An Overview of Radiation Processing Industry and Commercialization in Malaysia

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Ministry of Science, Technology and Innovation

Content of Presentation

- Introduction of Radiation Processing Technology
- Infrastructure and Facilities to Support R&D&C
- R&D Activities at Nuclear Malaysia
- Process of Commercialization of R&D Outcome

Introduction: Radiation Processing Industry in Malaysia

Gamma Operator	Capacity	Installation	Application
Ansell	400	1977	Medical product
Steriligamma	800	1993	Sterilization
ISOTRON	400	2001	Sterilization

EB Operator	Power/MeV	Installation	Application
Sumitomo	0.25, 0.8 & 2.0	1995 & 2001	Electronic Wire
Cryovac (M) Sdn. Bhd.	0.55	1996	Packaging Film
S.K. Polymer	0.15	1997	Packaging Film
Meditop Corporation	10	n/a	Medical Product
Electron Beam Sdn. Bhd.	10	2009	Medical Product
Continental Sime Tyre	0.3	n/a	Tyre

Note: All radiation facilities used for services and in house product

Radiation Processing Technology Division of Nuclear Malaysia

- **Established in 1990. Known as Radiation Processing Program**
- **Vision: A Referral Centre for Radiation Processing Technology**
- **IAEA Collaboration Centre/CoE**
- **Task: To promote radiation processing technology through R&D and transfer technology or product to private sector for commercialization**

Struktur Organisasi Agensi Nuklear Malaysia

NUKLEAR MALAYSIA

KEMENTERIAN SAINS, TEKNOLOGI DAN INOVASI

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Y. Bhg. Dato' Dr. Muhamad Bin Lebai Juri

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(PROGRAM PENYELIDIKAN & PEMBANGUNAN TEKNOLOGI)
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Dr. Zulkifli Bin Mohamed Hashim

PENGARAH KANAN
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Ir. Dr. Mohamad Puad Bin Hj. Abu

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Tn. Hj. Ahamad Sahali Bin Mardi

PENGURUS-PENGURUS

Unit Khidmat Latihan
En. Shafaai Bin Hassan

Secondary Standard Dosimetry Laboratory (SSDL)
Tn. Hj. Taiman Bin Kadni

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Bahagian Pengurusan Maklumat (BPM)
Tn. Hj. Iberahim Bin Ali

R&D@Nuclear Malaysia

Radiation Curing & Synthesis ↔ **Polymer Blend and Composites**

Radiation Curing and Synthesis

Radiation Conservation Technology

Enablers for R&D and Process of Commercialization

- Human Resources Capability
- R&D and Pre-Commercialization Funding
- Laboratory Facility
- Radiation Facility
- Collaboration with Industry for Technology Transfer

Human Resources and Capability

- 27 research officers in various field and expertise (8PhD, 12MSc and 7 BSc);
- To enhanced R&D activity (2013), Co-supervision 13PhD, 20MSc and 34 BSc students from local university
- As IAEA Collaboration Centre (CoE), Nuclear Malaysia received fellow from IAEA/SEA region/Middle East
- Training Programs for local/foreign scientists

International Recognition

IAEA Collaborating Centre in Radiation Processing of Natural Polymer (2006 – 2009)

IAEA Collaborating Centre in Radiation Processing of Natural Polymer & Nanomaterial (2010 – 2014)

GOVERNMENT SUPPORT R&D&C

SCIENCE FUNDS	TECHNO FUNDS	CRDF SME
◆ laboratory scale ◆ 2 – 3 years ◆ RI and Univ. only	◆ pilot scale – developmental stage ◆ requested by industry ◆ must have Univ. or RI partners ◆ Grants ◆ Incubator system	◆ commercialization ◆ marketing ◆ matching grants (1:1) ◆ Requested by industry

R&D Budget on Radiation Processing

- **Development Fund under RMK9** for 5 years: RM10 mil for R&D, procurement of analytical equipment and establishment of nano laboratory

- **Science fund** budget from Ministry of Science, Technology and Innovation
  - 2011 – RM923,685.00 (USD286,858.70) for 9 projects
  - 2012 –RM1,400,835.00 (USD435,041.93) for 15 projects
  - 2013 -RM1,347,923.40 (USD418,609.75) for 17 projects
- **IAEA/CRP budget for 3 projects**: Total Euro 13,000.00 per year for 3 years (2011 -2013).
- **IAEA TC Project MAL/1010**, Development of green materials and processes using ionizing radiation and nano materials for environmental remediation, 2012 - 2013 (budget for 2013, Euro 33,000.00)

Exchange rate 1USD = RM3.22

Commercialization Budget

- **Techno fund (Pre-commercialization)**
  - Pilot Production of Wound Management Products From Water-soluble **Chitosan** Derivatives For Pre-clinical, Clinical and Market Evaluations. Collaboration with SIRIM Bhd. and University Science Hospital. Total fund: RM3.9M (USD1,218,750.00), Dec. 2009 –Dec. 2012
  - Pilot Plant of Production of **Flame Retardant Wire and Cable**. Collaboration with Wonderful Compound. Total fund: RM3.0M (USD931,677.00) Aug 2009 until June 2010
  - Pilot plant **Bio-Plastic Packaging**. Collaboration with Zylon BioPlastic. Total fund: RM1.325M (USD414,062.50) Oct. 2007 until Sept. 2009
- **Commercialization of Research Development Fund (CRDF)**
  - **Sago Hydrogel** for Wound Dressing and Face mask. Collaboration with Rumbia Bio-Tech Sdn. Bhd. RM1.67 M (USD521,875), 2009 -2011

Laboratory Facilities

Polymer processing laboratory

- Melt blend mixers, hot & cold press, melt flow indexer, temp controlled two roll mill, three roll mill, injection molding machine –table top, etc

Polymer Characterization

- tensile machine, impact tester, hardness tester, scratch and abrasion tester, tackiness tester, etc.

- DSC, DMTA, TGA
- FTIR, Real Time FTIR
- GPC, HPLC, SLS
- SPM, TEM
- Nanophox
- Zeta potential etc.

Nano Laboratory

Scanning Probe Microscope

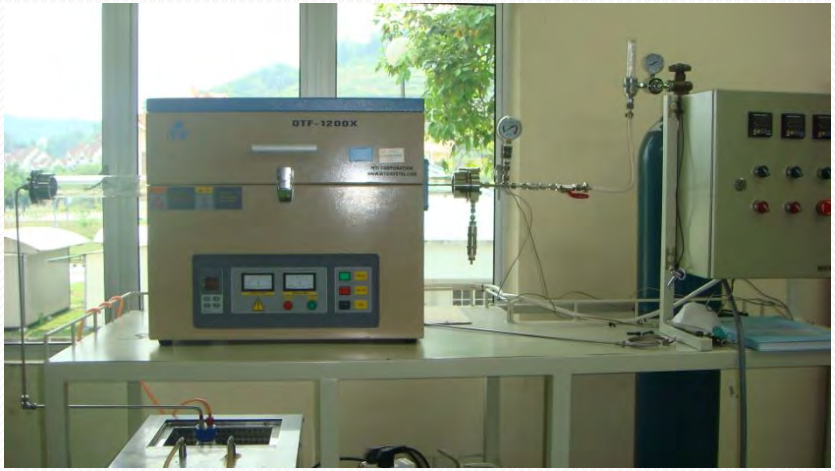
Asymmetric Flow Field
Flow Fractionation (AF4)

Dynamic Light Scattering

Device for synthesis of nanomaterials

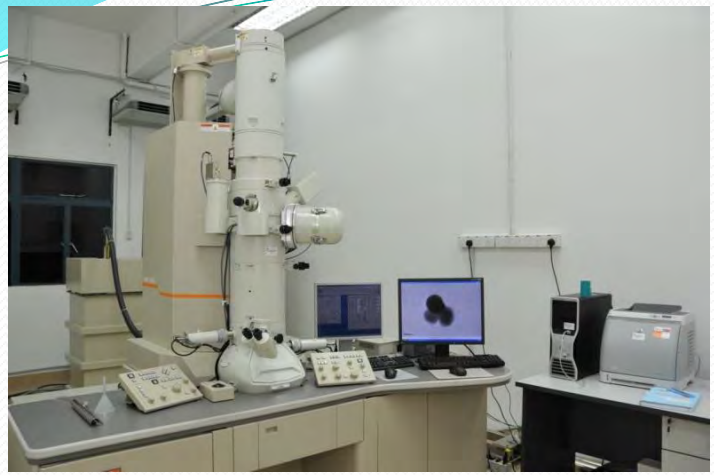
Electrospinning – Nano Fiber

Nano Mizer – Nano particle/gel



Chemical Vapor Deposition - Carbon Nano Tube (CNT)

Characterization of Nano Materials



Transmission Electron Microscope (TEM)

Vibration Sample Magnetometer

Vector Network Analyzer (VNA)

Zeta Potential

Gel Permeation Chromatography

Pilot Plant Facility to Support R&D and Commercialization Process of R&D Outcome

- **Pilot plants for Prove of Concept, Feasibility Study, Product Development and Demonstration Facility.**
- **Continuous flow gamma irradiation (RAYMINTEX) for vulcanize rubber latex and oligochitosan production**
- **Electron beam radiation facility for crosslink wire, cable, tube and hydrogel**
- **Thermoplastic processing for compounding, composite, wire and molding of polymer**
- **Synthesis of resin epoxy palm oil acrylate, butyrate and over print varnish from palm oil**

RAYMINTEX Gamma Facility

Latex/Chemical Tanks

Radiation Column

Gamma Radiation Chamber

Pumping system

Dosimeter

Pilot Plant for Crosslinking Wire, Cable and Tubing

ALURTRON: Electron beam accelerator, 3.0 MeV, 90kW with handling facility for research and continuous irradiation of wire and shrinkable tubes

Pilot Plant Synthesis of Resin from Palm Oil

Pilot Plant Thermoplastic /Natural Polymer Processing

Radiation Facilities Supporting the R&D

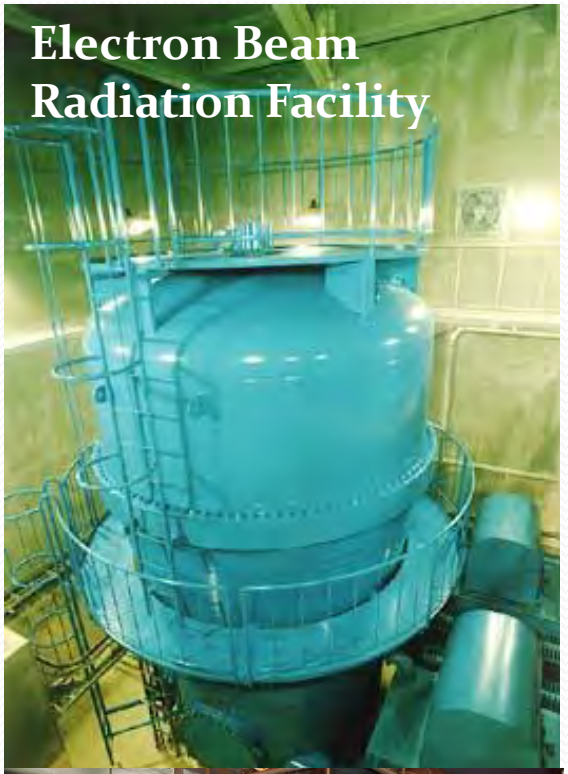
- Gamma and electron beam
  - Sinagama, Co-60 plant with design capacity ~ 2.0 MCi for sterilization
  - Raymintex, Co-60 plant with design capacity of 1.0 MCi for liquid irradiation
  - Electron accelerator, EPS3000, 3.0 MeV, 90kW
  - Electron accelerator, 1.0 MeV, 50 mA.
  - Curetron, 200 keV, 4kW
- UV irradiation system, 120 Watt/cm2
- High powered UV- fusion lamp

Radiation facilities to support R&D and provide radiation service for commercialization.

Irradiation Facilities at Nuclear Malaysia

Gamma Radiation Facility
Commercial & Research Loop

Continuous Flow
Gamma
Radiation
Vulcanize
Rubber Latex



Low Energy EB 200KeV (Curetron) and UV line

Timeline Project Achievements on Natural Polymers

Oligochitosan

Nano gel

Recycling NR waste

SWA

2010

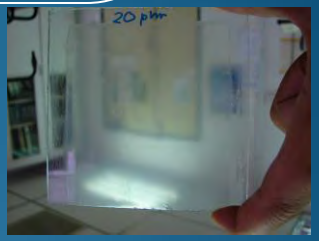
Radiation formation of micro and nano particles of natural polymers

ENR-Si nano hybrid

2006

Radiation processing of chitosan and chitosan derivatives

NR-Nano magnetic particle composites



Sago biofilm /biofoam

2004

NR-Thermoplastic Nano clay composites

2000

Agro fibers polymer composites

Radiation processing of sago hydrogel

Palm oil acrylate

1998

RVNRL

2012

Timeline Project Achievements on Synthetic Polymers

PVC radiation compatible tubing

2010

Radiation X-linking of nanoclay EVA-NR, PP, ect

2006

Radiation processing of ENR-PVC blend

Rad curing of nanosize silica composite coating

2004

Radiation Grafting of Membrane

Radiation processing of PE, HDPE, LDPE, EVA, PVC

Radiation processing of NR-PP, NR-PE blends, etc

2000

Radiation processing heat shrinkable materials

Radiation X-linking of wire and cable insulator

1998

Radiation curing of coatings of woods, cemboards, etc

Commercialization of Nuclear Malaysia Radiation Processing R&D Outcome

Commercialization of Sago Hydrogel for Health Care Application

Technology Platform

Sago Hydrogel as CARRIER of Bio Essence from the BIODIVERSITY

Rumbia Bio-Tech Pilot GMP Cosmetic Certified Plant: Production of Starch Hydorgel at Nuclear Malaysia Technology Park

Renewal Resources

Extraction Sago starch

Mixing Sago Gel

Coating Sago Gel

EB Accelerator Irradiation Source

Packaging

Crosslink Process Sago Gel

Health Care Sago Hydrogel

EB Processing: Crosslinking and Sterilization

Product facial mask sago starch hydrogel is being irradiated for crosslinking and sterilization processes.

Product pass under EB scanner for crosslinking and sterilization at 25KGy

Products outside EB irradiation chamber prior for irradiation

Sago Starch Hydrogel

Early Stage
Evaluation
Product
Performance

Rumbia
Future
Potential

ACNE Treatment

Testimonial Patient Proven Sago Hydrogel Performance

SAGO Hydrogel on Infected Burned Wound

Without Anti Biotic

Serious Electrical Burnt Patient 15 Days after Application of SAGO Hydrogel

RAYMINTEX Gamma Facility

Latex/Chemical Tanks

Radiation Column

Gamma Radiation Chamber

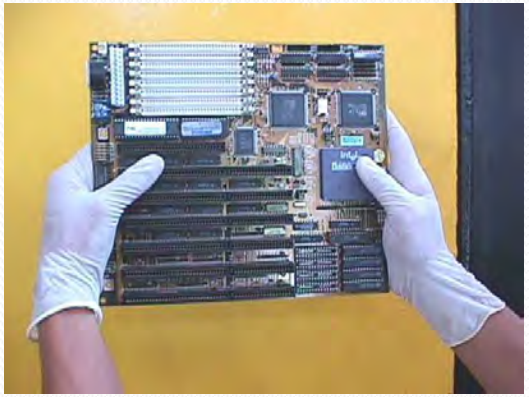
Pumping system

Dosimeter

Commercialization of Rubber Vulcanize Natural Rubber Latex (RVNRL) Finger Coat


Sulphur Free
Orange Finger Cots
Sulphur Free
Orange Finger Cots


RAYMINTEX
A New Bench Mark



Manufacturing of RVNRL

Year	Production (Kg)	Company
2006	27,325	2
2007	35,847	2
2008	27,310	2
2009	31,430	2
2010	72,500	2
2011 (until August)	49,140	2

Pilot scale production of plant growth promoter oligochitosan by RAYMINTEX continuous flow gamma facility

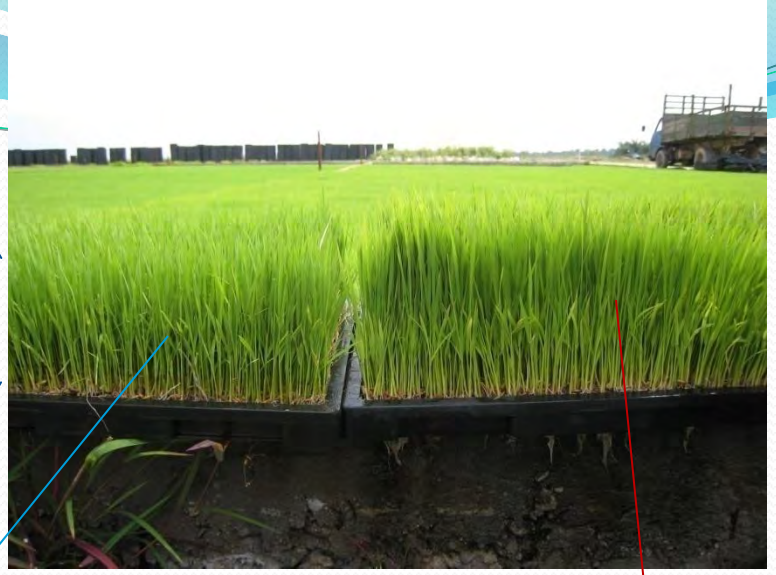
- **Chitosan** extract from shrimp shelves
- Production of oligochitosan as plant growth promoter in agriculture application such as rice, gaharu , pineapple and banana

Mixing tank

Storage tank

Transplanting system at FELCRA Seberang Perak

10cm



13cm

12 days after transplant

Treated with commercial products

Treated with oligochitosan

Commercialization of Chitosan Derivative for Wound Dressing

Products pass clinical evaluation in collaboration with Hospital of National University and University Science funded by Ministry of Science, Technology and Innovation

Clinical Test on Chitosan Derivative Sheet and Paste

Day 0

Sheet

Day 10

Day 0

Day 6

Paste

Day 21

Day 27

Commercialization of Heat Shrinkable Tube

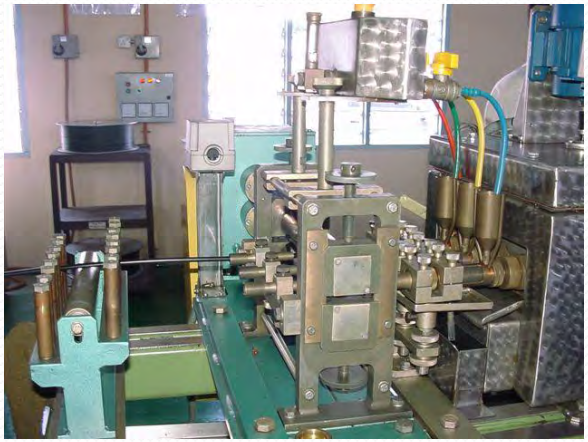
NDA Signing Agreement with Toplink

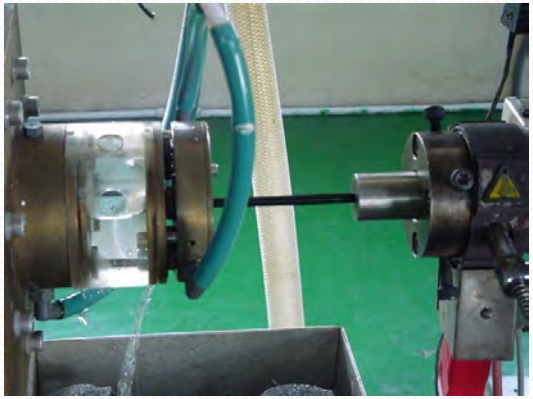
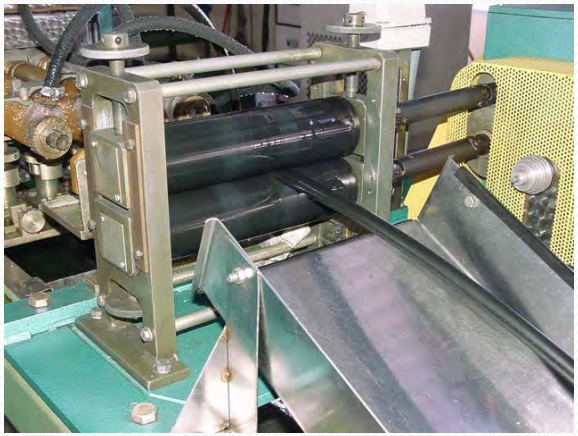
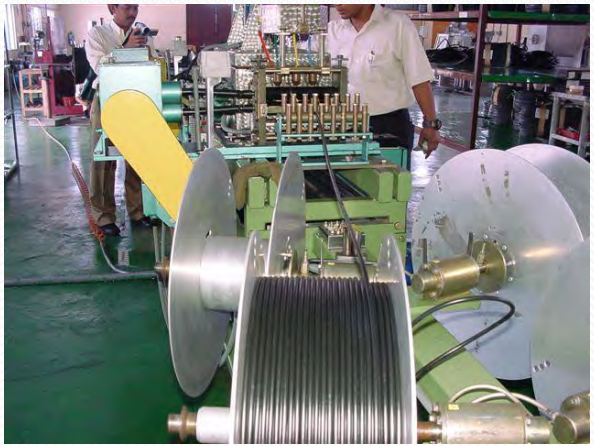

Break Lining Tube


Heat Shrinkable Tube


Tube shrink after heating

Pilot Plant Facility Processing Shrinkable Tube

Facility production of shrinkable tube at factory of collaborator

Handling system of EB radiation for tube and wire

NUKLEAR MALAYSIA

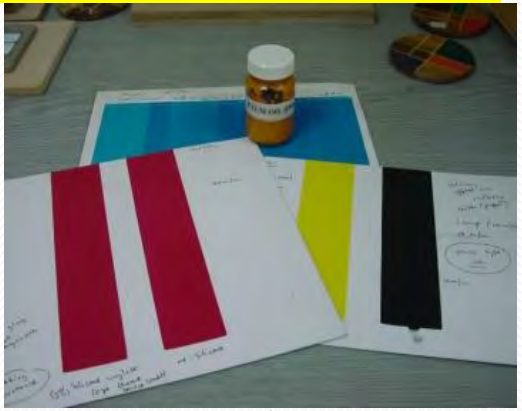
Wonderful Compound

NDA ELECTRON BEAM (EB) CROSSLINKING OF WIRE AND CABLE FOR AUTOMOTIVE

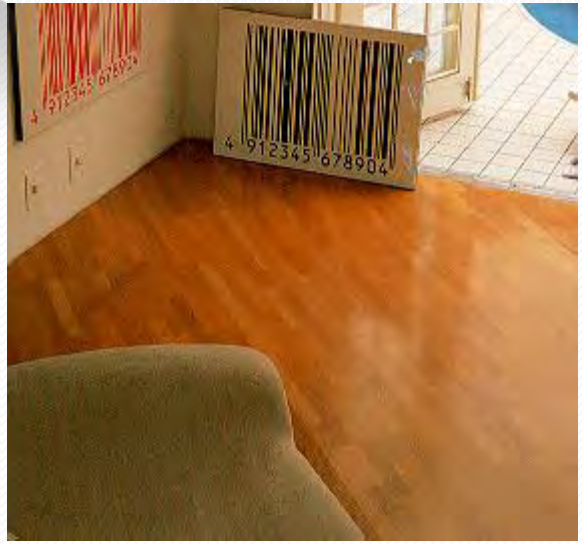
- ELV-4 WUBHS (wire under beam handling system)

PRODUCTION OF GREEN OR ECO-FRIENDLY COATINGS AND OVERPRINT VARNISHES FROM RADIATION CURABLEPALM OIL BASED RESINS

UV curing process of overprint varnishes (OPV)



Printing inks



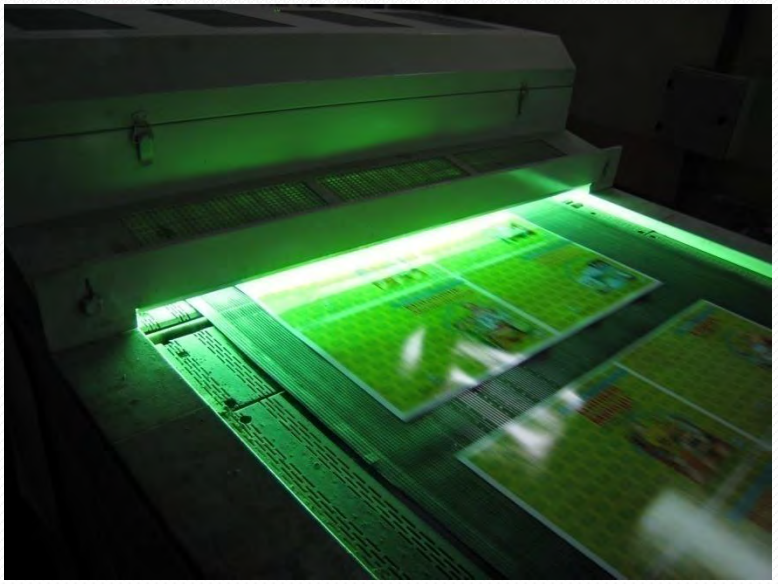
UV curable floor panels

Pressure Sensitive Adhesive (PSA)

Overprint Varnish (OPV) from EPOLA

Signing and exchange of Supply Agreement between Nuclear Malaysia and Ijima Industries Sdn Bhd
– To supply overprint varnish (OPV)

* Production: 200 kg/month
  Market Demand: 1500 – 2300 kg/month

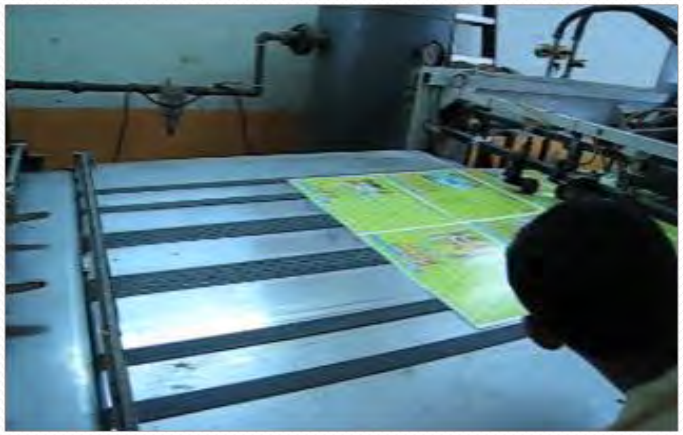


UV curing process of OPV based EPOLA at Ijima Industries Sdn Bhd

Production of coating material resin from oil palm

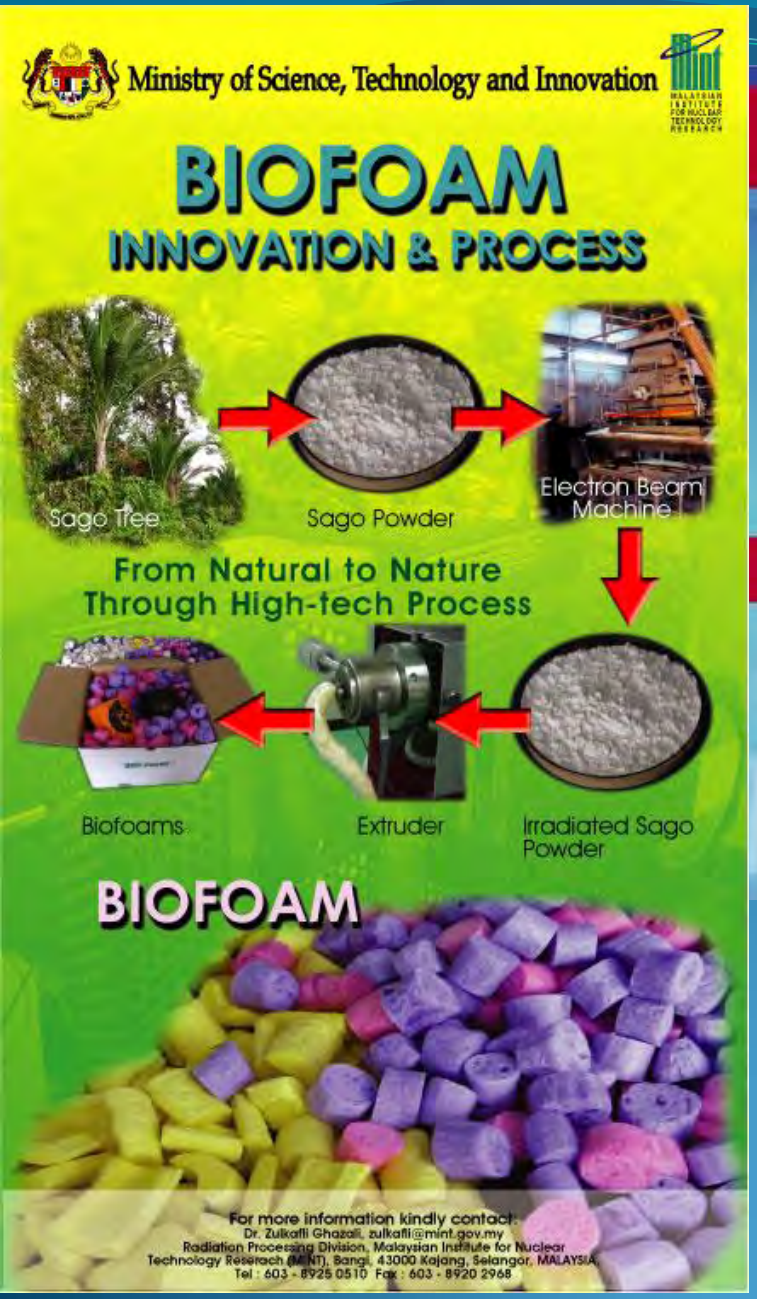
Pilot Plant of 150 liters Reactor Synthesis (EPOLA, POBUA and OPV)

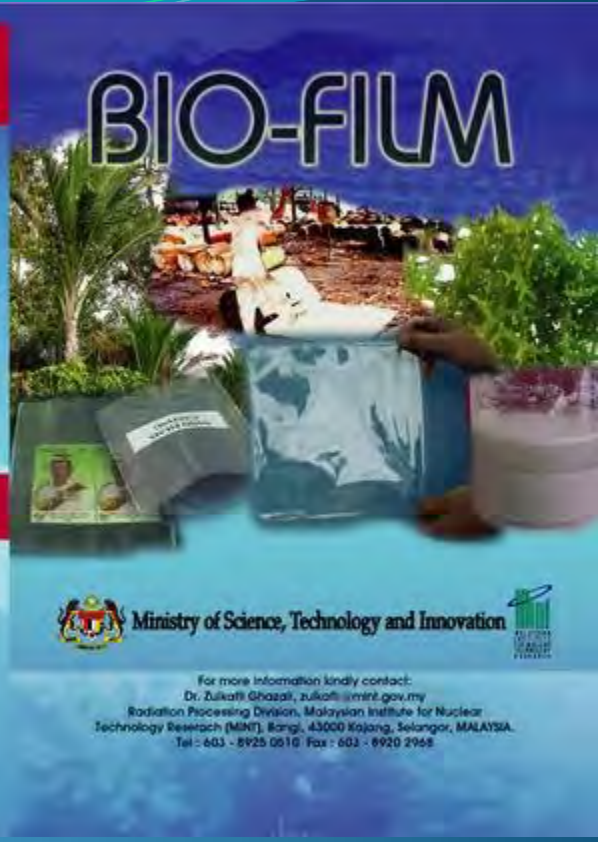
Pilot plant of radiation (UV/EB) curable palm oil (PO) based resins (epoxidise palm oil acrylate (EPOLA) and palm oil based polyurethane acrylated (POBUA) can be utilized to produce green or eco-friendly coatings, pressure sensitive adhesives (PSA), printing inks and overprint varnishes (OPV).



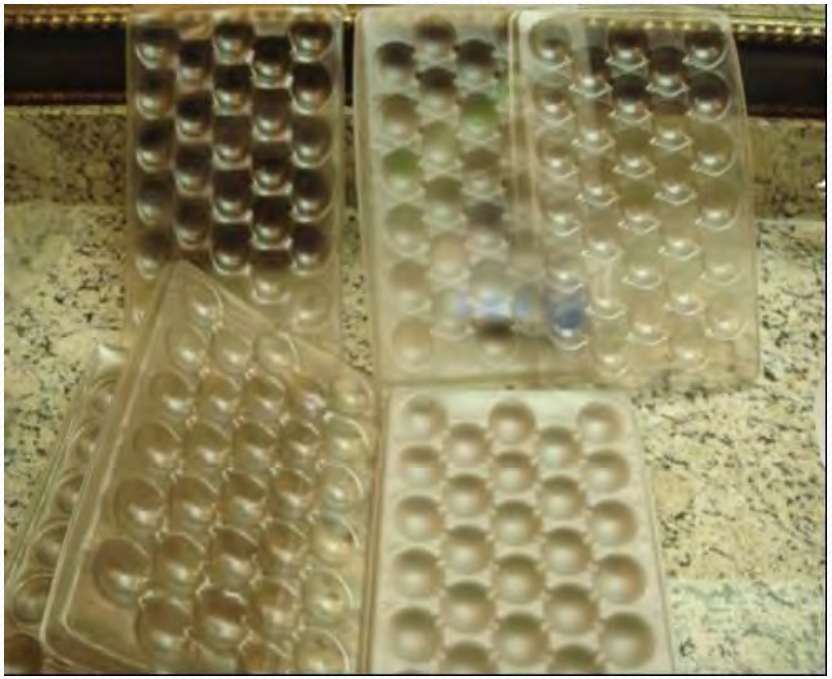
UV curing

Biodegradable Packaging





Prototype: Chocolate Tray



Radiation Crosslinkable Thermoplastic Elastomer (TPE) from Waste Rubber

MOSTI

PREPARED BY

Revocomm Technologies Sdn Bhd

Partners

Research & Development

NUKLEAR MALAYSIA

Technology Recognition / Project Funder

MOSTI

Products Thermoplastic Elastomer (TPE) Waste Rubber

TPE Rubber enables its customers to:

Advantage..

- ☑ TPE materials have the potential to be recyclable since they can be molded, extruded and reused like plastics,
- ☑ TPE also require little or no compounding, with no need to add reinforcing agents, stabilizers or cure system
- ☑ TPE rubber consumes less energy and closer and more economical control of product quality is possible

Disadvantage

- ☑ TPE relative to conventional rubber or thermoset are relatively high cost of raw materials, general inability to load TPEs with low cost fillers, such as virgin rubber
- ☑ The two most important manufacturing methods with TPEs are extrusion and injection molding, high machine cost.

ARTIFICIAL BAKAU PILE COMMERCIALIZATION: THE PROSPECTS

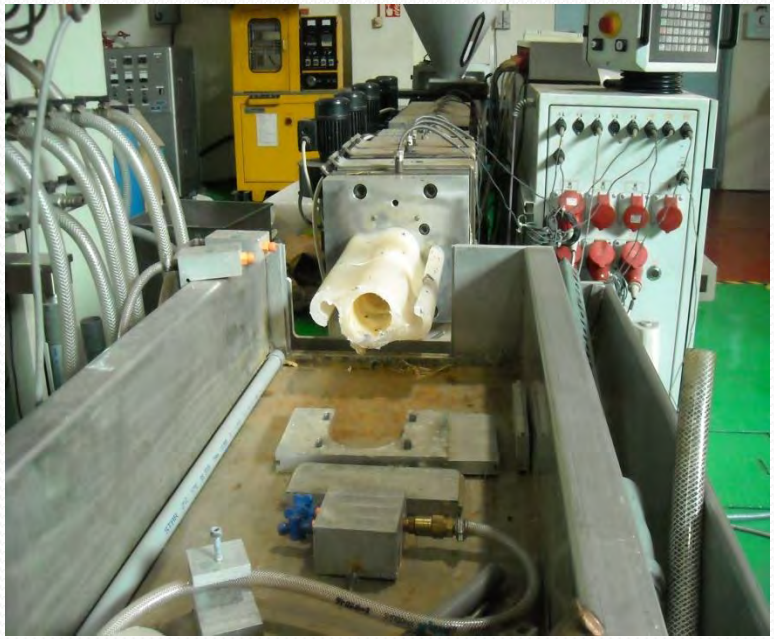
The Product:
Artificial Bakau Pile is an alternative method for soil erosion protection systems which has been developed to protect or reduce river bank scouring, coastal line erosion and other types of soil erosion. The hydro-dynamic design of the product incorporates interlocking systems for effective resistance and barrier against the scouring effect of river current.

The material:
Artificial Bakau Pile are constructed from a green material known as wood polymer composites which consists of natural wood fiber as the major reinforcing components.

The Technology:
The technology to produce and application of Artificial Bakau Pile are a hybridization of conventional and advanced polymer processing which utilizes existing Profile Extrusion Technology and advanced Compaction Extrusion Systems.

Prepared by : Faizal

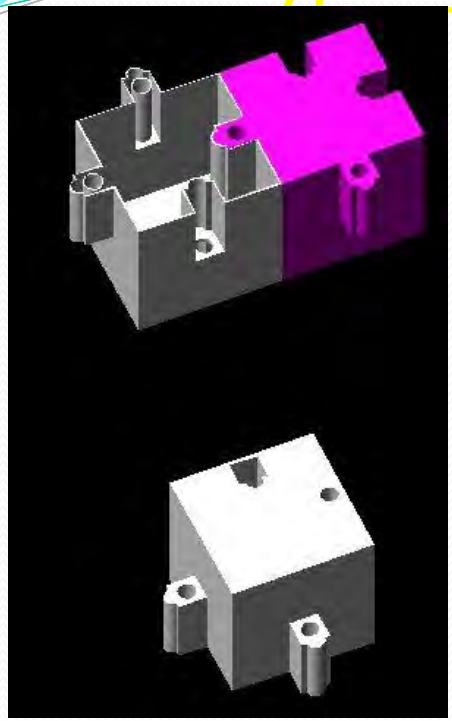
Failure & Disadvantages of Natural Mangrove (Bakau) Piling

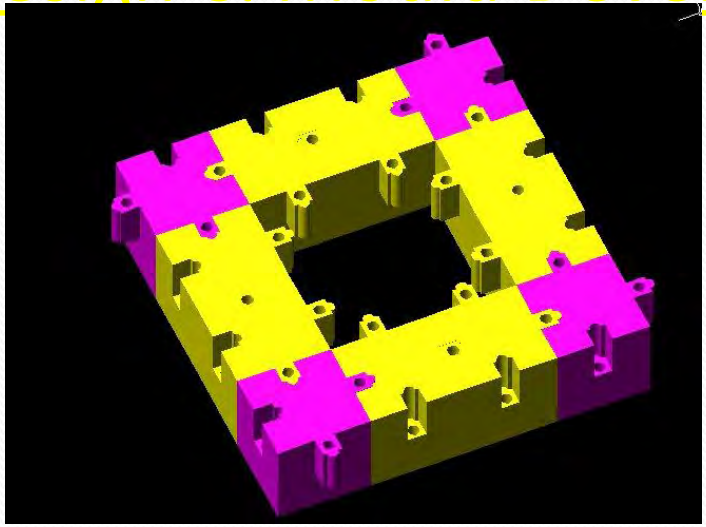


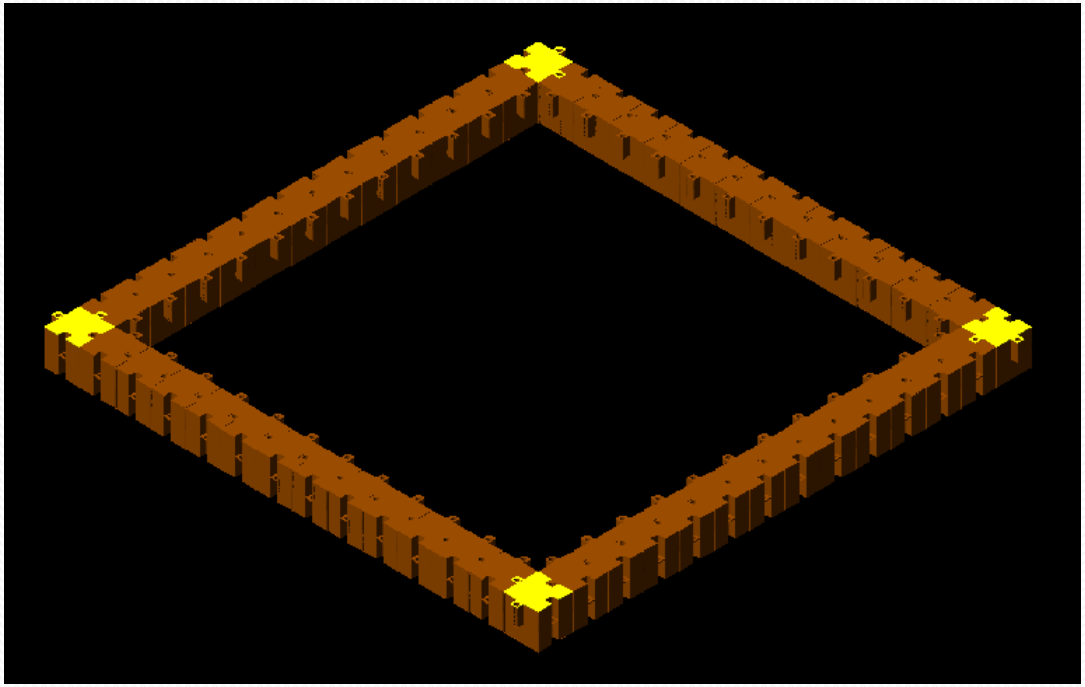
PROPOSAL FOR NEW BLUE OCEAN STARTEGY INITIATIVE (NBOS):

DEVELOPMENT OF MODULAR FLOATING CAGE FROM NANOHYBRID BIOCOMPOSITE MATERIAL FOR AQUACULTURE APPLICATION (FISH FARMING)

Prototype Design & Mould Development







Before

After

Radiation sterilisable PVC compounds for medical products

Gold Medal & Best of the best– 34rd International Exhibition of Inventions New Techniques and Products Geneva, Switzerland, 6-10 April 200

Tubing for dialysis, endotrachaea, feeding and pressure monitoring

Conclusion

- Radiation processing industry in Malaysia is growing at encouraging pace;
- Nuclear Malaysia role is to disseminate information and promote radiation processing technology capability vis-a-vis to conventional technology;
- Infrastructure, laboratory, pilot and irradiation facility at Nuclear Malaysia will enhance R&D activity and commercialization of radiation processing; and
- Successful commercialization of R&D finding could be achieve through collaboration and transfer technology to industry, and financial support from government and private sectors

Terima Kasih / Thank You

MALAYSIAN NUCLEAR AGENCY

MINISTRY OF SCIENCE, TECHNOLOGY AND INNOVATION (MOSTI)