64 baht per share, with a downside of 7.82% compared to the latest share price as of February 15, 2022, equal to 29.64 baht per share. The current share price is overvalued. Stay with DCF valuation as the divergence is in the “below 10% or downside”

Keywords: THIP, Valuation, Discounted Cash Flow

ETA04-M33

Valuation of A.J. Plast Public Company Limited

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This project utilizes the principle of cash flow valuation to assess the true value of the stock price of A. J. Plast Public Company Limited, a major company in Thailand engaged in the plastic industry. The company A. J. Plast Public Company Limited holds a retail trademark under the name A. J. Plast, registered in the Thai stock market under the trade group, AJ Plast PCL. The company's core business is the sale of plastic products and materials, including the production of sheets and films such as BOPP film, BOPET film, BOPA (Nylon) film, amd METALLIZED film, The manufactured production, the company also operates in the manufacturing of other plastic products.

Comparing income with stock prices, the sales of the company forecast to increases by 2.71% from 2019 to 2028 based on plastic exports by GDP growth in the constructionsector. Base on the forecast, my recommendation for A J. Plast is SELL.

Keywords: Discounted cash flow, A.J. Plast , Valuation

ETA05-P08

Development of Slippery Coating from Natural Wax for Paper Packaging

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The use of paper-based packaging has increased globally in both food and non-food industries due to its biodegradability. However, its hydrophilic nature causes poor water resistance which limits its application in liquid products. Liquid-impregnated or slippery surface is one of the methods used to improve water repellence with slippery properties. This technique requires a rough surface with low surface energy and a lubricating liquid which mostly composed of inorganic substances. Thus, this study aimed to develop slippery surfaces for paper packaging using natural coating materials. In this experiment, different concentration of two natural waxes; rice bran wax (RB) and soy wax (SW), were used to fabricate a rough surface with low surface energy, which later were compared with paraffin wax. Also, vegetable oil was used as a natural lubricating liquid. The result shows that after fabricating a rough surface on paper, 3% SW exhibited the highest water contact angle (~157.45°) and the lowest air permeability (0.557 μm/Pa.s) with water absorption of 15.11 g/m^2. This could be due to the greater homogeneity of the SW solution. After that, a vegetable oil was impregnated onto the fabricated surface. The result shows a lower contact angle for all oil-impregnated materials but more slippery properties. The 3% SW with oil exhibited the highest contact angle (~111.71°) and the lowest air permeability (0.016 μm/Pa.s) with water absorption of 8.028 g/m^2. When the coated papers were tested with various food and non-food liquids, the coated paper effectively resists food liquids but non-food liquids, and SW impregnated with oil exhibited the best slippery properties.

Keywords: Paper packaging, Slippery surfaces, Natural wax

ETA06-P11

Fructose-Derived Fluorescent Carbon Dots: Green Approach for Covert Security Inks

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Fluorescent inks are employed in commercial and security packaging; however, they often contain formaldehyde to achieve their fluorescent properties. This raises concerns about their potential environmental and health risks. Carbon dots (CDs) offer a promising alternative. It possesses inherent fluorescence, low toxicity, and is environmentally friendly. This study investigates the synthesis of CDs using a green approach with d-fructose as a precursor at varying concentrations (5%, 10%, and 15%). Characteristics of CD were compared from non-thermal and hydrothermal synthesis at 140°C and 160°C. The synthesized CDs exhibited fluorescence under 365 nm light excitation against a black background. However, non-thermal CDs have high alkalinity, restricting their use in ink development. UV-visible spectrophotometry showed that CDs derived from 10% fructose at 140°C had the highest light absorption at 286 nm and the strongest photoluminescence emission at 420 nm when triggered with 350 nm light. Utilizing CDs directly for covert security printing presented a challenge due to the solution's high-water content and substrate absorption. The stroke sharpness was improved with the addition of xanthan gum (0.1%) as a thickener. The resulting CDs ink was successfully applied to paper using two techniques: stamping and rod coating. Lightfastness testing revealed that the fluorescence properties remained largely intact after exposure to 0.35 W/m²/nm at 60°C for 24 hours. The fluorescence intensity showed no significant change after being exposed to a higher light intensity of 0.68 W/m²/nm. This study demonstrates the potential of CDs synthesized from d-fructose using a green approach for covert security printing applications, with promising lightfastness properties under UV light exposure

Keywords: Carbon dots synthesis, Fluorescence ink, Ink formulation

ETA07-P20

Development and Application of Polybutylene Succinate Film Containing Natural Agents for Hom Thong bananas Preservation

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Bananas (Musa spp.) are one of the famous tropical fruits consumed worldwide due to their rich source of bioactive compounds and promote health benefits. In Thailand, an individual-wrapped Cavendish banana or Hom Thong banana packed in commercially available plastic is not only a popular snack, and quick breakfast food but also can be convenient to buy in bulk in convenience stores. However, these best-selling items have a short shelf-life of up to 4 days while the waste of petroleum packaging becomes more apparent. Therefore, using biodegradable materials along with natural preservatives is a reasonable approach to achieve full biodegradability and an eco-friendly condition. The effects of natural agents and lignin nanoparticles (LN) incorporated into polybutylene succinate (PBS) composite film were developed via blown film extrusion. The active films on the quality and shelf-life of Hom Thong banana at 13 °C were investigated. The results showed that the natural agents and lignin nanoparticles were compatible with the PBS matrix, resulting in homogeneous surfaces and improved barrier properties. Moreover, PBS/LN/natural agent composite films especially thymol showed excellent antifungal efficacy in vitro, inhibiting the growth of *Lasiodiplodia theobromae*. Gas compositions inside all the banana packaging with perforation reach the equilibrium atmosphere within 2 days after storage which preserves Hom Thong banana quality, limiting microbial growth and extending banana shelf-life greater than 12 days at 13 °C.

Keywords: Hom Thong bananas, Polybutylene succinate, Packaging films

ETA08-P24

Development of Lignin-Coated Paper for Food Packaging

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Lignin, an abundant waste by-product of the pulp and paper industry, is predominantly burned for heat generation due to underutilization. This study aims to develop a sustainable coating for paper-based green packaging, replacing fossil-based polymer coatings. Lignin was chemically modified via esterification using palmitoyl chloride to enhance its hydrophobicity. Various degrees of substitution were applied to lignin, and chemical analyses of the resulting esterified lignin were conducted using Fourier Transform Infrared Spectroscopy (FTIR). Coatings were prepared using acetone as an organic solvent and applied to paper substrates. The impact of lignin concentrations (5%, 12.5%, and 25% by weight) on the barrier and mechanical properties of the coated paper was investigated. Unmodified lignin-coated paper exhibited water contact angles ranging from 70° to 95°, with an increase in lignin concentration to 25% resulting in a decrease in contact angle. The water Cobb value of paper coated with unmodified lignin at 5 wt.% concentration was 10.3 g/m^2, which increased to 36.9 g/m^2 at a lignin concentration of 25 wt.%. Esterified lignin coating exhibited significant ($p \leq 0.05$) improvements in barrier properties, with a water contact angle exceeding 110° and a reduced water Cobb value of 13.2 g/m^2 at a 25 wt.% esterified lignin concentration. The results showed the potential of esterified-lignin as a coating material for paper to improve its properties and make it suitable for use in biodegradable food trays. This approach could offer a sustainable alternative to conventional plastic packaging, contributing to reducing environmental pollution and promoting circular economy principles.

Keywords: Paper Coatings, Esterfied-lignin, Water contact angle

ETA09-P25

Development of Edible Coffee Films

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This research aimed to develop edible films made from cassava starch to be used as an edible coffee bag. Different types of the coffee films were made: Edible films were made from cassava starch for instant coffee packing, edible film made from cassava starch containing 1.0% w/w coffee flavor and edible film made from cassava starch containing 1.0% w/w orange flavor. The analyzed edible film characteristics included thickness, water vapor transmission rate, dissolution rate in hot water and room temperature water, heat sealing, color and sensory evaluation of the coffee film. The addition of 1.0% w/w flavor resulted in increased thickness and water vapor transmission rate but decreased water dissolution rate of edible films. The heat sealing ability of edible films was not affected by the addition of coffee and orange flavors. From the sensory evaluation of the smell of the cassava starch film incorporated with coffee and orange flavors of 30 people, it was found that most people liked and were satisfied with the smell of the coffee films. These films offer alternative green packaging and convenience to traditional coffee packaging.

Keywords: Essential Oil, Starch Film, Edible Film

ETA10-P26

Coating Paper with Poly(butylene succinate) and Lignin for Packaging of Pork Meat

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Currently, petroleum-based plastics, widely utilized across industries, pose significant environmental challenges, taking centuries to decompose and posing threats to human health, marine ecosystems, and the environment. In response, paper packaging materials emerge as a promising sustainable alternative. However, their inferior barrier properties necessitate coating materials for food packaging applications. This study introduces a biodegradable coating material comprising polybutylene succinate (PBS) and lignin. Lignin underwent esterification to enhance hydrophobicity, achieved through esterification with palmitoyl chloride, with chemical functional groups characterized via Fourier Transform Infrared Spectroscopy (FTIR). The study examines the impact of varying proportions of PBS and lignin concentrations on coated paper's barrier and mechanical properties. Paper coated solely with PBS displayed water contact angle values and Cobb values of 63.2° and 71.8 g/m², respectively. Increasing the proportion of pristine lignin to 50 wt.% (PBS/lignin-50:50) did not improved barrier properties. However, utilizing esterified lignin resulted in significant ($p \leq 0.05$) enhancements. At a PBS/esterified-lignin ratio of 90:10, the water contact angle increased to 117.8°. Further increasing the proportion to 50:50 led to the highest water contact angle of 142.2° and the lowest Cobb value of 6.0 g/m². These findings suggest that esterified lignin dissolved in PBS 50:50 presents a promising hydrophobic alternative for food packaging materials compared to conventional plastics.

Keywords: Coated paper, Esterified-lignin, Poly(butylene succinate)

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