



ASIA RUBBER-ELASTOMER FEDERATION INTERNATIONAL CONFERENCE 2026 (AREF-IC 2026)

8th to 10th September 2026
KUALA LUMPUR CONVENTION CENTER
(KLCC), MALAYSIA

PROGRAM & BOOK OF ABSTRACTS



In Conjunction with

Supporting Organizations:



Supported by:



TechnoBiz

www.prim.org.my/aref-ic-2026/
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**DELEGATES ARE WELCOME TO ATTEND
BOTH AREF-IC 2026 & 12th IRGCE PROGRAMS**



ASIA RUBBER-ELASTOMER FEDERATION INTERNATIONAL CONFERENCE 2026 (AREF-IC 2026)

WELCOME TO AREF-IC 2026



On behalf of The Plastics and Rubber Institute Malaysia (PRIM) and the Organising Committee, it is my great pleasure to welcome all delegates, distinguished speakers, industry partners, researchers, regulators, exhibitors, sponsors and students to the Asia Rubber-Elastomer Federation International Conference 2026 (AREF-IC 2026), held in conjunction with the 12th International Rubber Glove Conference and Exhibition (IRGCE 2026).

We are honoured to host this important gathering from 8 to 10 September 2026 at the Kuala Lumpur Convention Centre, Malaysia. The conference brings together the regional and global rubber, elastomer, polymer and glove community at a time when our industries are confronting significant change while also discovering new opportunities for growth, innovation and collaboration.

The operating environment for the rubber and polymer industries is becoming increasingly complex. Geo-economic fragmentation, energy-market volatility, evolving global trade conditions, stringent regulatory and product-safety expectations, sustainability imperatives, and rapidly advancing digital technologies are reshaping the way we develop, manufacture and market our products. These developments require us to look beyond conventional measures of competitiveness and to build businesses that are more innovative, resilient, responsible and trusted.

AREF-IC 2026 has been organised as a forum for meaningful exchange on these priorities. The programme brings together leading experts from industry, government, academia and research institutions to address a wide spectrum of timely subjects. These include the outlook for the Malaysian and global glove industries, natural-rubber sustainability, ESG and sustainable trade, advanced latex and elastomer technologies, circularity, renewable and hybrid energy, artificial intelligence, smart manufacturing, automation and future-ready workforce development.

The technical sessions highlight the depth of research and innovation taking place across our ecosystem demonstrate that the future of our industry will be shaped by science, responsible innovation and effective collaboration.

PRIM remains committed to serving as a professional platform that connects industrial practitioners, scientists, technologists, educators, regulators and emerging talent. We are especially pleased that this conference provides opportunities for students and young professionals through poster presentations, technical exchanges, Rising Star recognition and the dedicated student workshop. The continued progress of our sector depends on developing capable people with the technical knowledge, practical mindset and leadership qualities needed to advance the modern rubber and polymer industries.

I extend my sincere appreciation to the Asia Rubber-Elastomer Federation (AREF), our supporting organisations, government agencies, universities, research institutions, sponsors, exhibitors, speakers, session chairs and committee members for their invaluable contribution and commitment. I also record our heartfelt thanks to the organising team whose dedication has made this event possible.

We encourage all participants to make full use of the conference: engage with the speakers, exchange ideas with fellow delegates, visit the exhibition, support the researchers and students presenting their work, and build partnerships that can lead to practical solutions and lasting progress.

May AREF-IC 2026 and the 12th IRGCE 2026 serve as a catalyst for stronger regional cooperation and for a rubber and elastomer industry that is technologically advanced, globally trusted, commercially resilient and sustainable by design.

Thank you for your participation and support. We wish you a productive, rewarding and memorable conference experience in Kuala Lumpur.

SIN Yoong Cheong
President, The Plastics and Rubber Institute Malaysia (PRIM)
Organising Chairman, AREF-IC 2026



ASIA RUBBER-ELASTOMER FEDERATION INTERNATIONAL CONFERENCE 2026 (AREF-IC 2026)

AREF-IC 2026 Organising Committee

Sin Yoong Cheong - Organising Chairman

Dr. Amir Hashim Md. Yatim , FASc

Dr Roland Ngeow Yen Wan

Dr. Hjh Hafsa Mohd Ghazali, FASc.

Ng Kha Chan

Francesca Netto

Tan Lu Quan

Pong Kai See

Lim Sum Teck

Stanley Lim Hock Eng

Chan Von Lian

Chan Pak Kuen

Dr Patrick Tang Siah Ying

Sharon Khaw Pei Chin

Assoc. Prof. Ir. Dr. Fathilah binti Ali

Dr Ong Siew Kooi

PRIM Management Committee 2025-2027

Sin Yoong Cheong - President

Raja Sellamuthu - Vice-President (Rubber)

Francesca Netto - Vice-President (Plastics)

Dr. Ong Siew Kooi - Honorary Secretary (Until April 2026)

Sharon Khaw Pei Chin - Honorary Secretary (From May 2026)

Dr Patrick Tang Siah Ying - Assistant Honorary Secretary

Stanley Lim Hock Eng - Honorary Treasurer

Sin Siew Mun - Assistant Honorary Treasurer

Committee Members:

Pong Kai See

Lim Sum Teck

Chan Lee Khim

Chan Von Lian

Chan Pak Kuen

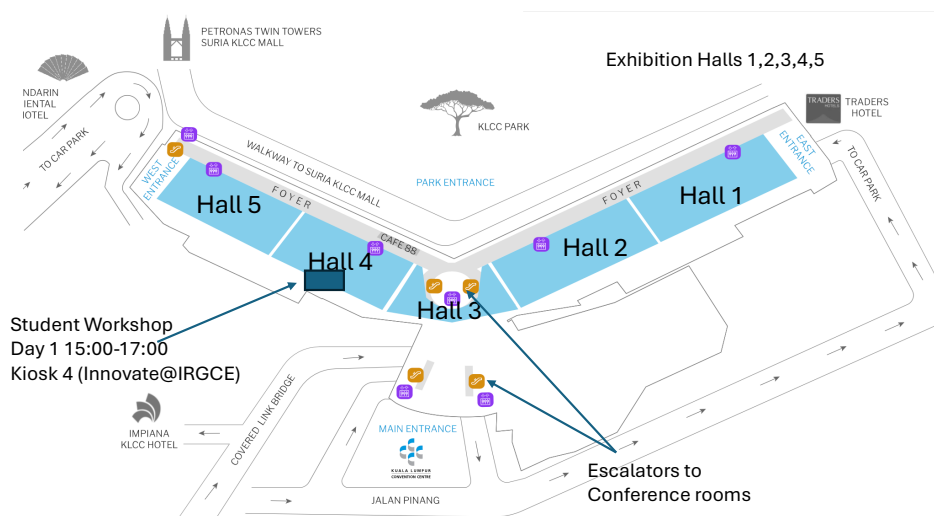
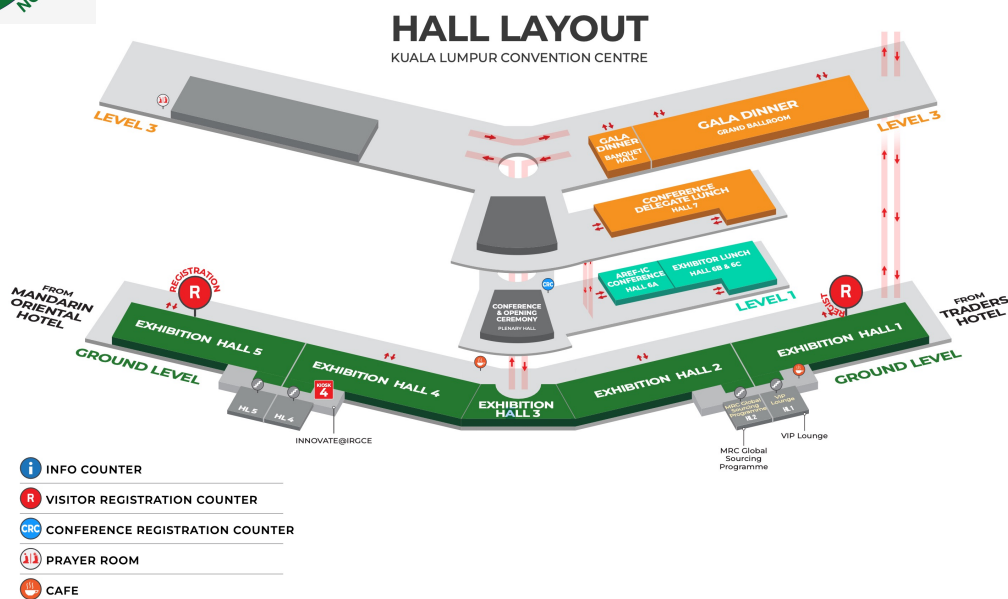
Ng Kha Chan

Dr Roland Ngeow Yen Wan

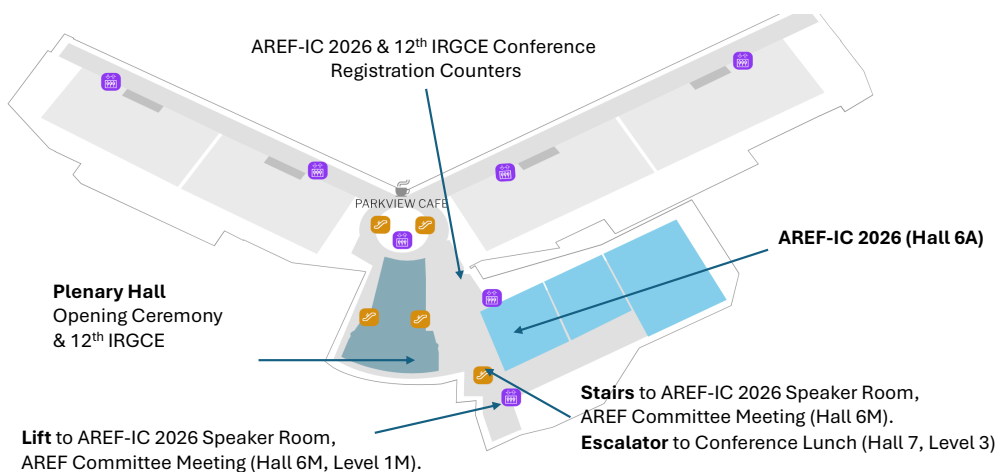
Dr. Hjh Hafsa Mohd Ghazali



AREF-IC 2026 & 12th IRGCE FLOOR GUIDE



Ground Floor Layout



First Floor Layout

CONFERENCE PROGRAMME AT A GLANCE

DAY 1 · TUESDAY 8 SEPTEMBER 2026 · PLenary HALL · LEVEL 1

08:30 - 09:00	REGISTRATION	(KLCC, LEVEL 1)
09:00 - 10:30	OPENING CEREMONY	(PLENARY HALL, LEVEL 1)
10:30 - 11:00	COFFEE BREAK	

11:00 - 11:40 Plenary 1 :

Prof. Dr. Yeah Kim Leng

Professor and Director, Economics Studies

Jeffrey Cheah Institute on Southeast Asia, Malaysia



12th INTERNATIONAL
RUBBER GLOVE
CONFERENCE &
EXHIBITION



ASIA RUBBER-ELASTOMER
FEDERATION INTERNATIONAL
CONFERENCE 2026
(AREF-IC 2026)

Towards a Soft Landing: How the Malaysian Glove Industry Can Mitigate Regression Amidst the Geopolitical Energy Crisis.

11:40 - 12:05

Prof. Dato' Dr. Adeeba Kamarulzaman, FASc

President and Pro Vice-Chancellor

Monash University Malaysia, Malaysia



12th INTERNATIONAL
RUBBER GLOVE
CONFERENCE &
EXHIBITION

From the Bedside to the Production Line

What Infectious Diseases Medicine Needs from the Next Generation of Gloves

12:05 - 12:30

Datuk Ts Dr. Muralitharan Paramasua

Chief Executive Officer

Medical Device Authority, Ministry Of Health Malaysia, Malaysia



12th INTERNATIONAL
RUBBER GLOVE
CONFERENCE &
EXHIBITION

Facilitating Global Market Access for Malaysian Medical Gloves through Regulatory Harmonisation

12:30 - 12:50

Panel Discussion & Moderated by:

Academician Prof. Dr. Ho. Chee Cheong, FASc

12th IRGCE 2026 Conference Technical Committee



12th INTERNATIONAL
RUBBER GLOVE
CONFERENCE &
EXHIBITION

12:50 - 14:00

Networking Lunch | Hall 7, Level 3 & Exhibition Visit | Hall 1-5, Ground Floor

CONFERENCE PROGRAMME AT A GLANCE

DAY 1 · TUESDAY 8 SEPTEMBER 2026 · PLenary HALL · LEVEL 1

13:45 - 14:45

CONCURRENT PROGRAMME · HALL 6A, LEVEL 1



ASIA RUBBER-ELASTOMER
FEDERATION INTERNATIONAL
CONFERENCE 2026
(AREF-IC 2026)

AREF TECHNICAL POSTER PRESENTATION

OPEN TO ALL DELEGATES

14:00 - 14:40 Plenary 2 :

Mr. Mohammad Hafezh Bin Abdul Rahman

Chief Sustainability and Information Officer

Malaysian Rubber Council, Malaysia



12th INTERNATIONAL
RUBBER GLOVE
CONFERENCE &
EXHIBITION



ASIA RUBBER-ELASTOMER
FEDERATION INTERNATIONAL
CONFERENCE 2026
(AREF-IC 2026)

Trusted Market Leader of the New Era Competing under geo-economic fragmentation, and creating trust beyond transactions

14:40 - 15:20 Plenary 3 :

Dato' Dr. Zairossani Mohd Nor

Director-General

Malaysian Rubber Board, Malaysia



12th INTERNATIONAL
RUBBER GLOVE
CONFERENCE &
EXHIBITION



ASIA RUBBER-ELASTOMER
FEDERATION INTERNATIONAL
CONFERENCE 2026
(AREF-IC 2026)

Glove 2030: Malaysia's Roadmap to High Value Sustainable Growth

15:00 - 17:00

**CONCURRENT PROGRAMME · EXHIBITION HALL 4,
KIOSK 4 (Innovate@IRGCE), GROUND FLOOR.**



ASIA RUBBER-ELASTOMER
FEDERATION INTERNATIONAL
CONFERENCE 2026
(AREF-IC 2026)

STUDENT WORKSHOP - How to Become a Better Polymer Professional

Peram Prasada Rao , TechnoBiz

REGISTERED STUDENT DELEGATES ONLY

15:20 - 15:40

Dr. Suttipong Angthong

Secretary-General

The Association of Natural Rubber Producing Countries



12th INTERNATIONAL
RUBBER GLOVE
CONFERENCE &
EXHIBITION

Navigating the Global Natural Rubber Outlook: Economic Synergies and Sustainable Initiatives for the Glove Ecosystem.

CONFERENCE PROGRAMME AT A GLANCE

DAY 1 · TUESDAY 8 SEPTEMBER 2026 · PLenary HALL · LEVEL 1

15:40 - 16:00 · Mr. Nikhil Vallabhan

Senior Consultant in the Chemicals, Materials & Food practice
Frost & Sullivan of Malaysia, Malaysia



Global Overview of the Rubber Gloves Industry. (Focus on Cleanroom Gloves)

16:00 - 16:20

Panel Discussion & Moderated by: Dr. Amir Hashim Md. Yatim, FASc
Chairman of 12th IRGCE 2026 Conference Technical Committee

16:20 - 16:45 Coffee break

16:45 - 17:05 Mr. Martin Heels

Technical Division Manager
SATRA Technology, United Kingdom



Extractable Chemical Residue from Medical Gloves and European Standards Update

17:00 - 18:00

PRIVATE MEETING

HOSPITALITY SUITE 6M, LEVEL 1M



AREF COMMITTEE MEETING

INVITATION ONLY · AREF COMMITTEE MEMBERS

17:05 - 17:25 Ms. Zhang Xinxin

Regional Director, Asia Pacific, Preferred by Nature, China



Navigating the Breakthrough Path: Challenges and Opportunities for Malaysia's Rubber Glove Industry under EU Green Regulations

17:25 - 17:45 Ms. Rikke Nygaard

Chief Executive Officer, QA MED Solutions, Denmark



The Regulatory Landscape of the EU for Glove Manufacturers

17:45 - 18:05 Mr. Mohamad Haris Bin Abdul Latif

Head of ESG
Malaysia External Trade Development Corporation, Malaysia



Sustainable Trade: Navigating the Future with ESG

CONFERENCE PROGRAMME AT A GLANCE

DAY 2 · WEDNESDAY, 9 SEPTEMBER 2026.

PARALLEL PROGRAMME · HALL 6A · LEVEL 1

09:00 - 09:40

Keynote 1:

Dr. Banja Junhasavasdikul

Chairman of the Board at Innovation Group (Thailand) Co.,Ltd



ASIA RUBBER-ELASTOMER
FEDERATION INTERNATIONAL
CONFERENCE 2026
(AREF-IC 2026)

Inspiration in Technology and Innovation

09:40 - 10:20

Keynote 2:

Mr. Peram Prasada Rao,

Founder & CEO, TechnoBiz, Thailand



ASIA RUBBER-ELASTOMER
FEDERATION INTERNATIONAL
CONFERENCE 2026
(AREF-IC 2026)

Young Talent as the Growth Engine of the Rubber Ecosystem: Skills, Mindsets, and Industry Responsibility

10:20 - 10:40

Mr. Raja Sellamuthu

Vice-President (Rubber),

The Plastics and Rubber Institute Malaysia (PRIM)



ASIA RUBBER-ELASTOMER
FEDERATION INTERNATIONAL
CONFERENCE 2026
(AREF-IC 2026)

PRIM Solutions Provider: Building core rubber technology expertise to empower and advance the modern rubber industries.

Chair: Mr. Lim Sum Teck

AREF-IC 2026 Organising Committee. PRIM Committee Member

PARALLEL PROGRAMME · PLENARY HALL · LEVEL 1

09:00 - 09:40

Plenary 4:

Prof. Dr. Robert G Hamilton

Professor of Medicine and Pathology

Johns Hopkins University School of Medicine, United States of America



12th INTERNATIONAL
RUBBER GLOVE
CONFERENCE &
EXHIBITION

Natural Rubber Latex (NRL) Allergy: Opinion on Current Status and Future Directions

CONFERENCE PROGRAMME AT A GLANCE

DAY 2 · WEDNESDAY, 9 SEPTEMBER 2026.

09:40 - 10:00

Ms. Nurulhuda Binti Abdullah

Research Officer in the Latex Science and Technology Unit
Malaysian Rubber Board, Malaysia



Comprehensive Review of Malaysia's Efforts in Controlling Natural Rubber Latex Protein Allergy

10:00 - 10:20

Ms. Dyana Adziera Jamaluddin

Research Officer
Malaysian Rubber Board, Malaysia



A Review of Extractable Protein Analysis in Gloves and Its Role in National Safety and Health Monitoring

10:20 - 10:40

Panel Discussion · Moderator:



Dr. Mok Kok Lang

Former Deputy Director General of Research and Innovation
Malaysian Rubber Board

10:40 - 11:10 Coffee break

ALL DELEGATES · PLENARY HALL · LEVEL 1

11:10 - 11:50

Plenary 5:

Mr. Panitan Junhasawasdikul

President
Innovation Group (Thailand) Ltd, Thailand



Rising Challenges To The New Wave : Finding The Sweet Spot For Rubber and Polymer In a Knowledge-Driven Era

11:50 - 12:30

Plenary 6:

Dr. Zhaomin Hou

Deputy Director, RIKEN Center for Sustainable Resource Science, Japan



Self-Healing Polyolefin Elastomers Enabled by Precision Copolymerization: Toward Durable and Sustainable Rubber Materials for Glove Applications

CONFERENCE PROGRAMME AT A GLANCE

DAY 2 · WEDNESDAY, 9 SEPTEMBER 2026.

12:30 - 12:50

Mr. Andrew Woon

Managing Director

Faber Castell Malaysia, Malaysia



12th INTERNATIONAL
RUBBER GLOVE
CONFERENCE &
EXHIBITION



ASIA RUBBER-ELASTOMER
FEDERATION INTERNATIONAL
CONFERENCE 2026
(AREF-IC 2026)

Accelerating AI Adoption: From Executive Questions to Scaled Business Value, a Practical Roadmap for Manufacturing Organizations

Chair : Dr. Eng Aik Hwee

12th IRGCE 2026 Conference Technical Committee

12:50 - 14:00

Networking Lunch | Hall 7, Level 3 & Exhibition Visit | Hall 1-5, Ground Floor

PARALLEL PROGRAMME · HALL 6A · LEVEL 1

14:00 - 14:20

Well Kam Lian Hooi

President of ODI International

VA Partners



ASIA RUBBER-ELASTOMER
FEDERATION INTERNATIONAL
CONFERENCE 2026
(AREF-IC 2026)

Organisation Development (OD) – Beyond Growth: Building a Business That Lasts

14:20 - 14:40

Invited Speaker - Prof. Dr. Eng. Ken Nakajima

Institute of Science Tokyo



ASIA RUBBER-ELASTOMER
FEDERATION INTERNATIONAL
CONFERENCE 2026
(AREF-IC 2026)

AFM Nanomechanics and its Application to Rubber Science

14:40 - 15:00

Assoc. Prof. Dr. Kannika Sahakaro

Prince of Songkla University



ASIA RUBBER-ELASTOMER
FEDERATION INTERNATIONAL
CONFERENCE 2026
(AREF-IC 2026)

Roles of antioxidants and processing stabilizers during mixing of silica/silane-filled natural rubber

15:00 - 15:20

Assoc. Prof. Dr. Yeampon Nakaramontri (AREF-RETA Rising Star Award)

Department of Chemistry, Faculty of Science,

King Mongkut's University of Technology



ASIA RUBBER-ELASTOMER
FEDERATION INTERNATIONAL
CONFERENCE 2026
(AREF-IC 2026)

Comparative Performance of Biomass-Derived Lignins as Sustainable Anti-Degradants for Carbon Black-Filled Tire Tread Rubber

CONFERENCE PROGRAMME AT A GLANCE

DAY 2 · WEDNESDAY, 9 SEPTEMBER 2026.

15:20 - 15:40

Prof. Charoen Nakason

Faculty of Science and Industrial Technology,
Prince of Songkla University



ASIA RUBBER-ELASTOMER
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CONFERENCE 2026
(AREF-IC 2026)

Sustainable Natural Rubber/Thermoplastic Starch Biocomposites Reinforced with Rice Husk Ash: Polarity, Dynamic Vulcanization, and Performance-Biodegradability Trade-Offs

Chair: Dr. Hjh Hafsah Mohd Ghazali, FASc.

AREF-IC 2026 Organising Committee. PRIM Committee Member

PARALLEL PROGRAMME · PLENARY HALL · LEVEL 1

14:00 - 14:20

Mr. Didier Guisado

Certification and Standardization Director
CTC Groupe, France



12th INTERNATIONAL
RUBBER GLOVE
CONFERENCE &
EXHIBITION

Standardization of Protective Gloves: Current Developments and Challenges

14:20 - 14:40

Mr. Ryota Okunishi

Researcher
Shiraishi Central Laboratories Co., Ltd, Japan



12th INTERNATIONAL
RUBBER GLOVE
CONFERENCE &
EXHIBITION

Development of a Water-Based CSM Latex Film Forming Method for Chemical Resistant Gloves

14:40 - 15:00

Mr. Diago Dai

Assistant VP
Reebow Intelligent Equipment Co., Ltd , China



12th INTERNATIONAL
RUBBER GLOVE
CONFERENCE &
EXHIBITION

Empowering the Automation Upgrade of the Glove Packaging Industry through Technological Innovation and ESG Principles

15:00 - 15:20

Dr. Teo Kim Teck

Managing Director
Polymeric Technology Sdn Bhd, Malaysia



12th INTERNATIONAL
RUBBER GLOVE
CONFERENCE &
EXHIBITION

Ammonia-free Latex: A Strategic Shift for the Rubber Industry

CONFERENCE PROGRAMME AT A GLANCE

DAY 2 · WEDNESDAY, 9 SEPTEMBER 2026.

15:20 - 15:40

Mr. Wouter De Jong

Principal Scientist

Cariflex R&D, Netherlands



Sustainable Polyisoprene Latex Manufacturing

Chair: Mr. Sivaynana Moorthy

12th IRGCE 2026 Conference Technical Committee

15:40 - 16:00 Coffee break

PARALLEL PROGRAMME · HALL 6A · LEVEL 1

16:00 - 16:20

Dr. Apinya Krainoi

Princess of Naradhiwas University



ASIA RUBBER-ELASTOMER
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CONFERENCE 2026
(AREF-IC 2026)

Effect of sodium alginate-stabilized conductive filler on the electrical conductivity and strain-sensing performance of natural rubber nanocomposites

16:20 - 16:40

Assoc. Prof. Dr. Ekwipoo Kalkornsura-pranee

Division of Physical Sciences, Faculty of Science,

Prince of Songkla University,



ASIA RUBBER-ELASTOMER
FEDERATION INTERNATIONAL
CONFERENCE 2026
(AREF-IC 2026)

Harnessing Non-Rubber Components and Property Relationships for High-Value Rubber Product Design

16:40 - 17:00

Dr. Masato Suzuki (AREF-SRIJ Rising Star Award)

The Yokohama Rubber Co., Ltd.



ASIA RUBBER-ELASTOMER
FEDERATION INTERNATIONAL
CONFERENCE 2026
(AREF-IC 2026)

Study of Image-Processing Method for Enhanced Visualization of Nanoscale Rubber Cross-Linked Network Structures from Electron Microscopy Images

17:00 - 17:20

Ms. Orrawan Pongchumpon

Manager of Research Center of Innovation Group

Innovation Group (Thailand) Ltd



ASIA RUBBER-ELASTOMER
FEDERATION INTERNATIONAL
CONFERENCE 2026
(AREF-IC 2026)

Technical Solutions in Recycled Plastic

Chair: Associate Professor Dr. Kannika Sahakaro

Prince of Songkla University

CONFERENCE PROGRAMME AT A GLANCE

DAY 2 · WEDNESDAY, 9 SEPTEMBER 2026.

PARALLEL PROGRAMME · PLENARY HALL · LEVEL 1

16:00 - 16:20

Dr. Phattarawadee Nun-Anan

Specialist - Chemical Innovation

Innovation Group (Thailand) Ltd, Thailand



Effect of Micro-and-Nano-sized Zinc Oxide Particles on the Properties of Natural Rubber Latex Films Prepared by Dipping Process.

16:20 - 16:40

Dr. Darren Yi Sern Low

Colloids and Polymer Group

Monash University, Malaysia



Advanced Rubber Material Innovations for Sustainable Glove and Protective Applications

16:40 - 17:00

Assoc. Prof. Dr. Ekwipoo Kalkornsurapranee

Associate Professor

Prince of Songkla University, Thailand



Novel Glutaraldehyde Crosslinking in Natural Rubber Latex: Mechanisms, Synergies, and Antimicrobial Applications

Chair: Prof Dr. Azura Binti A. Rashid

12th IRGCE 2026 Conference Technical Committee

17:00

END OF PLENARY HALL PROGRAMME

17:20

END OF DAY 2 PROGRAMME

CONFERENCE PROGRAMME AT A GLANCE

DAY 3 · THURSDAY, 10 SEPTEMBER 2026.

PARALLEL PROGRAMME · HALL 6A · LEVEL 1

09:00 - 09:40

Keynote 3

Ts. Dr. Chua Wen-Shyan

Head of Malaysian Smart Factory 4.0, Selangor Human Resource Development Centre (SHRDC), Malaysia



ASIA RUBBER-ELASTOMER
FEDERATION INTERNATIONAL
CONFERENCE 2026
(AREF-IC 2026)

From Smart to Sustainable: Harnessing AI, SIRI and COSIRI to Shape the Future of Rubber Manufacturing

09:40 - 10:00

Assoc. Prof. Dr. Arshad Adam Salema

Sustainable Energy and Development Lab,
Department of Mechanical Engineering, School of Engineering,
Monash University Malaysia.



ASIA RUBBER-ELASTOMER
FEDERATION INTERNATIONAL
CONFERENCE 2026
(AREF-IC 2026)

Alternative, sustainable, and hybrid energy sources for the commercial and industrial sectors

10:00 - 10:20

Mr. Ahmad Supian

HF Mixing Group Services SEA Sdn Bhd



ASIA RUBBER-ELASTOMER
FEDERATION INTERNATIONAL
CONFERENCE 2026
(AREF-IC 2026)

Efficient Manufacturing Of Rubber Compounds

10:20 - 10:40

Mr. Asmipudin Ali

Bridge Fields Resources Sdn Bhd



ASIA RUBBER-ELASTOMER
FEDERATION INTERNATIONAL
CONFERENCE 2026
(AREF-IC 2026)

Rubber Industry Circular Alliance

Chair: Mr. Pong Kai See, FPRIM, FASc
PRIM Past President

CONFERENCE PROGRAMME AT A GLANCE

DAY 3 · THURSDAY, 10 SEPTEMBER 2026.

PARALLEL PROGRAMME · PLENARY HALL · LEVEL 1

09:00 - 09:20

Dr. Bob Groves

Institute for Energy and Environmental flows
University of Cambridge, United Kingdom



The Process of Nitrile Latex Coagulant Dipping – A Review Part 1: Particle Chemistry & Film Physics

09:20 - 09:40

Prof. Alex Routh

Department of Chemical Engineering and Biotechnology
University of Cambridge, United Kingdom



The Process of Nitrile Latex Coagulant Dipping – A Review Part 2: Colloidal Science and Coating Technologies for Improved Performance in Glove Manufacturing

09:40 - 10:00

Dr. Andrew Kells

Vice President of Innovation and Intellectual Property
YTY Group, Malaysia



Optimizing the Last Line of Defense: The Critical Role of Glove Design in Limiting Contaminant Transfer and so in Preventing Nosocomial Infections

10:00 - 10:20

Dr. Chi Hoong Chan

Senior Polymer Scientist
Synthomer Sdn Bhd, Malaysia



Innovating Cleanliness and Comfort in Nitrile Gloves

10:20 - 10:40

Mr. Joshy Babu

Technical Service Manager
Getahindus (M) Sdn Bhd, Malaysia



Specialised Latex Grades to Address Challenges in the Glove Ecosystem

Chair: Dr. Ng Chiew Sum

Rubber Consultant

10:40 - 11:00 Coffee break

CONFERENCE PROGRAMME AT A GLANCE

DAY 3 · THURSDAY, 10 SEPTEMBER 2026.

PARALLEL PROGRAMME · HALL 6A · LEVEL 1

11:00 - 11:20

Dr. Nik Intan binti Nik Ismail

Malaysian Rubber Board



ASIA RUBBER-ELASTOMER
FEDERATION INTERNATIONAL
CONFERENCE 2026
(AREF-IC 2026)

Sustainable Eco-EPDM Hose Compounds Reinforced with Recovered Carbon Black: Mechanical, Rheological and Ageing Performance

11:20 - 11:40

Dr. Mahmud Iskandar Bin Seth A Rahim

Malaysian Rubber Board



ASIA RUBBER-ELASTOMER
FEDERATION INTERNATIONAL
CONFERENCE 2026
(AREF-IC 2026)

ACOUSTICAL PERFORMANCE OF DRY AND LIQUID EPOXIDIZED NATURAL RUBBER (ENR) FOAMS

11:40 - 12:00

ChM. Mohd Afieq bin Mohd Tajudin

Malaysian Rubber Board



ASIA RUBBER-ELASTOMER
FEDERATION INTERNATIONAL
CONFERENCE 2026
(AREF-IC 2026)

DETERMINATION OF HEAVY METALS IN RUBBER GLOVES USING ATOMIC ABSORPTION SPECTROSCOPY BASED ON THE ISO 6101 SERIES: ENSURING SAFETY AND COMPLIANCE

12:00 - 12:20

Assoc. Prof. Dr. Norazilawati Muhamad Sarih

Faculty of Science, Department of Chemistry,
Universiti Malaya



ASIA RUBBER-ELASTOMER
FEDERATION INTERNATIONAL
CONFERENCE 2026
(AREF-IC 2026)

Preparation of Soluble Highly Branched Polyisoprene by Anionic Polymerisation

12:20 - 12:40

Ts. Nik Zakaria bin Nik Yahya

Malaysian Rubber Board



ASIA RUBBER-ELASTOMER
FEDERATION INTERNATIONAL
CONFERENCE 2026
(AREF-IC 2026)

FIVE (5) YEARS FIELD PERFORMANCE ASSESSMENT OF CUPLUMP MODIFIED ASPHALT (CMA) AT A HIGH TRAFFIC LOAD PAVEMENT

Chair: Prof. ChM. Dr. Khairiah Binti Badri

Universiti Kebangsaan Malaysia (UKM)

CONFERENCE PROGRAMME AT A GLANCE

DAY 3 · THURSDAY, 10 SEPTEMBER 2026.

PARALLEL PROGRAMME · PLENARY HALL · LEVEL 1

11:00 - 11:20

Dr. Eng Aik Hwee

12th IRGCE 2026 Conference Technical Committee

Trainer & Consultant, K&W Training & Consulting, Malaysia



Advancing Quality Assurance in Disposable Rubber Glove Industry

11:20 - 11:40

Ms. Amarjit Kaur

Director

SHEMSI Sdn Bhd, Malaysia



From Compliance to Competitiveness: The Role of Standards in Advancing Environmental Sustainability in the Rubber Glove Industry

11:40 - 12:00

Dr. Zameri bin Mohamed

Research Officer (Processing and Sustainability Unit)

Malaysian Rubber Board, Malaysia



Carbon Footprint Quantification for Malaysian Rubber Industry based on Life Cycle Assessment Methodology

12:00 - 12:20

Dr. Tew Chian How

Sales Director

IBA Industrial, Belgium



From Ethylene Oxide and Gamma to E-Beam and X-Ray

12:20 - 12:40

Dr. Azira Abd Aziz

Senior Research Officer (Latex Science and Technology Unit)

Malaysian Rubber Board, Malaysia



The Next Generation of Biodegradable Gloves

Chair: Dr. Nurul Hayati binti Yusof

12th IRGCE 2026 Conference Technical Committee

12:40 - 14:00

Networking Lunch | Hall 7, Level 3 & Exhibition Visit | Hall 1-5, Ground Floor

CONFERENCE PROGRAMME AT A GLANCE

DAY 3 · THURSDAY, 10 SEPTEMBER 2026.

PARALLEL PROGRAMME · HALL 6A · LEVEL 1

14:00 - 14:20

Ms. Mahirah Mohd Idris

Malaysian Rubber Board



ASIA RUBBER-ELASTOMER
FEDERATION INTERNATIONAL
CONFERENCE 2026
(AREF-IC 2026)

ECO-FRIENDLY ORGANOSILANE MATERIAL FOR SURFACE PRETREATMENT TO ENHANCE ADHESION AND CORROSION RESISTANCE IN RUBBER-METAL BONDING SYSTEMS

14:20 - 14:40

Dr. Ismaliza Ismail

Malaysian Rubber Board



ASIA RUBBER-ELASTOMER
FEDERATION INTERNATIONAL
CONFERENCE 2026
(AREF-IC 2026)

Epoxy-Modified Chlorinated Rubber Primer for Rubber-To-Metal Bonding Systems in Marine Environments

14:40 - 15:00

Mrs. Norhanifah binti Mohd Yazid

Malaysian Rubber Board



ASIA RUBBER-ELASTOMER
FEDERATION INTERNATIONAL
CONFERENCE 2026
(AREF-IC 2026)

Assessing the Changes in Structural Integrity and Thermal Stability of Nitrile- Biofiller Film Under Soil Burial

15:00 - 15:20

Assoc. Prof. Ir. Dr. Fathilah binti Ali

Department of Chemical Engineering and Sustainability,
International Islamic University Malaysia



ASIA RUBBER-ELASTOMER
FEDERATION INTERNATIONAL
CONFERENCE 2026
(AREF-IC 2026)

Surface-Modified Natural Fibers in Natural Rubber Composites

Chair: Dr. Nik Intan binti Nik Ismail

Malaysian Rubber Board

15:20 · ALL DELEGATES · PLENARY HALL · LEVEL 1

CONFERENCE PROGRAMME AT A GLANCE

DAY 3 · THURSDAY, 10 SEPTEMBER 2026.

PARALLEL PROGRAMME · PLENARY HALL · LEVEL 1

14:00 - 14:20

Dr. Samsulida Binti Abdul Rahman

Director of Life Science Centre, SIRIM Berhad, Malaysia



Biosafety and Regulatory Compliance as Strategic Drivers in the Rubber Glove Industry

14:20 - 14:40

Mr. Shafizal Bin Yusof

Head of Licensing and Permits Unit, Malaysian Rubber Board



Safeguarding the Malaysian Rubber Glove Industry through Effective Licensing and Enforcement

14:40 - 15:00

Dr. Mohamad Danial Shafiq

Senior Lecturer, Universiti Sains Malaysia, Malaysia



Recovering Waste Latex from Bulk Residues and Wastewater: Insights on Circular Approach for the Glove Manufacturing Industry

15:00 - 15:20

Mr. Louie Lu Zuhong

Managing Director, Hu Chang Xu Sdn Bhd, Malaysia



Comparative Study on The Application of Stainless-Steel Hand Molds Versus Ceramic Molds in Nitrile And Latex Glove Manufacturing Processes

ALL DELEGATES · PLENARY HALL · LEVEL 1

15:20 - 15:40

Ts. Dr. Roland Ngeow Yen Wan

Rector of Academy Hevea Malaysia

Malaysian Rubber Board, Malaysia



Building Future-Ready Talent for the Rubber Glove Industry: Hands-on TVET and Generative AI Integration

Chair by: Assoc. Prof. Dr. Patrick Tang Siah Ying

12th IRGCE 2026 Conference Technical Committee

15:40 - 16:00

12th IRGCE 2026 & AREF-IC Closing Ceremony, Plenary Hall Level 1

16:00 · Coffee Break · End of Conference

AREF-IC 2026 POSTER PRESENTATIONS

P1	Karen Ng Mei Pou	Monash University Malaysia	Enhancing the Physicochemical Properties of Carboxylated Nitrile Butadiene Rubber Using Palm-Based Nanocellulose
P2	How Sher Wei	Monash University Malaysia	Advanced Moisturising Gloves with N-Acetylneuraminic Acid (NANA) for Sustained Skin Hydration
P3	Phuah Rou Jie	Universiti Malaya	Starch-Based Biopolymers as Sustainable Alternatives: A Review
P4	Abdul Qayyum Firdaus bin Yus'aimei	Universiti Malaya	Effects of 18-Crown-6 on the Living Anionic Polymerization of Poly(Methyl Methacrylate) at Ambient Temperature
P5	Aziha Mohd Salmi	International Islamic University Malaysia	Effect of Polyurethane with Various Carbon-based Fillers on Tensile Properties for Surface Coating Applications
P6	Nur Yasmin Hanani Mohd Khairani	Universiti Teknologi Mara	Smart Sustainable Outerwear from Recycled Plastic Bags: An Innovative Waste-to-Product Solution
P7	Nadia Wan Azman	Universiti Sains Malaysia	Physicomechanical Performance and Aging Behavior of Polycarbodiimide-Crosslinked Accelerator-Free Carboxylated Nitrile Butadiene Rubber Latex Gloves
P8	Dong Siew Feng	Universiti Malaysia Perlis	Nitrogen Removal by Ganoderma lucidum Pellets
P9	Marsya Syahira Marzuizuddin	International Islamic University Malaysia	Sustainable Agricultural Mulch Films: Enhanced Flexibility of PLA/TPU/Natural Fiber Composites
P10	Fatin Humaira Binti Mohd Fairuz	International Islamic University Malaysia	Characterization Of Polylactic Acid/Fiber Composites for Cosmetic Patch
P11	Neettha a/p Nai Sem	Universiti Sains Malaysia, Tuanku Syed Sirajuddin Engineering Campus	Development of Sustainable Antimicrobial Latex Films for Stethoscope Diaphragm Cover Applications
P12	Asma Izzati Asmadi	Universiti Sains Malaysia, Tuanku Syed Sirajuddin Engineering Campus	Investigation of Ageing and Weathering Properties of Self-Healing Rubber
P13	Ng Joey	Monash University Malaysia	Development and Evaluation of High-Acyl Gellan Gum-Based Biopolymer Coatings for Sustainable Paper Food Packaging: Formulation Optimization, Environmental Assessment, and Food Storage Applications
P14	Saiful Bahri bin Mohd Diah	Universiti Sains Malaysia	Prediction of Mold Filling and Air Entrapment in Natural Rubber Injection Molding Using a Homogeneous Multiphase Volume-of-Fluid CFD Model
P15	Nur Farah Liyana binti Mohd Fauzi	Universiti Sains Malaysia	The Preliminary Study of Electric Vehicle Tire Tread Formulation: A Review
P16	Nur Fazreen Binti Alias	Universiti Sains Malaysia	Development of Sustainable Conveyor Belt Compounds Based on Reclaimed Rubber
P17	Aliyu Tijjani Fadawa	Universiti Sains Malaysia	From Rubber Processing Samples to Biotechnological Solutions: A Conceptual Framework for Indigenous Microbial Consortium Development
P18	Darren Low Yi Sern	Monash University Malaysia	Cosmic Coat: Stretchable Natural Rubber Shield for Space Radiation Protection

P19	Siti Nur Aishah bt Adnan	Universiti Sains Malaysia Tuanku Syed Sirajuddin Engineering Campus	Effect of Silica Loadings on Properties of Waterborne Styrene-Acrylate Films
P20	Khim May Ooi	Xiamen University Malaysia	Hydrodeoxygenation of Palm Fatty Acid Distillate over Ni-Supported Defatted Spent Coffee Ground-Derived Activated Biochar Catalyst for Sustainable Aviation Fuel Production
P21	Andersson T'ng Khai Shern	Xiamen University Malaysia	Development of Thin Film Nanocomposite Membrane with Ionic Liquid Functionalized Graphene Oxide for Effective CO ₂ Separation
P22	Tan Wen Jian	Monash University Malaysia	Enhanced Cooling Performance of Lithium Polymer Batteries Using Micro Heat Pipes Integrated with Carbon Nanotubes Coatings
P23	Gabriella Ivana Sugianto	Xiamen University Malaysia	IoT-Driven Diagnostic Guidelines for Precision Orchard Management
P24	Adnin Najeehah Azman	Universiti Malaya	Isolating Sustainable Bio-Fillers for Next Generation Rubber Latex
P25	Dzaidatu Aqmal Ramlee	Universiti Malaya	Hybrid Polymer-Based Hydrogels for Wound Dressing Applications: A Review
P26	Amiera Balqis Binti Zainalabidin	Universiti Malaya	Polylactic Acid for Sustainable Agricultural Applications: A Review
P27	Jennifer B. Antonio	Monash University Malaysia	Investigation of the Thermal Properties of Sayote (<i>Sechium edule</i>) Fiber Loaded Starch/PVOH Composite Blends



ASIA RUBBER-ELASTOMER FEDERATION INTERNATIONAL CONFERENCE 2026 (AREF-IC 2026)

8th to 10th September 2026
KUALA LUMPUR CONVENTION CENTER
(KLCC), MALAYSIA

AREF-IC 2026 ORAL PRESENTATION ABSTRACTS



In Conjunction with

Supporting Organizations:



TechnoBiz

www.prim.org.my/aref-ic-2026/
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Day 2 0900 - Inspiration in Technology and Innovation

Banja Junhasavasdikul, Chairman of the Board
Innovation Group, Thailand

40+ years, Innovation Group passed through many economic crisis. We have been able to manage and grow after crisis through 'Inspiration in Technology and Innovation' Key drive of our success is build Internal Competency and Innovation. From a small organization of 3 persons, to become an International Technical Solution Provider in Polymer and Engineering Design with 6 factories in Thailand, 2 factories in Vietnam and provide products and services to over 20 countries, it needs a great effort in building organization, people, technology and innovation. Innovation Group passed through many challenges. We suffered from every economic crisis, but we could manage our growth through technology development and innovation. During Asia Financial Crisis 1997-1998, we were lucky, succeed in developing rubber out-sole formulation with Reebok. Reebok requested Chemical Innovation to set up rubber compounding plant to provide Reebok's outsole compounds globally. Followed with the request from Kitz to provide butterfly valve seals. It was big challenge in building rubber compounding and rubber molding plants from chemistry background and knowledge from research laboratories. We build those plants and processing technology from internal technology development. During American financial crisis in 2008, Innovation Group formed a J/V with a Japanese mold maker and build mold technologies. Recently, we built very strong engineering and product design team to work with major brands in automotive and automotive system makers. In every investment, Innovation Group has the concept to be the best in technologies and being the leader in the industry that we are working. In area of Innovation and product development, over 35 years, Innovation Group succeeds in product development by working closely with industry and customer through the concept of 'Outside-in' product development. Academic researchers do research based on their knowledge and experience. Mostly their research came out mainly as new material technical knowledge. Academic researchers have no 'Market Insight', chance of success of new material development of 'Inside-out' is dim and/or takes long time to commercial new products. While 'Outside-in Research', researcher needs market-insight and co-work with end-use in providing solutions and requirement to end-user. Chance of development success is high and takes shorter time. However, keys success in industrial product development are:

- How we offer 'Value Creation' to customers.
- Innovative products must meet product performance of customers.
- Innovative products must have the cost that customers and market can accept.

Innovation Group, now-a-day is working toward Green Material offering industry green polymer, 'Circular Economy' materials and solutions for green economy.

Keywords: Technology Innovation; Internal Competency; Outside-in Research; Value Creation; Circular Economy

Day 2 0940 - Young Talent as the Growth Engine of the Rubber Ecosystem: Skills, Mindsets, and Industry Responsibility

Peram Prasada Rao

Founder & CEO, TechnoBiz, Thailand

The rubber industry is entering a decisive phase shaped by sustainability pressures, digital transformation, and the shift toward an increasingly innovation-driven global economy. In this environment, competitive advantage will no longer be defined solely by scale or cost efficiency, but by the industry's ability to continuously generate, absorb, and apply innovation. At the core of this transition lies a critical question: are we effectively assessing, developing, and aligning talent to meet these evolving demands?

This topic positions young talent as the primary growth engine of the rubber ecosystem and emphasizes the need for a structured approach to skill assessment and development. It highlights the importance of establishing clear competency frameworks across technical, digital, business, and sustainability domains, supported by practical evaluation systems that measure real capabilities. The session also underscores the role of continuous learning, mentorship, and industry exposure in building professionals who can contribute meaningfully to innovation and value creation.

A central theme of the address is the urgent need for curriculum transformation, calling for stronger collaboration between industry and academia to integrate application-oriented learning, interdisciplinary knowledge, and embedded skill assessment mechanisms. By aligning education with industry realities and innovation priorities, the sector can significantly enhance the readiness and impact of future professionals.

The speech ultimately calls on senior executives to recognize talent development as a strategic lever in building an innovation-driven rubber economy. By investing in people through structured assessment, relevant education, and continuous development, the industry can strengthen its capacity for innovation, improve global competitiveness, and ensure sustainable long-term growth.

Speaker Profile



Peram Prasada Rao is the Founder and CEO of Techno Biz, a global platform focused on knowledge sharing and business growth in the rubber, polymer, and polyurethane industries. With over 28 years of international experience, he is recognized as an industry strategist and ecosystem builder. A Chemical Engineer with a Master's in Environmental Engineering, he actively supports companies in marketing, branding, and capability development. Under his leadership, TechnoBiz has completed a 20-year journey, emerging as a positive catalyst for workforce development and business growth across the rubber and polymer industries. He has established global platforms such as Rubber Week, PU Week, PolyWorld, and GRTE, connecting industry professionals worldwide. He also leads industry publications including Rubber Review, Plastics Review, and PU Review, and has enabled access to hundreds of specialized reference books through the TechnoBiz Store to support continuous learning. His initiative on *Executive Diploma Programs*, customized based on participants' background and business profile, is a unique and globally well-received approach to skill development in the industry. TechnoBiz continues to evolve by staying relevant to current and future needs, and every rubber professional and business can benefit from connecting with the platform. For latest updates, please visit www.technobiz.org

Day 2 1020 - PRIM Solutions Provider: Building Core Rubber Technology Expertise to Empower and Advance the Modern Rubber Industries

Raja Sellamuthu, Vice-President
The Plastics and Rubber Institute Malaysia (PRIM), Malaysia

The modern rubber industry is undergoing rapid transformations driven by stricter quality standards, automation, and evolving material specifications. A widening technical skills gap poses a challenge to manufacturing efficiency and product innovation. This paper presents PRIM Solutions Provider's strategic framework for building specialised rubber technology expertise through technical training, workforce upskilling, and operational consulting. Core focus areas include compound formulation, curing dynamics, extrusion and moulding processes, and failure analysis. The framework aligns technical teams with operations and production management, from initial tooling through final part sign-off. Structured training can reduce scrap rates, accelerate new-product-development cycles, empower workforces, and advance the competitiveness of the rubber industry.

Keywords: Rubber Technology; Technical Upskilling; Workforce Empowerment; Process Optimization; Manufacturing Excellence.

Day2 1400 - Organisation Development (OD) Beyond Growth: Building a Business that Lasts

Well Kam Lian Hooi
VA Partners Group

In today's fast-evolving business landscape, technical and product innovation alone are no longer enough to guarantee long-term market leadership. For Small and Medium Enterprises (SMEs) including the rubber and elastomer ecosystem, the ultimate challenge lies in scaling effectively without breaking under pressure in the process of growth and progressing through different eras. Business resilience requires a shift from reactive 'survival mode' to a proactive 'systemic growth'. Organisation Development (OD) is the engine that drives this shift and transformation. This 20-minute masterclass will uncover how modern, Integrative Organisation Development (OD) serves as the engine for sustainable growth. It involves the progressive integration of Business, People and System as an organisation-wide development via an agile, structured framework tailored for sustainable growth effectively, optimising Business Strategy, Human Capital, System & Technology adoption and secure market resilience and Corporate Success. The Executive Sharing will also highlight a structured yet agile and integrative approach around three high-impact dimension, in line with the theme of the conference:

1. The Strategic Mindset Shift
2. The Diagnostic Framework (Methodology & Alignment)
3. The Transformation Pathway (Execution)

Keywords: Organisation Development (OD); Sustainable Growth; Small and Medium Enterprises (SMEs); Business Resilience; Organisational Transformation.

Day 2 1420 - AFM Nanomechanics and its Application to Rubber Science

Ken Nakajima

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Atomic force microscope, invented in 1986, is used worldwide across various fields as a tool for glimpsing the nanometer world. I utilize this microscope to peer into the internal structure of rubbery materials. Beyond merely observing structure, I utilize the AFM principle where the probe directly contacts the material, employing it as a tool to probe physical properties. This is the technique called as AFM nanomechanics. Rubbery materials are inherently heterogeneous. For example, they may contain mixtures of two or more rubbers, or have minute fillers added. This heterogeneity is precisely how we achieve the desired physical properties. Due to this non-uniform structure, conventional methods could not reveal what kind of response occurs within the material, for instance, when it is stretched. AFM nanomechanics visually presents how materials respond to mechanical stimuli. This allows us to understand, for example, how polymer chains respond internally when rubber is stretched, enabling the elucidation of mechanisms linking macroscopic properties to nanoscale behavior. Rubbery materials are viscoelastic, exhibiting not only elasticity but also viscosity. Understanding the mechanisms of energy dissipation allows for a deeper comprehension of rubbery material properties and paves the way for further improvements in their characteristics. The presentation will also cover the latest topics, including discussions on energy dissipation mechanisms derived from such viscoelastic measurements.

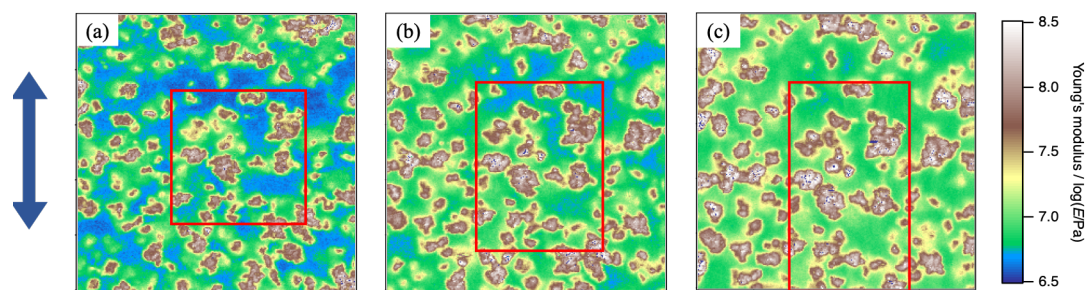


FIGURE 1. In situ AFM elastic modulus mappings for silica/SBR without silane coupling agent in $1.0 \times 1.0 \mu\text{m}$ areas under elongation of (a) 0%, (b) 21%, and (c) 44%

Keywords: rubber; materials; characterization; performance; sustainability

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Day 2 1440 - Roles of antioxidants and processing stabilizers during mixing of silica/silane-filled natural rubber

Kannika Sahakaro^{1,a}, Ammarin Kraibut¹, Sitisaiyidah Saiwari¹, Wisut Kaewsakul², Wilma K. Dierkes² and Jacques W.M. Noordermeer³

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As degradation of natural rubber (NR) during mixing at high temperature under strong shear force is of our concern, this work investigates the effect of aging antioxidants and processing stabilizers, i.e., 2,2,4-TriMethyl-1,2-dihydroQuinoline (TMQ) and N-(1,3-dimethylbutyl)-N-Phenyl-p-Phenylene Diamine (6PPD), 2,2,6,6-TetraMethylPiperidin-1-yl)Oxyl (TEMPO), Tris(2,4-di-tert-Butyl-Phenyl)Phosphite (TBPP), and Pentaerythritol Tetrakis(3-(3,5-di-tert-Butyl-4-HydroxyPhenyl)Propionate) (PTBHPP). The compounds with TMQ and 6PPD show higher viscosities and larger elastic responses compared to the reference compound, attributed to their ability to suppress rubber degradation during compounding resulting in higher molecular weight. Based on a model compound study, TMQ slightly reduces the silanization efficiency in the compounds, while other stabilizers do not interfere. However, this interference does not give an adverse effect to the final properties. Both TMQ and 6PPD enhance filler-rubber interaction, while TEMPO appears to terminate chain radicals of rubber during mixing, leading to permanent breakdown of the chains and so lower molecular weight, and TBPP does not work in this system as its melting point is higher than the mixing temperature. A practical silica-filled NR compound containing a blend of TMQ/6PPD shows improved mechanical properties of the vulcanizates, highlighting the essential role of these antioxidants added during mixing to suppress rubber degradation. The extra addition of PTBHPP into the system with TMQ/6PPD does not help in preventing rubber degradation during mixing, but it provides a positive effect on long-term aging stability.

Keywords: Natural rubber; silica-silane mixing; degradation; antioxidants; stabilizers

Acknowledgments: Thanks the Netherlands Natural Rubber Foundation (Rubber Stichting), the Prince of Songkla University Ph.D. Scholarship, and the Faculty of Science and Technology, PSU Pattani Campus, Thailand for financial support.



K. Sahakaro finished a BSc in Rubber Technology from PSU (1994), an MSc in Polymer Science and Technology from University of Manchester (UK) (1998), and a PhD in Polymer Science and Technology from University of Leeds (UK) (2002). She was a postdoctoral fellow at University of Twente (UT), the Netherlands in 2004-2005. So far, she published 93 articles on Scopus (80 articles on Web of Science), 1 patent, and 6 book chapters. H-index: Google Scholars 32; Scopus 29; Web of Science 27.

Day 2 1500 - Comparative Performance of Biomass-Derived Lignins as Sustainable Anti-Degradants for Carbon Black-Filled Tire Tread Rubber

Yeampon Nakaramontri^a and Navadol Laosiripojana

Sustainable Polymer & Innovative Composite Materials Research Group, Department of Chemistry, Faculty of Science, King Mongkut's University of Technology Thonburi, Bangkok, Thailand

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The development of sustainable alternatives to conventional petroleum-based rubber anti-degradants has become increasingly important due to environmental concerns surrounding 6PPD-derived transformation products. This study evaluated three biomass-derived lignins—commercial kraft lignin (Com-KL), laboratory-extracted kraft lignin (Ex-KL), and organosolv lignin (Ex-OL)—as renewable stabilizers for carbon black-filled tire tread compounds. The effects of lignin type on mechanical properties, thermo-oxidative and accelerated weathering resistance, dynamic mechanical behavior, abrasion, fatigue, and ozone resistance were systematically investigated. An optimum lignin loading of 5 phr provided a balanced combination of reinforcement and durability. Among the lignins examined, Ex-KL exhibited the best overall aging stability, showing the smallest reductions in tensile properties after thermal and QUV aging. Dynamic mechanical analysis also revealed that Ex-KL produced the lowest $\tan \delta$ at 60 °C, indicating improved rolling resistance while maintaining satisfactory wet-grip performance. Although lignin-based compounds showed lower fatigue crack resistance than those containing 6PPD, the results demonstrate that lignin is an effective bio-based bulk stabilizer against thermo-oxidative degradation. This work highlights the potential of lignin-rich biomass as a sustainable functional additive for next-generation tire tread compounds within a circular bioeconomy framework.



Keywords: Natural rubber; Lignin; Thermal stability; Antioxidant; Tire tread.



Biography

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Personal History:

Yeampon Nakaramontri is an Associate Professor in the Department of Chemistry, Faculty of Science at King Mongkut's University of Technology Thonburi. He received his B.Sc. in Rubber Technology and Ph.D. in Polymer Technology from Prince of Songkla University, completing his doctoral degree in 2016 at the Pattani campus. In 2018, he conducted postdoctoral research in collaboration with Prince of Songkla University and Osnabrück University of Applied Sciences before joining KMUTT as a lecturer. Dr. Nakaramontri is internationally recognized for his research on innovative natural rubber (NR) and advanced elastomeric materials. His work focuses on the development of sustainable and multifunctional rubber composites, particularly conductive NR, self-healing NR, disinfectant NR, biodegradable NR, piezoresistive and piezoelectric NR systems, thermoplastic–NR blends for 3D printing, controlled-release fertilizer systems, water-cured NR, and rubber waste recycling technologies. His multidisciplinary approach integrates polymer chemistry, materials science, engineering, agriculture, and biomedical applications to expand the versatility of natural rubber as a sustainable platform material. With support from the Department of Chemistry at KMUTT, he has authored more than 80 international publications and holds 15 petty patents related to rubber and polymer innovation. His research contributions span conductive rubber nanocomposites, dynamic crosslinking systems, thermoplastic elastomers, antibacterial rubber materials, and sustainable polymer technologies. He currently leads the “PSU × KMUTT Multidisciplinary Research & Innovation Project,” coordinating collaborations among more than 50 researchers and lecturers from multidisciplinary backgrounds. Dr. Nakaramontri has received several prestigious awards for his scientific contributions, including Rising Star Awards from both the Faculty of Science and the university level at KMUTT, the Thailand Rising Star Award from the Polymer Society of Thailand in 2022, and the Thailand Rising Star Award from the Rubber-Elastomer Technology Association in 2024. Through his research, teaching, and industrial collaborations, he continues to promote the advancement of sustainable rubber technologies and circular materials innovation applications.

Day 2 1520 - Sustainable Natural Rubber/Thermoplastic Starch Biocomposites Reinforced with Rice Husk Ash: Polarity, Dynamic Vulcanization, and Performance-Biodegradability Trade-Offs

Charoen Nakason^{1, a}, Skulrat Pichaiyut¹, Siriporn Buakaew¹ and Nattapon Uthaipan²

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Growing demand for low-carbon and circular materials is accelerating research on sustainable rubber-based thermoplastic elastomers that can balance mechanical performance, durability, processability, and environmental degradability. This plenary lecture summarizes three related studies on epoxidized natural rubber (ENR)/thermoplastic starch (TPS) biocomposites reinforced with rice husk ash (RHA), an agro-waste-derived silica-rich biofiller. The work integrates three key design variables: ENR polarity, RHA loading, and blending/curing system. ENR/TPS blends were prepared at a 50/50 weight ratio by melt blending and dynamic vulcanization, using RHA as a reinforcing and degradation-promoting filler. The first study demonstrated that RHA loading strongly controls the balance between reinforcement and biodegradation. A loading of 20 phr gave the optimum mechanical and thermomechanical performance, with tensile strength increasing by about 160% compared with the unfilled blend, whereas excessive RHA caused agglomeration and reduced strength. Higher RHA contents promoted soil-burial weight loss, reaching about 65% after 10 months at 50 phr RHA. The second study compared simple blending along with sulfur, peroxide, and phenolic dynamic vulcanization in RHA-filled ENR/TPS blends. The phenolic system produced the highest tensile strength, Shore A hardness, thermal stress-relaxation resistance, and a finer dispersed morphology, while the peroxide system gave the highest elongation, illustrating a clear performance-flexibility-degradability trade-off. The third study showed that increasing rubber polarity from NR to ENR25 and ENR50 improved interfacial adhesion with TPS and RHA. ENR50/TPS/RHA20 showed the most balanced properties, including tensile strength of 5.3 MPa, elongation at break of 410%, improved thermal resistance, reduced water absorption, and limited soil-burial weight loss. Overall, polarity-tuned ENR, optimized RHA loading, and appropriate dynamic vulcanization provide a practical framework for designing sustainable rubber-starch biocomposites for packaging, agricultural containers, disposable products, and other applications where moderate mechanical performance, renewable content, and controlled environmental degradation are required.

Keywords: Epoxidized natural rubber (ENR); thermoplastic starch (TPS); rice husk ash (RHA); dynamic vulcanization (DV); biodegradability



Prof. Dr. Charoen Nakason is a professor at the Faculty of Science and Industrial Technology, Prince of Songkla University, Surat Thani Campus, Thailand. His research focuses on natural rubber technology, epoxidized natural rubber, rubber-based thermoplastic elastomers, thermoplastic vulcanizates, polymer blends, bio-based fillers, and sustainable rubber materials. His work combines rubber compounding, dynamic vulcanization, morphology-property relationships, thermal and dynamic mechanical characterization, and environmental performance evaluation. He has supervised graduate research and published extensively on natural rubber blends and composites for advanced and sustainable applications.

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Day 2 1600 - Effect of sodium alginate-stabilized conductive filler on the electrical conductivity and strain-sensing performance of natural rubber nanocomposites

Apinya Krainoi¹ and Kanoktip Boonkerd^{2,3,a}

Technology and Engineering Division

Malaysian Rubber Board

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The development of novel composite materials has been driven by the increasing demand for advanced sensor technologies. This has created new opportunities for the application of natural rubber (NR) composites in strain-sensing devices. Owing to its outstanding elasticity, flexibility, and mechanical durability, NR is an excellent matrix material for strain sensors. In addition to their superior mechanical performance, NR-based strain sensors offer several advantages, including biocompatibility, biodegradability, renewability, and cost-effective production, making them attractive candidates for sustainable and flexible sensing applications. Hence, these composites can be utilized in soft robotics, wearable technologies, medical applications, and motion sensors. In this work, natural rubber (NR)-based nanocomposite for strain sensors application were prepared using different rubber matrices, namely, unmodified NR and epoxidized NR with 25 and 50 mol % epoxidized natural rubber (ENR25 and ENR50) respectively. In addition, the rubber nanocomposites were prepared *via* latex technology, with sodium alginate (Alg) employed as a dispersing agent to facilitate the dispersion of the conductive filler as carbon nanotubes (CNTs). The results demonstrated that the polar functional groups present in the rubber matrix played a crucial role in promoting the homogeneous dispersion of CNTs within the nanocomposite suspension. Furthermore, the incorporation of Alg as a dispersing agent promoted a more homogeneous dispersion of CNTs in the rubber nanocomposites. The incorporation of Alg significantly enhanced the mechanical properties of the CNT-filled NR, ENR25, and ENR50 nanocomposites. The electrical properties clearly indicated that the polar functional groups in the rubber matrix contributed to enhanced electrical conductivity. In addition, the incorporation of Alg further improved the electrical conductivity of the rubber nanocomposites. Moreover, the relative resistance change ($\Delta R/R_0$) was also enhanced by the addition of Alg. Among all the nanocomposites investigated, ENR25/CNT-Alg exhibited the highest strain sensitivity, making it the most promising candidate for strain-sensing applications.

Keywords: Natural rubber; Sodium alginate; Nanocomposite; Electrical property; Strain sensor

Day 2 1620 - Harnessing Non-Rubber Components and Property Relationships for High-Value Rubber Product Design

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Natural rubber is experiencing a continuous increase in global demand due to its eco-friendly characteristics. With increasing environmental awareness, the significantly lower Carbon Footprint (CFP) of natural rubber is highly advantageous (NR: approximately 0.28 kg CO₂e/kg, versus synthetic rubbers like SBR, EPDM, and NBR at 2.40, 2.83, and 3.07 kg CO₂e/kg, respectively). However, because natural rubber is a bio-based material, it contains a substantial amount of non-rubber components, which can create limitations in processing and applications for high-value products. This research focuses on understanding the fundamental relationships between these non-rubber components and the resulting material properties. This understanding is key to managing natural rubber effectively, adding value, and maximizing its benefits across various dimensions. For instance, while proteins are often viewed as a drawback in medical applications, they actually provide significant benefits to rubber processing and enhance certain material properties. Consequently, this study emphasizes the strategic management, optimization, and targeted utilization of these intrinsic non-rubber components. By conducting comparative analyses of natural rubber latex from different sources, the relationships between non-rubber constituents (predominantly proteins), molecular weight distribution (MWD), and the macroscopic properties of the elastomer were elucidated. The findings reveal that intrinsic protein content and distinct MWD patterns fundamentally dictate vulcanization behavior and internal networking structures. Specifically, latex characterized by elevated protein levels and a bimodal MWD demonstrates superior mechanical properties, increased green strength, and enhanced thermal stability. These enhancements occur because proteins act as natural co-activators during the curing process, fostering robust hydrogen-bonding interactions, promoting physical chain entanglements, and facilitating profound strain-induced crystallization. Ultimately, this study underscores that the deliberate management of non-rubber components transcends traditional quality control, serving as a powerful and synergistic innovation tool. By mastering these complex structure-property relationships, the industry can pioneer the design and manufacturing of novel, high-performance, and high-value elastomer products, thereby creating new economic value and redefining the future of the global natural rubber ecosystem.

Keywords: Natural Rubber; Non-Rubber Components; Carbon Footprint (CFP); High-Value Elastomers; Molecular Weight Distribution; Synergistic Innovation Management

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Ekvipoo Kalkornsurapranee

Prince of Songkla University, Thailand



Short Biography: Associate Professor Ekvipoo Kalkornsurapranee, Ph.D.

Associate Professor Ekvipoo Kalkornsurapranee, Ph.D., currently holds a position in the Division of Physical Science, Faculty of Science, Prince of Songkla University (PSU), Songkhla, Thailand. His foundational academic journey was completed at the same institution, where he earned his doctoral degree in Polymer Technology (Ph.D.) in 2013. Dr. Kalkornsurapranee immediately commenced his academic career at PSU, joining the faculty as a Lecturer in 2013. His significant contributions to research and education led to his promotion to Associate Professor in 2020. This year also marked the start of his concurrent administrative leadership role, as he took on the responsibility of Director of the Natural Rubber Innovation Research Institute (NR-IRI) at PSU, a position he continues to hold. The core of Dr. Kalkornsurapranee's research expertise is dedicated to enhancing the functional performance and commercial value of natural rubber, transforming this vital resource into advanced material solutions. His work is systematically

structured around three critical technological pillars: advanced modification techniques to significantly improve the thermal stability of natural rubber; the innovation and development of thermoplastic natural rubbers (TPVs) designed to possess processability equivalent to traditional synthetic thermoplastics; and the pioneering of novel vulcanization techniques that are both energy-efficient, utilizing lower temperatures, and chemically minimal, requiring reduced chemical content. His scholarly output reflects a career of high productivity and translational impact. Dr. Kalkornsurapranee is the author of over 60 international scientific publications and holds 20 granted patents and petty patents in Thailand, underscoring the commercial readiness of his innovations. His current focus remains highly translational, centered on the development of specialized materials derived from natural rubber, including skin barrier patches, slow-release and shape memory polymers. These applications are targeted for deployment across a diverse range of critical sectors, including the medical, toy, agricultural, forensic and sport court flooring industries.

Day 2 1640 - Image Analysis for Rubber: Quantitative Evaluation of Network Structures

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Understanding nanoscale polymer network structures in rubber is essential for exploring their connection to mechanical properties. However, the application of advanced image analysis methods, including deep learning, is constrained by the severe scarcity of annotated data. Additionally, noise inherent in electron micrographs complicates the quantitative evaluation of rubber network structures. To address these challenges, we propose an image analysis framework integrating mathematical modeling and noise reduction. We use the Hessian matrix to mathematically model and highlight local network features, effectively suppressing noise [1]. Geometric parameters extracted from the skeletonized network showed a strong correlation with mechanical properties, demonstrating the effectiveness of the proposed quantitative evaluation method.

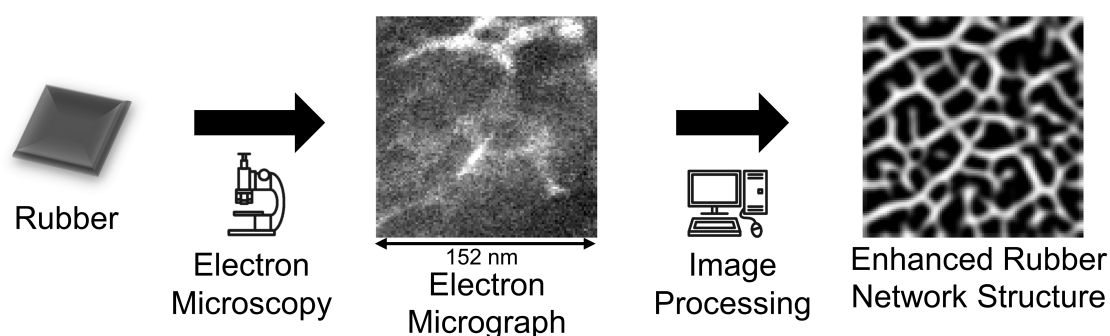


FIGURE 1. Schematic illustration of the image-processing workflow used to enhance rubber network structures from an electron micrograph.

Keywords: Rubber; Image Analysis; Mathematical Modeling; Noise Reduction; Hessian Matrix

Acknowledgments: The author expresses deep gratitude to Prof. Yasuhiko Igarashi for his invaluable guidance, and to the colleagues and management at The Yokohama Rubber Co., Ltd. for their extensive cooperation and for providing an excellent research environment.

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Masato Suzuki is a researcher in the Materials Analysis Laboratory at The Yokohama Rubber Co., Ltd., Japan. He received his Ph.D. from the University of Tsukuba. His work focuses on rubber data science based on measurement data and physical property data, with particular emphasis on image analysis of rubber materials, including electron microscopy images.

Day 2 1700 - Technical Solutions in Recycled Plastic

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In order to reduce carbon emission and certain work toward to net-zero; There is demand to use recycled materials. Global sustainability trends and regulatory pressure increase demand of using recycled plastic. However, there are technical limitations in using recycled plastic because of the product processability, performance of products in melt strength, physical of the mechanical properties in meet requirements of final product. Research Center of Innovation Group has been would on additives in improving mechanical and physical properties of recycled polyethylene, recycled polypropylene (both homo-and co-polymers) C- Boost in functional modifier to improve stiffness, impact resistance and processability in melt recycle PE, As well as P-boost we have two grades of P-Booth for homoPolymer PP and Co-polymer PP. In customers' production trials, both C-Booth and P-Booth work well in real industrial applications, supporting the transition from low-value recycled plastic toward more sustainability and circular plastic economy.

Keywords: Plastic circularity; recycled plastics; plastic modifiers; sustainable materials



Biodata:

Education

- Master's degree in Material Technology, King Mongkut's University of Technology Thonburi, Bangkok
- Bachelor's degree in Polymer Engineering, Suranaree University of Technology, Nakhon Ratchasima,

Work Experience : 10 Years-Research and Development

- Develop new products for the olefin-based plastic compound including PE and PP compounds, PP/filler, PP/Elastomer/filler, TPO/TPE compound, plastic modifiers and valuable recycle
- Develop new biodegradable products such as high heat cutlery and food container
- Provide technical support for the commercialization activities to launch the novel functional additive product for the plastic industry
- Troubleshoot problems of both production and molding relate to the plastic compound and ensure formulation run flawlessly on a production scale

Day 3 0900 - From Smart to Sustainable: Harnessing AI, SIRI and COSIRI to Shape the Future of Rubber Manufacturing

Chua Wen-Shyan

Selangor Human Resource Development Centre (SHRDC), Malaysia

The rubber industry is entering a new era where competitiveness is no longer determined solely by production capacity and cost efficiency, but increasingly by digital transformation, sustainability, and the intelligent use of artificial intelligence (AI). As global markets demand lower carbon footprints, greater supply chain transparency, and higher operational resilience, manufacturers must evaluate their readiness to embrace Industry 4.0 and sustainable manufacturing practices. This presentation explores how the Smart Industry Readiness Index (SIRI) and the Consumer Sustainability Industry Readiness Index (COSIRI) provide practical frameworks for assessing digital and sustainability maturity across rubber manufacturing operations. SIRI enables manufacturers to evaluate their readiness in process, technology, and organisational capabilities, while COSIRI measures sustainability performance across operations, energy, circularity, product stewardship, supply chains, and clean technologies. Building on these foundations, the presentation highlights how Artificial Intelligence is accelerating the transition towards Sustainable Smart Factories through predictive maintenance, intelligent quality inspection, process optimisation, energy management, and data-driven decision-making. AI not only enhances productivity and operational efficiency but also enables manufacturers to achieve measurable improvements in resource utilisation, carbon reduction, and environmental performance. By combining digital readiness, sustainability assessment, and AI adoption into a unified transformation strategy, rubber manufacturers can identify high-impact improvement opportunities, prioritise investments, and develop resilient factories that are prepared for future market expectations. The presentation will demonstrate that sustainable smart manufacturing is no longer a future aspiration but a strategic necessity for ensuring long-term competitiveness and growth in the rubber industry.

Keywords: rubber; materials; characterization; performance; sustainability



Speaker Profile:

Ts. Dr. Chua Wen-Shyan , Head of Malaysian Smart Factory 4.0, Selangor Human Resource Development Centre

Dr. Chua Wen-Shyan is currently the Head of Malaysian Smart Factory 4.0 under the Selangor Human Resource Development Centre (SHRDC). He obtained his Ph.D. in Control Systems Engineering and B.Eng. in Mechatronics Engineering from Monash University Malaysia. His key area of expertise lies mainly in the area of Control and Automation Systems, Fault Detection and Identification (FDI), and Predictive Maintenance Strategies; which are widely used in Industry 4.0 applications. He is also appointed by the Malaysia Productivity Corporation (MPC) in collaboration with the Machinery and Equipment Productivity Nexus (MEPN) as one of the mentors (advisors) for the PRODUCTIVITY1010 initiative to support the industries in their journey towards digital transformation. Dr. Chua is also certified as a Smart Industry Readiness Index (SIRI) and Consumer Sustainability Industry Readiness Index (COSIRI) Assessor and an appointed Regional Ambassador by the International Centre for Industrial Transformation (INCIT) to drive the adoption of Sustainable Smart Factories in Malaysia. In Dr. Chua also introduced the Artificial Intelligence Readiness Index (AIRI) which is part of the collaboration with AI Singapore to support industries to identify gaps in their AI adoption journey in Malaysia. As the Head of Malaysian Smart Factory 4.0, Dr. Chua and his team are focused in delivering high impact talent development programs to accelerate the growth of local talents who would be the workforce in supporting the growth of Industry 4.0. The programs developed by his team at the Malaysian Smart Factory 4.0 are also able to support the industries and community towards achieving sustainable digital transformation through high impact talent development strategies.

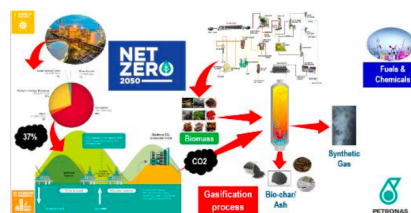
Day 3 0940 - Alternative, sustainable, and hybrid energy sources for the commercial and industrial sectors

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¹Sustainable Energy and Development Lab, Department of Mechanical Engineering, School of Engineering, Monash University Malaysia, Jalan Lagoon Selatan, 47500 Bandar Sunway, Selangor, Malaysia.

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Energy security is a critical global issue, particularly impacting the commercial and industrial sectors amid the current energy crisis. This study examines the urgent need for sustainable and hybrid energy solutions to mitigate rising operational costs and carbon emissions associated with traditional energy sources. Specific attention is given to energy-intensive industries, such as the rubber industry, which face mounting pressure to reduce their dependence on conventional grid energy while maintaining operational competitiveness. Through three case studies, the presentation highlights the role of grid-connected solar photovoltaic (GCPV) systems and alternative energy in enhancing energy efficiency and sustainability. The first case involves an electric bus depot, where an optimized 850 kWp GCPV system demonstrated a cost of energy (COE) of 0.434 MYR/kWh, significantly lower than the conventional grid's COE of 0.48 MYR/kWh. The second case assesses a 232.5 kWp GCPV system installed on a commercial building in Malaysia, which produced approximately 301.5 MWh of energy in 2019, thereby avoiding roughly 177 metric tons of CO₂ emissions. The final case focuses on the gasification of biomass for syngas production, utilizing captured CO₂ to support decarbonization goals in heavy industry by 2050. These case studies collectively illustrate the technical and economic benefits of adopting renewable energy technologies, advocating a transition to a circular economy in which sustainable energy underpins long-term industrial viability. The energy security of the rubber industry can be addressed through a hybrid, sustainable approach that integrates renewable sources, thereby reducing grid dependency, stabilizing energy costs, and advancing the industry's decarbonization trajectory in alignment with national and global sustainability targets.



Keywords: Energy security; renewable energy; Grid-Connected Solar Photovoltaic (GCPV); biomass gasification; industrial decarbonization.

Day 3 1000 - Efficient Manufacturing of Rubber Compounds

Ahmad Zafrullah Supian
HF Mixing Group Services SEA Sdn Bhd

Efficient manufacturing of rubber compounds is critical to achieving consistent product quality, reducing operational costs, and meeting increasing sustainability demands in the rubber processing industry. This presentation explores advanced mixing technologies developed by HF Mixing Group and their role in optimizing compound production.

The focus is placed on key process innovations, including improved rotor and chamber designs, intelligent temperature and energy control, and integrated automation systems that enhance dispersion quality and mixing homogeneity.

In addition, the presentation highlights how digital monitoring and data-driven process control enable predictive maintenance and real-time optimization, contributing to higher equipment availability and reduced downtime. Practical case studies demonstrate measurable improvements in productivity, material efficiency, and environmental performance.

Keynote references:

Modern process concepts such as tandem mixing systems enable optimized separation of masterbatch and final mixing stages, significantly improving throughput and process stability. Continuous mixing technologies further enhance efficiency by reducing batch dependency, enabling steady-state production, and lowering specific energy consumption.

Advanced mixing step strategies—such as optimized filler incorporation, controlled silanization phases, and precise thermal management—allow for superior dispersion and reduced compound variability. By leveraging these technologies, manufacturers can achieve shorter cycle times, improved batch-to-batch consistency, and enhanced material performance.

Keywords: Rubber; materials; characterization; performance; sustainability

Day 3 1020 - Rubber Industry Circular Alliance (RICA)

Asmipudin Ali

Bridge Fields Resources Sdn Bhd, Malaysia

The Rubber Industry Circular Alliance (RICA), presented by Bridge Fields Resources Sdn Bhd, outlines a practical circular economy model for the rubber industry centered on waste recovery, reprocessing, and value-added reuse of rubber materials. Bridge Fields Resources positions itself as an established Malaysian recycler and manufacturer, founded in 2004, with capabilities in latex reclaimed rubber, black latex and tire reclaim, and patented recycling technology for nitrile latex gloves, supported by certifications including GRS and ISO9001. The presentation defines circularity in rubber as a regenerative system that keeps materials in productive use through reuse, remanufacturing, and recycling while minimizing waste and virgin resource extraction. Key operating principles include designing rubber products for longevity and recoverability, reprocessing production scrap and off-spec rubber back into manufacturing and recovering end-of-life rubber products to create secondary raw materials for new applications.

Keywords: rubber; materials; characterization; performance; sustainability

Day 3 1100 - Sustainable Eco-EPDM Hose Compounds Reinforced with Recovered Carbon Black: Mechanical, Rheological and Ageing Performance

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Technology and Engineering Division

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Recovered carbon black (RCB), derived from the pyrolysis of end-of-life tyres, has emerged as a promising sustainable alternative to conventional carbon black in rubber compounding. This study investigates the influence of filler loading (50–150 phr) on the processing, mechanical, and thermal aging characteristics of sustainable Eco-EPDM-based hose formulations. A comparative analysis was performed between non-reinforcing carbon black (N990) and recovered carbon black (RCB; particle size: 35–90 nm, I_2 No: 15.4 mg/g) to evaluate their performance as sustainable filler in high-performance elastomer matrices. The results show that at moderate substitution levels, RCB-filled Eco-EPDM compounds exhibit comparable cure behavior, tensile strength, and hardness to N990-filled systems, while demonstrating improved elongation at break, indicating enhanced flexibility of the Eco-EPDM matrix. Ageing resistance remained within acceptable limits, confirming the suitability of Eco-EPDM for durable hose applications even with RCB incorporation. However, higher RCB loadings led to increased compound viscosity and higher compression set, particularly at elevated temperatures, which may affect long-term elastic recovery. These changes are attributed to differences in surface area, particle characteristics, and ash content between RCB and virgin carbon black. Overall, the findings demonstrate that Eco-EPDM combined with RCB can provide a sustainable material platform for hose applications, enabling partial replacement of conventional carbon black while maintaining balanced performance, provided that filler loading is carefully optimized to ensure processability, mechanical integrity, and durability.

Keywords: Recovered Carbon Black (RCB); Eco-EPDM; ageing resistance; sustainable material

Day 3 1120 - Acoustical Performance of Dry and Liquid Epoxidized Natural Rubber (ENR) Foams

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Malaysian Rubber Board

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The present study aims to investigate the noise control capabilities of dry and liquid rubber foams produced from epoxidized natural rubber (ENR), due to its excellent properties in damping. The acoustical efficiencies of these ENR-based foams were compared against a commercially available acoustic foam, ethylene-propylene-diene monomer (EPDM). The results demonstrate that the foam type significantly influences noise control performance. Specifically, dry and liquid rubber foams reached a sound transmission loss of 15 dB at frequencies of 500 Hz and 1500 Hz, respectively. In contrast, the commercial EPDM foam only achieved the same 15 dB threshold at a higher frequency of 2500 Hz. These differences are attributed to the physical and microstructural properties of the foams. Therefore, this study provides valuable insights for designing dry and liquid rubber foams with optimized non-acoustical parameters to meet specific noise control requirements in various sectors, including automotive, locomotive, and household applications.

Keywords: Dry rubber; liquid rubber; foam; noise; transmission loss.

Day 3 1140 - Determination of Heavy Metals in Rubber Gloves using Atomic Absorption Spectroscopy based on The ISO 6101 Series: Ensuring Safety and Compliance

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The determination of heavy metals in industrial rubber gloves is essential for ensuring product safety, regulatory surveillance, and compliance with international market requirements. Heavy metals such as lead (Pb), zinc (Zn) and manganese (Mn) may be introduced during rubber compounding through pigments, stabilisers, fillers, and vulcanisation activators. While certain metals play functional roles in rubber processing, excessive concentrations may pose toxicological risks and potentially compromise compliance with Malaysian and international regulatory standards. This study presents the determination of selected heavy metals in industrial rubber gloves using Atomic Absorption Spectroscopy (AAS) based on procedures from the ISO 6101 series for metal analysis in rubber materials. Samples were subjected to nitric acid digestion under controlled reflux conditions to achieve complete mineralisation of the rubber matrix, followed by filtration, dilution with ultrapure water, and elemental quantification using flame AAS. Method validation was conducted in accordance with the requirements of ISO/IEC 17025, including evaluation of calibration linearity, limits of detection (LOD), limits of quantification (LOQ), repeatability, intermediate precision, spike recovery, and estimation of measurement uncertainty. The method demonstrated excellent linearity ($R^2 > 0.995$), recoveries between 80–110%, and relative standard deviations below 5%. The results demonstrate that AAS provides a robust, reliable, and cost effective analytical approach for heavy metal analysis in rubber gloves. The adoption of internationally recognised analytical standards within an accredited laboratory framework strengthens regulatory oversight and reinforces global confidence in the safety and compliance of Malaysia's rubber glove industry.

Keywords: Atomic Absorption Spectroscopy (AAS); heavy metals; rubber gloves; safety and compliance

Day 3 1200 - Preparation of Soluble Highly Branched Polyisoprene by Anionic Polymerisation

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Highly branched polymers have better solubility, lower viscosity, and easier processing compared to linear polymers. In this study, highly branched polyisoprene was successfully synthesised using anionic polymerisation based on the modified “Strathclyde route”. Isoprene was copolymerised with divinylbenzene (DVB) using *sec*-butyllithium as initiator in toluene solvent. Tetramethylethylenediamine (TMEDA) was added to promote chain transfer reactions and reduce gel formation during polymerisation (see **FIGURE 1**). The effects of TMEDA and DVB concentrations on the polymer properties were studied. The results showed that soluble highly branched polyisoprene could be produced successfully at suitable DVB and TMEDA ratios. Higher DVB content increased branching but excessive DVB caused gelation. Size exclusion chromatography confirmed the formation of branched polymers through broader molecular weight distributions compared to linear polyisoprene. ¹H NMR analysis showed that the polymers mainly contained 3,4-polyisoprene microstructure. Thermal analysis indicated that the glass transition temperature increased with increasing branching density and molecular weight. Rheological studies demonstrated that the branched polymers had lower viscosity than linear polymers due to reduced chain entanglement. The polymers also showed good shear thinning behaviour, indicating better processability. In conclusion, highly branched polyisoprene was successfully synthesised through anionic polymerisation using DVB and TMEDA. The modified method reduced gelation while maintaining branching formation. The resulting polymers showed improved rheological properties and have potential for advanced polymer applications.

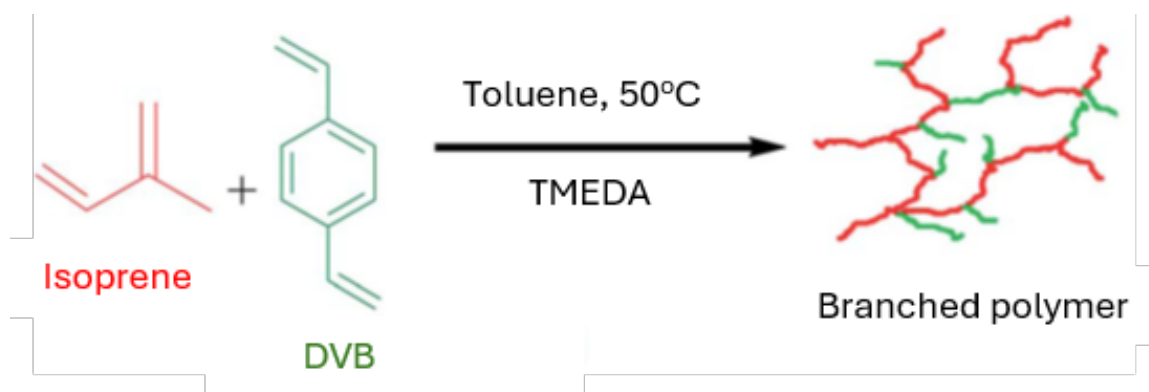


FIGURE 1. Synthetic route for the preparation of branched poly(isoprene) via anionic polymerization.

Keywords: Highly branched polymer; Soluble polyisoprene; Anionic polymerisation; Divinylbenzene (DVB); Tetramethylethylenediamine (TMEDA).

Acknowledgments: This research was financially supported by Universiti Malaya through the UM Frontier Research Grant (FG042-17AFR) and by the Ministry of Education (MOE) through the Fundamental Research Grant Scheme (FRGS) (FP136-2019A). The authors also thank the Department of Chemistry, Faculty of Science, Universiti Malaya, for providing the research facilities.

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Day 3 1220 - Five (5) Years Field Performance Assessment of Cuplump Modified Asphalt (CMA) at a High Traffic Load Pavement

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The most critical issue in Malaysia that the pavement failures at high traffic route was due to the bituminous layer aging subjected to extreme long loading times by the slow moving heavy commercial vehicles. This continuous scenario had caused major structural deteriorations and permanent deformation of the bituminous pavement surface. Bitumen modification provided potential solution to the issue, where the use of natural rubber helps in enhancing the properties of the bitumen. Malaysian Rubber Board (MRB) had developed Cuplump Modified Bitumen (CMB), an innovative product that used cuplump rubber as an additive in neat 60/70 bitumen to increase the durability of the pavement. Recent studies show that CMB complies with the specification of Polymer Modified Asphalt and Natural Rubber Modified Asphalt as per Standard Specification for Road Works by Public Works Department (PWD). A study conducted by MRB and PWD to assess the field performance of Cuplump Modified Asphalt (CMA) – an asphaltic concrete made of a mixture CMB with aggregates; and the pavement area selected is FT10 Jalan Gemas – Rompin, Tampin, Negeri Sembilan. Comparison study between CMA and asphaltic concrete (AC) 14; including the mix design, construction method and performance monitoring. The results show that after 58 months CMA is durable, where the resistance to crack and rutting formation is slightly better than AC14. Continuous field assessment is needed to define CMA long-term performance advantages over AC14 pavement.

Keywords: Rubber; materials; characterization; performance; sustainability

Day 3 1400 - Eco-Friendly Organosilane Material for Surface Pretreatment to Enhance Adhesion and Corrosion Resistance in Rubber–Metal Bonding Systems

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In recent years, the replacement of chromate-based metal surface pretreatments has become increasingly important due to environmental and health hazards. As a safer alternative, organosilane-based surface pretreatments have attracted significant attention for their ability to enhance interfacial adhesion and provide high corrosion resistance of organic coatings. In this study, Bis-[3-(triethoxysilyl)propyl]tetrasulfide (TESPT) was used to modify the surface of mild steel, and its potential as an eco-friendly surface pre-treatment for rubber-to-metal bonding systems was evaluated. The properties of the TESPT pretreated surface were evaluated using adhesion testing, contact angle, Fourier Transform Infrared (FTIR) spectroscopy and Electrochemical Impedance Spectroscopy (EIS). The results indicated that TESPT silane significantly enhanced the adhesion strength of Chemlok 205 on mild steel substrates compared to untreated samples. This improvement is attributed to the increased surface energy and the formation of siloxane networks that promote interfacial bonding. The corrosion resistance of TESPT pretreated samples showed only moderate improvement with inhibition efficiency maximum up to 50% under different conditions, suggesting limitations in barrier performance under aggressive conditions. Despite this, the overall findings demonstrate that organosilane-based treatments provide a promising and environmentally sustainable alternative to conventional chromate systems.

Acknowledgments

The authors gratefully acknowledge the Malaysian Rubber Board (MRB) for its technical support, access to research facilities and valuable contributions to this work. Appreciation is also extended to the UKRP team for their assistance and collaborative support throughout the research. Their combined expertise and contributions have been instrumental in facilitating the successful execution of this research.

Keywords: Organosilane; rubber-metal bonding; surface treatment; eco-friendly material

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Day 3 1420 - Epoxy-Modified Chlorinated Rubber Primer for Rubber-To-Metal Bonding Systems in Marine Environments

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Engineering Design and Product Development Unit

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Rubber-to-metal bonded components are widely used in various engineering applications. However, their long-term reliability is significantly reduced in aggressive marine environments due to interfacial degradation of the bonding systems. A key factor is the generation of hydroxyl ions during corrosion reactions at the exposed metal, which degrades the chlorinated rubber-based primer and consequently weakens adhesion at the rubber-metal interface. Despite the widespread industrial use of chlorinated rubber primers, their stability under alkaline conditions and cathodic disbonding remains insufficiently studied, and effective modification strategies to mitigate degradation are limited. In this study, an industrial chlorinated rubber-based primer was modified with epoxy resin to enhance its resistance to hydroxyl-induced degradation. The modified primers were evaluated through pull-off adhesion, alkaline exposure, and cathodic disbonding tests to simulate harsh service conditions. In parallel, Fourier Transform Infrared (FTIR) spectroscopy was used to elucidate the underlying degradation mechanisms at the molecular level. The results indicated that epoxy incorporation promotes stronger chemical bonding at the primer/metal interface, resulting in increased adhesion strength compared to the unmodified control. Additionally, the modified primer exhibited significantly greater resistance to hydroxyl-ion attack, attributable to its lower permeability to aggressive species and enhanced chemical stability at the interface. Spectroscopic analysis showed that adhesion failure in the unmodified primer after exposure to hydroxyl-rich ions was primarily due to bulk coating degradation, whereas the epoxy-modified primer failed primarily via alkaline hydrolysis. These findings demonstrate that epoxy modification significantly enhances coating integrity and barrier performance, resulting in improved resistance to hydroxyl ion attack and reduced adhesion failure.

Keywords: Rubber-to-metal bonding; marine environment; primer coating; corrosion; adhesion

Day 3 1440 - Assessing the Changes in Structural Integrity and Thermal Stability of Nitrile-Biofiller Film Under Soil Burial

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The disposal of polymeric waste, particularly single-use nitrile gloves following the COVID-19 pandemic, poses a severe environmental challenge due to their resistance to natural decomposition. To address this issue, we assessed the biodegradation of nitrile films incorporated with a biofiller over an 18-month soil burial period. The degradation process was evaluated by analyzing the structural and physical properties of the nitrile films. The thermal stability changes due to incorporation of biofiller was also assessed. Atomic Force Microscopy (AFM) was utilized to examine surface topographic changes. The AFM analysis revealed that chemical degradation led to physical deterioration, determined by heterogeneous surface erosion (cracks and protrusions) and microbial's activities indentation, which significantly altered surface roughness (Ra and Rq) profiles. Supporting this structural and thermal disruption, physical property assessments after the 18-month burial revealed that the crosslinking density of all films exhibited a distinct negative linear correlation with exposure time, confirming polymer chain scission and crosslink cleavage. Thermogravimetric Analysis (TGA) demonstrated the thermal stability is not influenced by the biofiller incorporation. Ultimately, these findings indicated that incorporating a biofiller effectively promotes the structural breakdown of nitrile films under appropriate soil conditions while thermal stability is not negatively affected, thus offering a viable pathway for mitigating rubber waste.

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Keywords: Biodegradability; Nitrile; Biofiller; AFM; TGA

Day 3 1500 - Surface-Modified Natural Fibers in Natural Rubber Composites

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The blending of polymers with natural fibres has received growing attention due to their potential in sustainable and eco-friendly material development. Composites made from natural rubber (NR) and lignocellulosic fibres such as oil palm empty fruit bunch (EFB) offer promising prospects, yet challenges remain in improving their interfacial compatibility and mechanical performance. This study aimed to investigate the structural, mechanical, thermal, morphological, biodegradability, and acoustic properties of NR/EFB composites reinforced with surface-functionalized EFB fibres. The fibres were treated using a combination of alkali and silane coupling agents— γ -aminopropyltrimethoxysilane, γ -chloropropyltrimethoxysilane, γ -glycidoxypyltrimethoxysilane, and γ -mercaptopropyltrimethoxysilane—prior to compounding with NR on a two-roll mill and vulcanization via hot pressing. Characterisation included tensile testing, FTIR, SEM, TGA, soil burial for biodegradation, and sound absorption testing using the Kundt tube method. Numerical models (ROM, MROM, Halpin-Tsai, Modified Guth, and Modified Bowyer & Bader) were applied to predict Young's modulus and correlated with experimental results. The glycidoxypyltrimethoxysilane-treated fibres produced the best mechanical reinforcement, achieving a Young's modulus of 0.0244 GPa in composites with 20 phr of medium-length fibres. Morphological analysis revealed strong fibre-matrix interaction with minimal voids. Biodegradability tests showed reduced weight loss for treated fibres, indicating improved environmental resistance. Thermal stability remained comparable across all composites. Notably, the treated composite exhibited enhanced sound absorption at 800 Hz and 1,000 Hz, suggesting its suitability for noise-dampening applications. Given the growing demand for lightweight, bio-based acoustic materials, these NR/EFB composites show promising potential for use in interior paneling and insulation in aerospace and transportation sectors.

Keywords: natural rubber; natural fiber; surface-modify; silane.



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P1 - Enhancing the Physicochemical Properties of Carboxylated Nitrile Butadiene Rubber Using Palm-Based Nanocellulose

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The growing demand for sustainable materials has driven interest in replacing synthetic additives in rubber products with renewable, bio-based alternatives. This study investigates the utilisation of cellulose nanocrystals (CNCs) extracted from palm oil empty fruit bunch (EFB) as a green reinforcing nanofiller for carboxylated nitrile butadiene rubber (XNBR) film. This study aimed to evaluate the effect of EFB-derived CNC on the mechanical, chemical and morphological properties of XNBR films as well as to assess the feasibility of developing a CNC/XNBR glove prototype. Mechanical testing revealed substantial enhancement in tensile properties, with the optimum CNC loading of 0.15 phr achieving a remarkable 324% improvement in tensile strength compared with neat XNBR. This improvement indicates strong rubber–filler interactions and uniform CNC dispersion within the matrix. FTIR analysis indicated hydroxyl-rich CNC incorporation via H-bonding without altering the C=C bonds of XNBR. Morphological studies revealed uniform CNC dispersion and smoother film surfaces at lower concentrations, while excessive loading led to agglomeration and reduced reinforcement efficiency. In our laboratory, glove prototypes containing 0.15 phr CNC were successfully fabricated and met the ASTM D5151 requirements for watertightness and dimensions. These findings demonstrate that EFB-derived CNC is a sustainable and promising nanofiller for producing high-performance next-generation nitrile gloves while promoting circular bioeconomy practices.

Keywords: Nitrile butadiene rubber; Cellulose nanocrystals; Empty fruit bunch; Strength; Nitrile gloves.



Karen Ng is a PhD candidate in Chemical Engineering at Monash University Malaysia, where her research focuses on developing sustainable self-healing XNBR nanocomposites reinforced with cellulose nanofibers for advanced nitrile glove applications. Her interests include polymer composites, nanocellulose and green materials for more sustainable rubber products. She aims to translate academic research into practical industrial solutions that improve glove durability, performance, and environmental sustainability.

P2 - Advanced Moisturising Gloves with N-Acetylneuraminic Acid (NANA) for Sustained Skin Hydration

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Keywords: Moisturising gloves; dry skin; contact dermatitis; hydrating; skin barrier

Occupational skin dryness is a persistent problem among healthcare and other glove-dependent workers, arising from prolonged glove wear and frequent hand hygiene, which disrupts the skin barrier and exacerbates post-occlusive moisture loss. This study evaluates the incorporation of N-acetylneuraminic acid (NANA), a natural sialic acid found in edible bird's nest, into a glove coating to provide sustained skin hydration during use. NANA was incorporated into a water-based acrylic polymer containing propylene glycol (PG) and applied to natural rubber latex films via a simple dipping process, yielding a stable, uniform, and hydrophilic coating. The coating showed a fast-acting hydration profile suitable for frequently changed gloves: it absorbed water within 4 minutes, effectively rehydrating the surface and releasing NANA; delivered NANA into the epidermis and increased water retention by 14% within 1 hour, indicating rapid penetration and moisturization. In a human-wear study, the coated gloves reduced skin water loss by 13%, with 70% of participants reporting a noticeable improvement in skin condition. These findings demonstrate a clear translation from NANA's molecular bioactivity to coating performance and human efficacy, supporting its application as a practical strategy to mitigate glove-associated skin dryness in real-world use.

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P3 - Starch-Based Biopolymers as Sustainable Alternatives: A Review

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Keywords: Starch; Biopolymer; Sustainable; Biodegradable; Agricultural Source.

The growing demand for sustainable materials has encouraged the exploration of biopolymers as renewable alternatives to conventional polymers. Among these materials, starch has attracted considerable attention due to its abundance, biodegradability, low cost, and availability from various agricultural sources (see **FIGURE 1**). However, the direct use of starch remains challenging because of its hydrophilic nature and potential processing limitations. This review discusses the potential of starch-based biopolymers as sustainable components in polymer applications. The study focuses on the role of starch as a bio-based filler, reinforcing agent, biodegradable phase, and potential modifier in polymeric material systems. Attention is given to the compatibility challenges between starch and polymer matrices, as well as strategies used to improve interfacial adhesion, including surface modification, compatibilization, and hybridization with other natural fillers. Starch-based materials show significant potential for the development of more sustainable polymers, particularly in applications where partial renewability and reduced dependence on petroleum-based materials are desirable from an environmental perspective. Nevertheless, further research is needed to balance sustainability with mechanical durability, moisture resistance, processing stability, and long-term performance. This review highlights current opportunities, limitations, and future perspectives for incorporating starch-based materials into sustainable polymer applications and technologies.

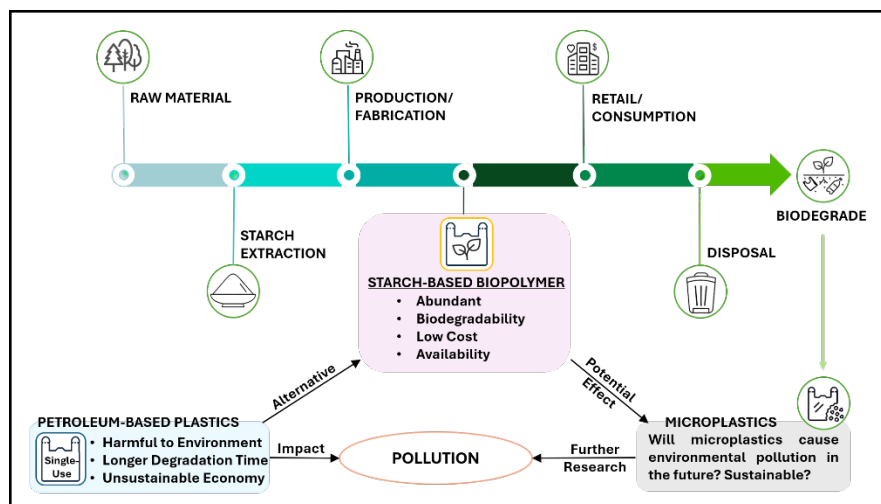


FIGURE 1. The graphical abstract of this study.

ACKNOWLEDGEMENTS

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P4 - Effects of 18-Crown-6 on the Living Anionic Polymerization of Poly(Methyl Methacrylate) at Ambient Temperature

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Keywords: Living anionic polymerization; Poly(methyl methacrylate); End-functionalization; Azobenzene

Poly(methyl methacrylate) (PMMA) is a versatile thermoplastic renowned for its optical clarity, UV stability, and processability. The design of polymers with controlled architecture and end-functionalization is critical for tailoring properties to specific applications. Azobenzene end-functionalized PMMA merges PMMA's structural advantages with the photoresponsive characteristics of azobenzene, which undergoes reversible *trans*–*cis* photoisomerization under specific wavelengths of light. This enables dynamic control over material properties including shape, surface topology, and optical behavior, making such polymers promising candidates for light-responsive coatings, optical data storage, and stimuli-responsive smart materials. Methyl methacrylate (MMA) was polymerized via living anionic polymerization under inert, anhydrous conditions using Schlenk techniques in dry THF. Potassium *tert*-butoxide (*t*-BuOK) served as the initiator, with and without 18-crown-6 ether as a chelating agent to assess its influence on polymerization control (see **FIGURE 1**). Targeted number-average molecular weights (M_n) of 5,000–50,000 g mol⁻¹ were explored. GPC analysis revealed that PMMA synthesized without crown ether maintained relatively narrow dispersities ($\bar{D}$ = 1.138–1.446) with molecular weights close to target values. In contrast, the addition of 18-crown-6 ether at all crown ether-to-initiator ratios resulted in markedly elevated molecular weights and broad dispersities ($\bar{D}$ up to 4.603), indicating loss of living character. One sample from the 2:1 system formed ultra-high molecular weight species or aggregates unable to pass through a 0.2 μ m syringe filter. These findings suggest that crown ether promotes uncontrolled chain propagation rather than improving ion-pair dissociation under these conditions. The addition of 18-crown-6 ether does not improve control over PMMA synthesis via living anionic polymerization. Instead, it leads to significantly higher molecular weights and broader dispersities. Crown ether was therefore excluded from subsequent azobenzene end-functionalized PMMA syntheses. Future work will focus on designing two azobenzene derivatives (AZO1 and AZO2) for end-functionalization, as well as characterizing the photoresponsive behaviour of AZO1- and AZO2-functionalized PMMA and evaluating their potential for application in stimuli-responsive and smart material systems.

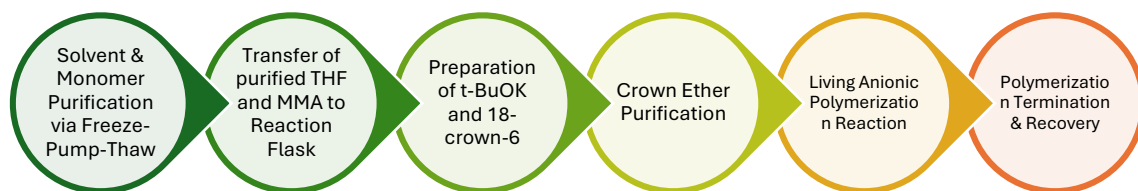


FIGURE 1. Methodology for investigating the effect of crown ether on the living anionic polymerization of PMMA.

Acknowledgments

This research was financially supported by the Ministry of Higher Education Malaysia under the Fundamental Research Grant Scheme [FRGS/1/2023/STG04/UM/02/22; Project Number: FP064-2023]. The authors also thank the Department of Chemistry, Faculty of Science, Universiti Malaya for providing the research facilities.

P5 - Effect of Polyurethane with Various Carbon-based Fillers on Tensile Properties for Surface Coating Applications

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Keywords: polyurethane, carbon-based fillers, tensile testing, coatings.

Polyurethane (PU) made from polycaprolactone (PCL) and palm oil polyol offers promising prospects, yet challenges remain in improving their mechanical performance. The incorporation of fillers in PU has garnered increasing demand due to its potential for developing sustainable materials while enhancing the mechanical properties. To achieve standard measurement for coatings in automotive sectors, the selection of appropriate materials should be considered. Thus, this study aimed to identify the ideal carbon-based filler that balances the strength and flexibility of the PU. Tensile testing was conducted on PU/carbon-based filler films at three different concentrations (0.5 phr, 1.0 phr, and 1.5 phr). Given the growing demand for bio-based materials and enhanced functionalities, these PU/carbon-based fillers composites show promising potential for use in coatings in automobile sectors.

P6 - Smart Sustainable Outerwear from Recycled Plastic Bags: An Innovative Waste-to-Product Solution

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Keywords: Recycled HDPE; Plastic Bag Waste; Sustainable Fashion; Multifunctional Outerwear; Circular Economy

Plastic bag waste has emerged as a significant environmental challenge due to its extensive use and low biodegradability. Simultaneously, the textile and fashion industries are under increasing pressure to adopt sustainable materials and circular economy practices. This study aimed to develop a transformable multifunctional vest from recycled High-Density Polyethylene (HDPE) plastic bags and evaluate its physical, mechanical, and consumer acceptance performance as a sustainable fashion product. Recycled HDPE plastic bags were cleaned, processed, and fabricated into sheet materials consisting of three different layer configurations: 4, 8, and 12 layers. The fabricated materials were characterized in terms of thickness, weight, density, tensile strength, and tearing strength. A multifunctional vest prototype with a vest-to-bag transformable feature was subsequently developed. Consumer acceptance was assessed through a survey involving 30 respondents to evaluate the product's functionality, usability, and sustainability appeal. The results revealed that increasing the number of HDPE layers led to higher thickness, weight, and tearing strength. The 12-layer configuration exhibited the highest tearing strength of 33.19 N, indicating superior resistance to propagation of tears. In contrast, the 4-layer sample demonstrated the highest tensile strength of 4.51 MPa. Among the tested configurations, the 8-layer material provided the most balanced combination of mechanical performance, durability, flexibility, and wearer comfort, making it the most suitable candidate for multifunctional outerwear applications. Consumer feedback indicated a positive perception of the product, particularly regarding its sustainable concept, innovative design, and transformable functionality.



Nur Yasmin Hanani Binti Mohd Khairani is a Bachelor of Textile and Clothing Technology (Hons.) graduate from Universiti Teknologi MARA (UiTM), Faculty of Applied Sciences. Her academic interests include fashion and apparel design, textile innovation, sustainable materials, and circular fashion practices. Throughout her undergraduate studies, she consistently demonstrated academic excellence and was awarded the Dean's List Award. She successfully graduated with First Class Honours. The research presented in this study was conducted as part of her Final Year Project, which focused on the development of a transformable multifunctional vest from recycled High-Density Polyethylene (HDPE) plastic bags as a sustainable fashion solution. Through this project, she explored the potential of converting plastic waste into value-added wearable products that promote environmental sustainability and innovative design. Her work reflects her commitment to advancing sustainable practices within the textile and fashion industry.

P7 - Physicomechanical Performance and Aging Behavior of Polycarbodiimide-Cross- Linked Accelerator-Free Carboxylated Nitrile Butadiene Rubber Latex Gloves

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Keywords: Carboxylated Nitrile Butadiene Rubber; Accelerator-free crosslinker; Polycarbodiimide (PCDI); Low-temperature curing; Film thickness

Accelerator-free (AF) Carboxylated Nitrile Butadiene Rubber (XNBR) glove systems have been proposed as safer alternatives to conventional accelerator-based formulations; however, prior studies are largely restricted to isolated latex grades or single curing conditions, limiting confidence in industrial robustness and scalability. This study presents the extended systematic evaluation of polycarbodiimide/zinc oxide (PCDI/ZnO)-crosslinked accelerator-free carboxylated acrylonitrile butadiene rubber (XNBR) gloves across key manufacturing variables governing real-world performance. Gloves of three controlled thicknesses (55, 70, and 90 μm), produced from latex grades with varying acrylonitrile content, are cured over a wide temperature range (65, 90 and 110°C) to elucidate structure–processing–performance relationships. Mechanical integrity is comprehensively assessed according to ASTM D6319 requirements. Notably, the results demonstrate that AF XNBR gloves can achieve compliant performance even under low-temperature curing conditions, challenging the prevailing assumption that high thermal input is essential. These findings establish the practical sufficiency and industrial viability of PCDI/ZnO-based AF systems, providing a robust framework for optimization and large-scale adoption.

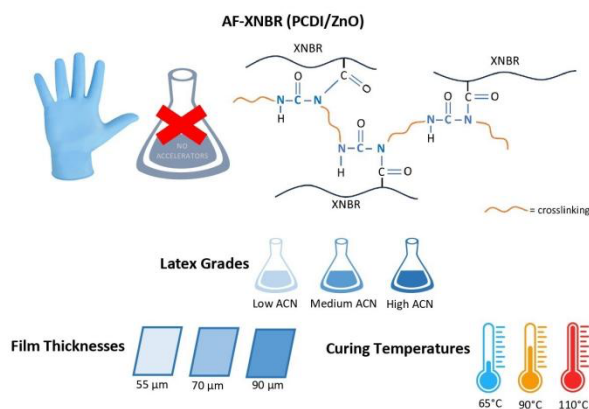


FIGURE 1. Graphical abstract

P8 - Nitrogen Removal by *Ganoderma lucidum* Pellets

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Keywords: Nitrogen; Ganoderma; pellets; nitrate; nirate

In recent years, anthropogenic activities have significantly increased the production and release of reactive nitrogen compounds into the environment, leading to serious ecological and water quality concerns. In this study, *Ganoderma lucidum* was investigated for the potential to reduce nitrogen content in wastewater systems. Aerobic batch experiment was conducted to evaluate the nitrogen removal performances in synthetic wastewater. Pure culture of *G. lucidum* was maintained on malt extract agar (MEA) plates at 25 °C, and actively growing mycelia from 9-day-old cultures was used for inoculum preparation. For submerged cultivation, mycelial pellets were generated by inoculating agar plugs into potato dextrose broth (PDB) followed by incubation at 25 °C under shaking conditions of 100 rpm for 7–10 days. A batch aerated 2L reactor was set up to study the ammoniacal nitrogen (NH₄⁺-N) removal at pH5.5. The initial nitrogen loading and chemical oxygen demand (COD) loading were 30 mg/L NH₄⁺-N and 11400 mg/L, respectively. Results showed 96.31% ammoniacal nitrogen (NH₄⁺-N) removal and 43.69% COD reduction at 48h. Nitrite (NO₂-N) and nitrate (NO₃-N) were detected at 5 mg/L and 11.2 mg/L, respectively at 48h. The accumulation of nitrate following ammonium depletion indicated heterotrophic nitrification activity. Additionally, biomass dry cell weight increased 13.51% compared to initial dry cell weight at 48h. The results strongly suggested nitrogen assimilation into *G. lucidum* pellets. Further enzymatic assays (glutamine synthase and glutamate dehydrogenase) can be carried out to confirm the heterotrophic nitrification activity. The findings of this study will serve as a fundamental understanding of nitrogen biotransformation in *G. lucidum* as well as one of the promising sustainable biological approaches to reduce nitrogen pollution.



Dong Siew Feng graduated with BSc Biotechnology degree from Universiti Putra Malaysia (UPM). She is currently a Research Graduate Student in the Faculty of Chemical Engineering and Technology, Universiti Malaysia Perlis (UniMAP). She is studying for the MSc of Bioprocess Engineering programme under the supervision of Senior Lecturer Dr. Noorulnajwa Diyana Yaacob. Her postgraduate study focuses on mycoremediation using edible and medicinal mushroom in pollutants detoxication and biotransformation.

P9 - Sustainable Agricultural Mulch Films: Enhanced Flexibility of PLA/TPU/Natural Fiber Composites

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Keywords: Degradable Mulch Film, Polylactic Acid, Thermoplastic Polyurethane.

Biodegradable mulch films are increasingly explored as sustainable alternatives to conventional plastic films in agriculture. While polylactic acid (PLA) offers environmental advantages, its widespread adoption is hindered by inherent brittleness and low durability. This study investigates the properties of PLA blended with thermoplastic polyurethane (TPU) and reinforced with natural fillers and activated carbon to enhance mechanical strength, flexibility, and degradability. The composites were prepared via a solvent casting method. To optimize formulation, mechanical testing was conducted using a Universal Testing Machine (UTM) to screen different concentrations of PLA and TPU blend ranging from 1 wt% to 5 wt%. Subsequently, different natural fibre types including kenaf fibre, carboxymethyl cellulose (CMC), microcrystalline cellulose (MCC), and cellulose were evaluated at a fixed concentration of 3 wt%. This systematic approach identified the optimum filler type and concentration required to maximize both tensile strength and flexibility. Given the growing demand for eco-friendly materials, this research directly demonstrates significant potential for commercial agricultural application.

P10 - Characterization Of Polylactic Acid/Fiber Composites for Cosmetic Patch

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Keywords: Cosmetic patch, Polylactic Acid, Cellulose, Microcrystalline cellulose, Carboxymethyl cellulose

Polylactic Acid (PLA) is a biodegradable polymer derived from renewable resources, offering a sustainable alternative to conventional plastics. Despite its environmental benefits, PLA faces challenges, particularly its limited mechanical strength in patch applications. This study aims to develop a strong patch from PLA reinforced with fibers, including cellulose, microcrystalline cellulose, and carboxymethyl cellulose, at two different thicknesses (100 μm and 200 μm) using the solution casting method. The incorporation of these fibers enhances the mechanical strength of the composite. The developed composite will be characterized and analyzed using tensile testing, structural and morphological characterization, thermal analysis, biodegradability testing, and stability assessment. This study aligns with the growing emphasis on the development of sustainable and eco-friendly materials for patch applications.

P11 - Development of Sustainable Antimicrobial Latex Films for Stethoscope Diaphragm Cover Applications

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Keywords: Natural rubber (NR) latex; synthetic polyisoprene latex; antimicrobial agents; latex dipping process.

Healthcare-associated infections remain a significant concern due to the repeated use of medical devices that frequently contact multiple patients. Among these devices, the stethoscope diaphragm has been identified as a potential source of bacterial cross-contamination, highlighting the need for effective antimicrobial protective materials. This study developed sustainable antimicrobial latex films based on natural rubber (NR) and synthetic polyisoprene (PI) latex for stethoscope diaphragm cover applications using a latex dipping process. Mangosteen peel powder (MPP), a renewable bio-based antimicrobial, and zinc oxide nanoparticles (ZnONPs) were incorporated at 1 and 2 phr to evaluate their effects on film performance. A customized stethoscope diaphragm former was designed to produce uniform latex covers under optimized dipping conditions. The prepared films were characterized for mechanical properties, swelling behaviour, crosslink density, and antibacterial performance against Gram-negative bacteria using the agar diffusion method, while surface morphology and bacterial attachment were examined using scanning electron microscopy (SEM). The results showed that NR latex films exhibited superior tensile strength, tear strength, and crosslink density compared with PI latex films. ZnONPs at 2 phr provided the best overall balance between mechanical integrity and antibacterial performance, whereas MPP demonstrated the feasibility of incorporating a sustainable plant-derived antimicrobial into latex formulations. SEM observations confirmed reduced bacterial attachment and suppression of early-stage biofilm formation on antimicrobial-treated films. The findings demonstrate that antimicrobial functionalization can be successfully integrated into conventional latex dipping technology while maintaining desirable film performance. This work provides a practical strategy for developing functional latex products with potential applications in infection control and advanced rubber engineering.

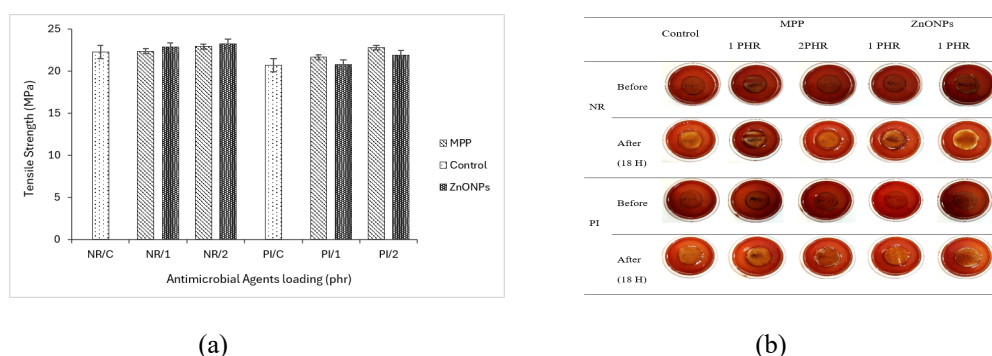


FIGURE 1. The (a) tensile strength and (b) antimicrobial activity of control and antimicrobial NR and PI latex films at different antimicrobial agents loading

P12 - Investigation of Ageing and Weathering Properties of Self-Healing Rubber

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Keywords: Natural rubber; Self-healing rubber properties; Ageing; Weathering.

Self-healing natural rubber has emerged as a promising material for enhancing the durability and service life of automotive tyres by enabling autonomous repair of mechanical damage. However, its long-term performance is often compromised by thermal ageing and environmental weathering, which reduce mechanical properties and healing efficiency. This study investigates the effects of thermal ageing and natural weathering on self-healing natural rubber and evaluates the effectiveness of different antioxidants in improving its ageing resistance. Self-healing rubber compounds containing various antioxidant systems were prepared and characterized through cure analysis, tensile testing, Shore A hardness, puncture-proof evaluation, healing efficiency assessment, and scanning electron microscopy (SEM). The samples were exposed to different ageing conditions to simulate long-term service environments, and all experiments were performed in triplicate to ensure reliable and reproducible results. The results demonstrate that ageing significantly affects the mechanical integrity and self-healing performance of natural rubber. The incorporation of antioxidants effectively improved resistance to oxidative degradation, although their performance varied depending on the antioxidant type. An optimum antioxidant system successfully balanced ageing resistance with sufficient polymer chain mobility, preserving both mechanical strength and self-healing capability. This study provides valuable insights into the design of durable self-healing rubber materials for sustainable, puncture-resistant tyre applications and other advanced elastomeric products.

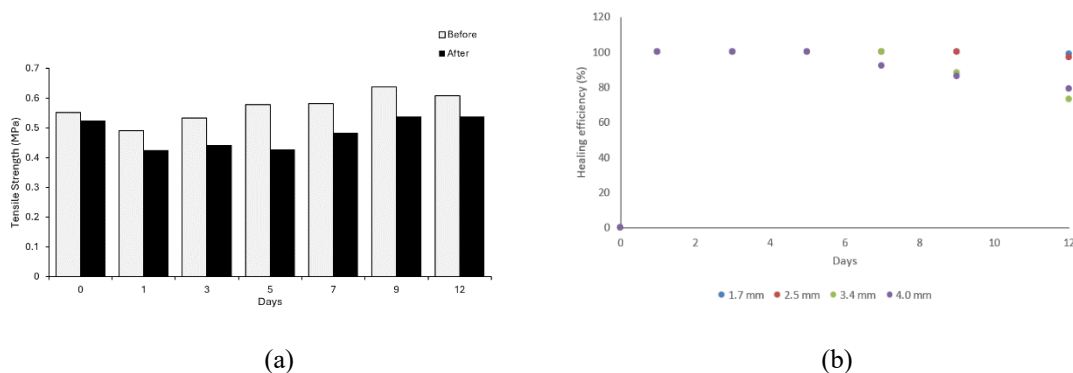


FIGURE 1. The tensile strength and the self-healing efficiency of natural rubber with TMQ as its antioxidant.

P13 - Development and Evaluation of High-Acyl Gellan Gum-Based Biopolymer Coatings for Sustainable Paper Food Packaging: Formulation Optimization, Environmental Assessment, and Food Storage Applications

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Keywords: Biopolymer coatings; Freeze-thaw stability; Biodegradability; Bread storage; Water vapour permeability

Growing environmental concerns over plastic waste have accelerated the search for sustainable alternatives to conventional food packaging. This study investigated the suitability of biopolymer-based coatings composed of gellan gum/nanofibrillated cellulose (GGNFC) and gellan gum/zein (GGZ) as eco-friendly food-packaging materials to replace conventional synthetic packaging. To assess their stability and performance under temperature variations encountered during storage and transportation, single- and bilayer-coated papers prepared at room temperature and 45 °C were subjected to freeze-thaw (FT) cycling. FTIR analysis revealed changes in hydrogen-bonding interactions after FT exposure, indicating structural rearrangements within the coating matrix. These changes influenced barrier and mechanical properties, with the lowest water vapour permeability (WVP) generally observed at the 4th cycle, suggesting temporary densification before structural loosening at higher FT cycles. GGZ-containing coatings (single and bilayer) showed greater FT stability, with better retention of tensile strength and WVP over 8 FT cycles than GGNFC coatings, attributed to polysaccharide-protein interactions and redistribution of bound and free water. Coatings dried at 45 °C exhibited improved mechanical stability due to a denser network formed via faster solvent evaporation and enhanced polymer chain organisation. These formulations were further evaluated in storage studies using bread as a high-moisture food model, respectively. Bread packaging systems showed greater fluctuations in WVP and mechanical properties due to continuous moisture migration and plasticization. Overall, bilayer-coated papers, particularly GGZ-containing coatings, demonstrated reduced fluctuations in barrier and tensile properties and improved regulation of food moisture content, water activity, and texture during storage. Soil burial testing confirmed that the biopolymer-coated papers were biodegradable, demonstrating a balance between enhanced performance and environmental degradability. In addition, toxicity screening using *Galleria mellonella* showed no significant acute toxicity (100% survival at 72 h), although minor sublethal stress responses (e.g., weight loss and melanisation) were observed, indicating a favourable safety profile. Overall, bilayer structure and moderate drying temperature enhanced durability and functional performance without compromising biodegradability or food-contact safety, supporting their potential for sustainable food-packaging applications.



P14 - Prediction of Mold Filling and Air Entrapment in Natural Rubber Injection Molding Using a Homogeneous Multiphase Volume-of-Fluid CFD Model

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Keywords: Natural rubber injection molding; Computational fluid dynamics; Volume-of-Fluid; Mold filling; Air entrapment.

Natural rubber injection molding is widely employed to manufacture high-performance elastomeric components with complex geometries. However, predicting mold-filling behavior and air entrapment remains challenging because of the highly non-Newtonian, shear-thinning rheological characteristics of natural rubber compounds. Reliable numerical prediction of these phenomena is essential for minimizing molding defects and reducing trial-and-error during mold development. This study investigates the capability of a homogeneous multiphase Computational Fluid Dynamics (CFD) model based on the Volume-of-Fluid (VOF) method to predict mold filling and air entrapment during natural rubber injection molding. The rheological behavior of the rubber compound was described using the Cross and Carreau constitutive models implemented in ANSYS Fluent. The numerical model was validated against published experimental observations and Cadmould simulation results. Both rheological models successfully reproduced the evolution of the advancing flow front, with the Cross model demonstrating closer agreement with reference data. The simulations further revealed that cavity thickness significantly influences mold-filling behavior. Thicker cavities exhibited faster filling because of lower hydraulic resistance, while higher local shear rates promoted shear-thinning behavior, thereby reducing the apparent viscosity of the rubber compound. Air entrapment was predominantly concentrated near the cavity extremities, and the thinner cavities exhibited approximately 86% higher trapped-air volume than the thicker cavities. The predicted air-entrapment regions provide practical guidance for vent placement during mold design to reduce molding defects. The proposed homogeneous multiphase VOF framework demonstrates the capability of general-purpose CFD software to accurately predict mold filling, viscosity evolution, and air-entrapment behavior in natural rubber injection molding. The findings highlight the potential of CFD as a practical digital engineering tool for optimizing mold design, reducing manufacturing defects, and supporting advanced rubber manufacturing.

P15 - The Preliminary Study of Electric Vehicle Tire Tread Formulation: A Review

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Keywords: Electric vehicle tire; Tire tread formulation; Natural rubber; Reinforcing fillers; Rubber compounding.

The rapid growth of electric vehicles (Evs) has created new challenges in tire tread due to their higher vehicle weight, instant torque and reduced noise compared to conventional internal combustion engine vehicles. These operating conditions require tire tread compounds with an optimized balance of wear resistance, rolling resistance, wet grip and durability. This paper presents a preliminary review of EV tire tread formulation with a particular focus on natural rubber (NR)-based compounds. The review examines the influence of key formulation, including reinforcing fillers, curing systems, processing oils and additives on the physical, mechanical and dynamic properties of tire tread rubber. Recent studies on silica- and carbon black-filled NR compounds are discussed to highlight their roles in improving traction, abrasion resistance and energy efficiency. Existing formulation strategies and optimization approaches reported in the literature are also summarized to identify current trends and research gaps in EV tire tread development. The findings provide a fundamental understanding of the relationships between formulation parameters and tire performance, serving as a basis for the future design and optimization of NR-based EV tire tread compounds. In conclusion, this review establishes the groundwork for subsequent experimental studies aimed at developing sustainable and high-performance tire tread formulations for electric vehicle applications.

P16 - Development of Sustainable Conveyor Belt Compounds Based on Reclaimed Rubber

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Keywords: Reclaimed rubber; Natural rubber; Nitrile butadiene rubber; Sustainable materials; Rubber recycling.

Globally, the rubber industry generates large amounts of waste, such as used tires and industrial rubber products, which leads to serious environmental issues because rubber does not degrade easily. The increasing demand for sustainable rubber products has encouraged the incorporation of reclaimed rubber (RR) into industrial applications such as conveyor belts. This study aimed to develop and characterize conveyor belt compounds based on reclaimed rubber formulations blended with natural rubber (NR) and, for selected formulations, nitrile butadiene rubber (NBR). The compounds were evaluated in terms of their mechanical, physical, thermal, and chemical properties. The results showed that increasing RR content reduced tensile strength and elongation at break due to the degraded structure and reduced elasticity of reclaimed rubber, while the modulus at 100% elongation (M100) and hardness increased, indicating greater stiffness. Abrasion resistance decreased with higher RR loading; however, formulations containing NBR exhibited superior wear resistance, demonstrating the beneficial effect of NBR in improving the durability of NR/RR blends. Swelling analysis revealed lower swelling ratios with increasing RR content, suggesting higher cross-link density and reduced polymer chain mobility. The findings demonstrate that reclaimed rubber is a viable and sustainable alternative for conveyor belt compound formulations, offering potential cost savings and environmental benefits.

P17 - From Rubber Processing Samples to Biotechnological Solutions: A Conceptual Framework for Indigenous Microbial Consortium Development

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Keywords: Indigenous microorganisms; microbial consortium; VOC; VFA; rubber processing emissions; biodegradation; odor mitigation.

Rubber processing industries generate persistent odor emissions associated with microbial transformation of rubber-derived organic compounds, producing volatile organic compounds (VOCs), volatile fatty acids (VFAs), and sulfur-containing odorous compounds. Although conventional odor control technologies are available, their application may be constrained by energy requirements, chemical consumption, and operational complexity. This study explores indigenous microorganisms from rubber-processing environments as potential biological resources for future sustainable odor mitigation. Rubber-derived samples were collected and subjected to microbial isolation, purification, glycerol preservation, and molecular identification using 16S rRNA and ITS sequencing followed by NCBI BLAST analysis. Indigenous bacterial and fungal isolates were successfully recovered and identified, demonstrating the presence of indigenous microbial resources adapted to rubber-associated environments. Based on these findings, a conceptual framework was proposed for future development of bacterial–fungal consortia through compatibility screening, consortium optimisation, VOC/VFA biodegradation assessment, GC-MS-based metabolite profiling, and biofilter application. The proposed framework highlights the potential role of metabolic complementarity between fungal degraders and bacterial utilizers in enhancing pollutant transformation. This study provides an initial microbial resource platform and establishes a pathway toward developing indigenous microbial-based strategies for sustainable odor management in the rubber processing industry.

ACKNOWLEDGEMENTS

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P18 - Cosmic Coat: Stretchable Natural Rubber Shield for Space Radiation Protection

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Keywords: Natural rubber; Coating; Radiation shielding; Pharmaceuticals; Space

Exposure to cosmic radiation, secondary X-rays and γ -rays during space missions can compromise the stability and efficacy of pharmaceutical compounds through radiolysis and the formation of toxic degradation byproducts. To address this challenge, a lightweight and flexible natural rubber/tungsten carbide (NR/WC) composite coating was developed as a radiation-shielding material for aerospace medical storage applications. This work represents the first reported space testing of Malaysian natural rubber-based shielding coatings. The NR/WC composite was integrated into prototype medicine storage units and launched aboard SpaceX Bandwagon-1 on 21st April 2025 for microgravity and space environment evaluation. Composites containing varying loadings of tungsten carbide (WC) were fabricated and characterized for their mechanical properties and photon attenuation performance. The incorporation of WC improved both mechanical strength and radiation shielding capability of the composites. Among the formulations studied, the 5 phr WC composite demonstrated the best overall performance, exhibiting enhanced tensile strength, high elongation at break and the highest linear attenuation coefficients against X-rays and γ -rays. Further evaluation will be conducted following retrieval of the prototype and experimental data after completion of the mission.

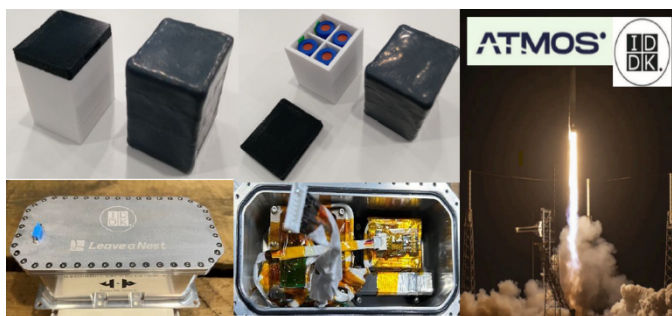


FIGURE: Images of the uncoated and NR/WC-coated medicine box prototype, and the launch of SpaceX Bandwagon-1 carrying the ATMOS space capsule with our prototype for space environment evaluation.

P19 - Effect of Silica Loadings on Properties of Waterborne Styrene-Acrylate Films

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Keywords: waterborne polymer; styrene-acrylate; functionalized silica nanoparticles, film morphology; thermal stability; mechanical properties.

Waterborne polymer systems have attracted increasing attention as environmentally friendly alternatives to solvent-borne materials because they can reduce volatile organic compound (VOC) emissions. The growing need for lightweight polymer films with improved thermal stability, mechanical performance, and structural uniformity has encouraged the incorporation of functionalized silica nanoparticles into styrene-acrylate systems. This study aimed to develop and characterize waterborne styrene-acrylate with the addition of functionalized silica based on the optimum formulation of the ratio between styrene and acrylate with different functionalized silica loadings. The dispersions and films were evaluated in terms of their thermal, morphological, and mechanical properties. The results showed that silica incorporation influenced the degradation behavior and glass transition temperature of the films, indicating changes in thermal resistance and polymer chain mobility. Morphological observations revealed that well-dispersed silica promoted a more compact film structure, while excessive silica loading caused particle agglomeration and surface irregularities, which reduced the effectiveness of silica reinforcement in the polymer matrix. Tensile analysis suggested that the mechanical response depended strongly on the balance between polymer flexibility and silica reinforcement, where optimum silica loading improved structural stability, but excessive loading reduced film uniformity. FTIR analysis supported the presence of styrene-acrylate functional groups and interfacial interactions between silica and the polymer matrix. The findings demonstrate that controlled silica incorporation is an effective approach for tailoring the structure–property relationship of waterborne styrene-acrylate films, offering potential for sustainable functional coating applications requiring balanced thermal, morphological, mechanical performance, and overall long-term durability.

P20 - Hydrodeoxygenation of Palm Fatty Acid Distillate over Ni-Supported Defatted Spent Coffee Ground-Derived Activated Biochar Catalyst for Sustainable Aviation Fuel Production

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Keywords: Defatted Spent Coffee Grounds (DSCG); Activated Biochar Catalyst; Hydrodeoxygenation (HDO); Palm Fatty Acid Distillate (PFAD); Sustainable Aviation Fuel (SAF)

Aviation accounts for more than 2% of global carbon dioxide (CO₂) emissions, driving increasing interest in sustainable aviation fuel (SAF) to support the global target of net-zero emissions by 2050. Hydrodeoxygenation (HDO) is a promising route for producing SAF-range hydrocarbons from renewable lipid feedstocks. Palm fatty acid distillate (PFAD), a low-value by-product of palm oil refining, represents an attractive feedstock, while the growing coffee industry generates substantial quantities of spent coffee grounds (SCG), necessitating effective waste valorization. Following oil extraction, defatted spent coffee grounds (DSCG) remain largely underutilized despite their potential as carbonaceous catalyst supports. However, studies on DSCG-derived activated biochar as a catalyst support for PFAD hydrodeoxygenation remain limited. This study evaluates the catalytic performance of Ni-supported DSCG-derived activated biochar for the HDO of PFAD, integrating two waste resources into a circular pathway for SAF production. Activated biochar with a BET surface area of 1215 m² g⁻¹ was prepared from DSCG and subsequently impregnated with 10–30 wt% Ni via wet impregnation method followed by calcination. HDO reactions were conducted in a fixed-bed reactor at 380 °C for 0.5 h. The catalyst produced C7–C20 SAF-range hydrocarbons with total selectivities ranging from 22–30% through hydrodeoxygenation, decarboxylation, and decarbonylation pathways, followed by hydrogenation of unsaturated intermediates. Among the products, C15 and C17 hydrocarbons exhibited the highest selectivities of 8–11% and 6–10%, respectively, reflecting the high palmitic (C16:0) and oleic (C18:1) acid contents of PFAD. Increasing the Ni loading from 10 wt% to 30 wt% increased the residual free fatty acid content from 3% to 7%, which is attributed to excessive Ni loading causing pore blockage, metal agglomeration, and reduced accessibility of active sites. Overall, this work demonstrates a sustainable strategy for converting two abundant waste resources into SAF-range hydrocarbons using a novel Ni-supported DSCG-derived activated biochar catalyst, contributing to circular bioeconomy development and supporting global Sustainable Development Goals.

Acknowledgments

This study was funded by Xiamen University Malaysia Research Fund [grant numbers XMUMRF/2020-C5/IENG/0028, XMUMRF/2023-C12/IENG/0061 and XMUMRF/2025-C16/IENG/0081]. Main appreciations to Zuspresso (M) Sdn. Bhd. and KL-Kepong Oleomas Sdn. Bhd. for contributions of SCG and PFAD respectively.

P21 - Development of Thin Film Nanocomposite Membrane with Ionic Liquid Functionalized Graphene Oxide for Effective CO₂ Separation

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Keywords: thin film nanocomposite (TFN); graphene oxide; ionic liquid; Pebax-1657; CO₂ separation

The growing demand for biogas upgrading has intensified the need for highly selective CO₂/CH₄ separation membrane. Pebax-1657 dense film membranes have been extensively studied over decades for gas separation; however, the low gas permeability remains a critical bottleneck. To mitigate the limitation, thin film nanocomposite (TFN) membranes have emerged as a prominent approach in CO₂ separation, where nanofillers are incorporated into the matrices of thin polymeric membranes to improve gas permeability and gas selectivity. In this study, the performance of TFN membrane is tailored through a systematic approach to investigate various parameters, including porous support thickness, phase inversion time and selective layer coating number. Graphene oxide (GO) is favored as nanofiller for its oxygen-rich functional groups, however high loadings often lead to interfacial defects caused by filler agglomeration. Hence, covalent functionalization of GO with ionic liquid was introduced to enhance GO dispersion and improve CO₂ adsorption capacity. Therefore, this study aims to incorporate GO as nanofiller with ionic liquid functionalization to develop TFN membranes with effective CO₂ separation. It was found that optimizing phase inversion time and selective coating layer number produces membrane with excellent CO₂/CH₄ separation. Besides, the results showed that selective layer with ionic liquid-functionalized GO contribute positively towards CO₂ permeance without compromising CO₂/CH₄ selectivity.



Andersson T'ng Khai Shern is currently a research graduate student pursuing a Master of Chemical Engineering in Xiamen University Malaysia. Beyond excelling in his academic pursuits, he possesses a fervent interest in research-driven endeavors. He has demonstrated his competence and dedication in the research of membrane technology, with a specific emphasis on greenhouse gas separation and environmental sustainability. His enthusiasm for research has also extended his passion to the exploration of a variety of nanomaterials, particularly in contributing towards the advancement of biogas separation using membrane technology. He has demonstrated a noteworthy passion for Sustainable Development Goals (SDGs), a passion that unleashes his potential and a dedication to pushing boundaries in environmental sustainability endeavors, leading to tremendous achievement in competitions and conference events. Andersson's experiences go beyond the academic realm, entailing active participation in extracurricular activities, not to mention his significant contribution in XMUM IChemE student chapter.

P22 - Enhanced Cooling Performance of Lithium Polymer Batteries Using Micro Heat Pipes Integrated with Carbon Nanotubes Coatings

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Keywords: Battery cooling; Carbon nanotubes; Micro heat pipe; Phase-change heat transfer; Ultrafast water permeation.

Effective thermal management is essential for optimizing the performance, lifespan, and safety of lithium polymer (LiPo) batteries under high discharge rates. This study experimentally investigates water-charged carbon nanotube-coated micro heat pipes (CNT-MHP) against air forced convection (FC), uncharged micro heat pipes (U-MHP), and conventional water-charged uncoated micro heat pipes (C-MHP). Mechanistically, the system operates via an efficient phase-change loop as shown in **Figure 1a**, this process is optimized by an internal superhydrophilic layer of functionalized carbon nanotubes, which introduces hydroxyl (-OH) groups that drastically lower fluid friction. This enables ultrafast water transport, enhancing evaporation, condensation, and fluid circulation while preventing premature structural dry-out.

Experimental results show that the CNT-MHP significantly outperforms other methods, demonstrating an extraordinary peak effective thermal conductivity of 5498 W/(m·K) with a 71% improvement over the C-MHP and a 24% higher overall heat transfer coefficient. This superiority is clearly captured in **Figure 1b**, the two-dimensional temperature contours of the battery surface cooled by FC, U-MHP, C-MHP, and CNT-MHP at a discharge rate of 9 A, which visually contrast the spatial heat distribution across each setup. While the FC and U-MHP contours reveal severe localized hotspots that breach safe operational limits, the CNT-MHP array exhibits absolute thermal command, uniformity, and stabilization, capping the peak core battery surface temperature at just 31.7°C. This rests well below the critical 35°C healthy performance threshold, marking a vital temperature reduction of over 7.3°C compared to conventional forced air convection and proving the CNT-MHP's transformative potential for securing safer high-drain energy storage systems.

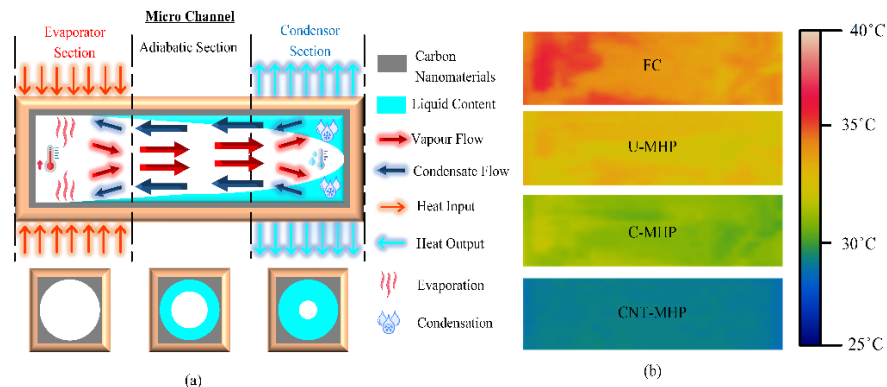


FIGURE 1. (a) Operation of a micro heat pipe, (b) Two-dimensional temperature contours of battery surface.

P23 - IoT-Driven Diagnostic Guidelines for Precision Orchard Management

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Keywords: Precision Agriculture; Subsurface Kinetics; Irrigation Optimization; Resource Management; IoT.

Traditional orchard management frequently relies on labor-intensive, calendar-based schedules that ignore site-specific soil dynamics, resulting in inefficient nutrient use and increased environmental runoff. This study introduces a low-cost, data-driven diagnostic framework that utilizes IoT sensor networks to translate complex subsurface kinetics into actionable operational guidelines. The research establishes three fundamental pillars for sustainable orchard management: diagnostic health assessment through "staircase" transpiration signatures which was monitored at 12-hour intervals to proactively mitigate metabolic risks; optimized fertigation synchronized with peak morning nutrient uptake to minimize chemical leaching into the hydrosphere; and precise water management maintained within a 20% to 30% soil moisture window to prevent saturation-induced hypoxia. Monitoring confirms that moisture levels exceeding 28% should trigger a suspension of fertigation to avoid oxygen depletion in the rhizosphere. By synergizing plant physiology with daily automated operations, this framework provides a quantitative standard for risk management. This accessible, transferable model empowers producers to enhance productivity while promoting long-term environmental stewardship and informed agricultural policy in diverse rubber and fruit-based ecosystems.

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P24 - Isolating Sustainable Bio-Fillers for Next Generation Rubber Latex

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Keywords: Nanocrystalline Cellulose; Kenaf Fibers; Nitrile Butadiene Rubber Latex; Acid Hydrolysis; Bio-fillers.

Rubber-based composites are widely used in mobility and industrial applications due to their durability, flexibility and vibration damping performance. However, conventional fillers such as carbon nanotubes (CNTs) and graphene are petroleum derived and face increasing environmental, regulatory and sustainability challenges that creating a critical need for renewable alternatives. Nanocrystalline cellulose (NCC) is a promising bio-based filler although its hydrophilic nature often limits dispersion in hydrophobic rubber matrices. This stud investigates the extraction and characterization of NCC from kenaf fibers using sulfuric acid hydrolysis as a sustainable route for reinforcement in nitrile butadiene rubber (NBR) latex. Transmission electron microscopy (TEM) revealed rod like crystalline nanoparticles while Fourier transform infrared spectroscopy (FTIR) confirmed the successful removal of amorphous lignin and hemicellulose without altering the cellulose structure. X-ray diffraction (XRD) analysis demonstrated enhanced crystallinity with the highest crystallinity index (71.06%) achieved for the 40% sulfuric acid treatment. This optimized hydrolysis conditions produced highly crystalline and well dispersed NCC which provided a scalable and environmentally friendly strategy and well dispersed sustainable bio fillers for advanced rubber composites. The TEM micrographs in **FIGURE 1** confirm the successful isolation of crystalline, rod-like nanoparticles via controlled acid hydrolysis of kenaf fibers.

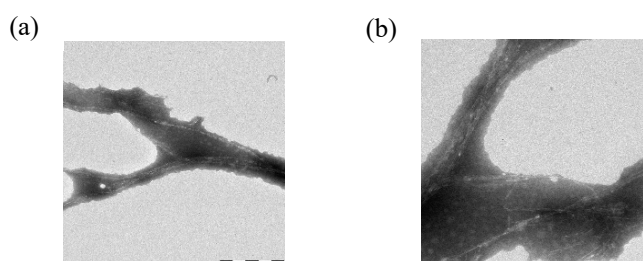


FIGURE 1. (a) TEM images of 30% nanocrystalline cellulose (NCC) at 500 nm and (b) 200 nm scales.

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P25 - Hybrid Polymer-Based Hydrogels for Wound Dressing Applications: A Review

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Keywords: Hybrid Hydrogels; Polymer Blends; Biomaterials; Wound Dressing.

Traditional wound dressings, typically composed of non-degradable polymers, often fail to address the needs of efficient wound care. These conventional materials require frequent dressing changes, which can lead to increased pain, infection risk, and disruption of the healing process. Consequently, the development of biodegradable and patient-friendly wound dressings has become a critical area of research. Hydrogels are three-dimensional polymeric networks that retain large amounts of water without losing their structural integrity. Hydrogels promote wound healing by maintaining a moist environment, thereby reducing the risk of infection compared with dry healing conditions. This review examines advanced hydrogel frameworks developed by combining natural and synthetic polymers to integrate biological activity with mechanical strength, while analyzing how the incorporation of selected bioactive compounds and responsive cross-linking strategies enhances hydrogel performance. It aims to provide a comprehensive understanding of hybrid polymer-based biomaterials and their specialized applications in wound healing (refer to **FIGURE 1**).

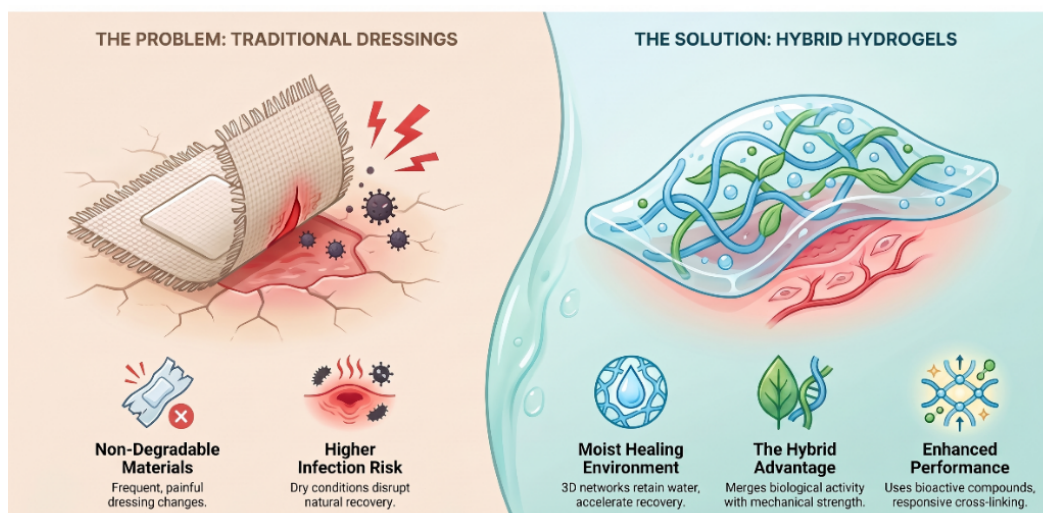


FIGURE 1. Illustration of traditional dressings and hybrid hydrogels.

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P26 - Polylactic Acid for Sustainable Agricultural Applications: A Review

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Keywords: Polylactic Acid; Biodegradable Polymer, Agricultural Application; Mechanical Properties; Degradation Behaviour.

Petrochemical-based polymers have become major contributors to global environmental concerns due to their high resistance to degradation. As a sustainable alternative, biodegradable polymers, such as polylactic acid (PLA), polybutylene adipate terephthalate (PBAT), and cellulose, have attracted considerable research interest. Among these materials, PLA, derived from lactic acid obtained from renewable resources, is widely recognised for its biodegradability, biocompatibility, and favourable mechanical properties. This review provides a comprehensive overview of recent advances and prospects of PLA for agricultural applications, with particular emphasis on its potential to reduce the environmental impacts associated with conventional plastics and mitigate microplastic accumulation. Despite these advantages, the widespread adoption of PLA remains limited by its inherent brittleness and low impact resistance, which restricts its broader utilisation. Therefore, future research should focus on optimising the degradation behaviour and mechanical performance of PLA to meet the growing demands of sustainable agricultural applications (refer to **FIGURE 1**).

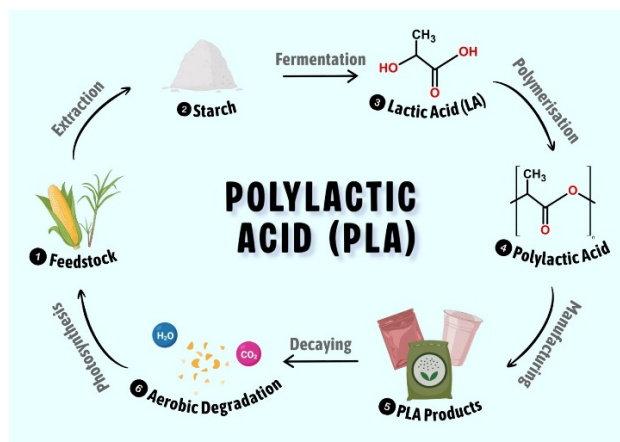


FIGURE 1. Life cycle of a biodegradable polylactic acid.

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P27 - Investigation of the Thermal Properties of Sayote (*Sechium edule*) Fiber Loaded Starch/PVOH Composite Blends

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Keywords: Starch/PVOH; Thermal stability; Sayote fiber loading; Composite blending; Delayed degradation

The thermal properties of starch/PVOH formulations gelatinized with glycerol, cross-linked with boric acid, incorporated with clay and loaded with 2 wt%, 4 wt%, and 7 wt% sayote fibers were investigated. The FTIR spectra, SEM micrographs, DSC, and TGA results revealed a successful blending in starch/PVOH (50/50) and starch/PVOH (65/35) formulations with glycerol as plasticizer and boric acid as cross-linking agent. Plasticized and cross-linked starch/PVOH reinforced with clay and varying amounts of sayote fiber suggest more inter- and intra- molecular hydrogen bonding interactions, making the composite more crystalline and thermally stable. The SEM micrographs showed a smoother surface with the addition of boric acid and a more orderly woven surface with 2 wt% sayote fiber loading. DSC thermograms reveal that the formulations were compatible and had good blending interactions, since the experimental enthalpies of melting were higher than their theoretical values. The addition of sayote fiber increased the thermal stability of starch/PVOH composite blends and prevented the re-crystallization of starch. TGA curves showed that the addition of sayote fibers formed stronger blends that delayed the degradation of the composite. The starch/PVOH (50/50) and starch/PVOH (65/35) composite blends were more crystalline and thermally stable at 2 wt% to 4 wt% sayote fiber loading.

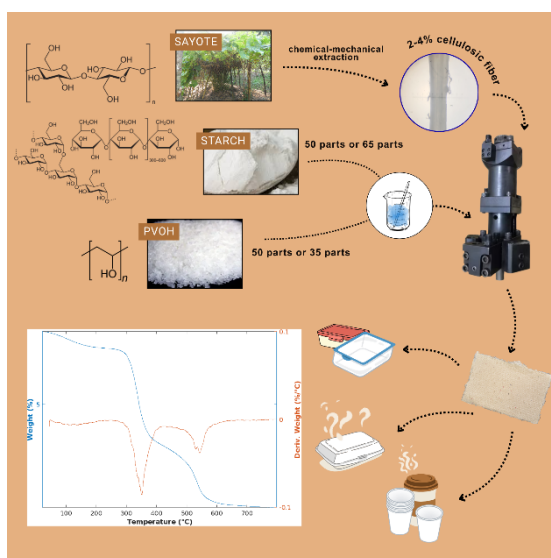


FIGURE 1: The figure shows the graphical abstract of the study.

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