An Overview of Radiation Processing Industry and Commercialization in Malaysia

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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

<table>
<thead>
<tr>
<th>Gamma Operator</th>
<th>Capacity</th>
<th>Installation</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ansell</td>
<td>400</td>
<td>1977</td>
<td>Medical product</td>
</tr>
<tr>
<td>Steriligamma</td>
<td>800</td>
<td>1993</td>
<td>Sterilization</td>
</tr>
<tr>
<td>ISOTRON</td>
<td>400</td>
<td>2001</td>
<td>Sterilization</td>
</tr>
</tbody>
</table>

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

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
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 (8 PhD, 12 MSc and 7 BSc);
- To enhanced R&D activity (2013), Co-supervision 13 PhD, 20 MSc 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

<table>
<thead>
<tr>
<th>SCIENCE FUNDS</th>
<th>TECHNO FUNDS</th>
<th>CRDF</th>
</tr>
</thead>
<tbody>
<tr>
<td>laboratory scale</td>
<td>pilot scale – developmental stage</td>
<td>commercialization</td>
</tr>
<tr>
<td>2 – 3 years</td>
<td>requested by industry</td>
<td>marketing</td>
</tr>
<tr>
<td>RI and Univ. only</td>
<td>must have Univ. or RI partners</td>
<td>matching grants (1:1)</td>
</tr>
<tr>
<td></td>
<td>Grants</td>
<td>Requested by industry</td>
</tr>
<tr>
<td></td>
<td>Incubator system</td>
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</tbody>
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**GOVERNMENT SUPPORT R&D&C**

- **SCIENCE FUNDS**
  - laboratory scale
  - 2 – 3 years
  - RI and Univ. only

- **TECHNO FUNDS**
  - pilot scale – developmental stage
  - requested by industry
  - must have Univ. or RI partners
  - Grants
  - Incubator system

- **CRDF**
  - SME

- 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 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

**Commercialization of Research Development Fund (CRDF)**

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)
- Zeta Potential
- Vibration Sample Magnetometer
- Vector Network Analyzer (VNA)
- 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
- Pumping system
- Dosimeter
- Gamma Radiation Chamber
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
Radiation formation of micro and nano particles of natural polymers

Radiation processing of chitosan and chitosan derivatives

Sago biofilm /biofoam

Agro fibers polymer composites

Palm oil acrylate

Recycling NR waste

Oligochitosan

Nano gel

ENR-Si nano hybrid

NR-Nano magnetic particle composites

NR-Thermoplastic Nano clay composites

2010

2006

2004

2000

1998

RVNRL

Excellent Clarity/Transparency

Biodegradable Films

Recycling NR waste

Oligochitosan

Nano gel

ENR-Si nano hybrid

NR-Nano magnetic particle composites

NR-Thermoplastic Nano clay composites

2010

2006

2004

2000

1998

RVNRL
Radiation processing of ENR-PVC blend

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

Radiation processing heat shrinkable materials

Radiation curing of coatings of woods, cemboards, etc

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

Radiation curing of nanosize silica composite coating

Rad curing of nanosize silica composite coating

Radiation Grafting of Membrane

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

Radiation X-linking of wire and cable insulator

PVC radiation compatible tubing

Timeline Project Achievements on Synthetic Polymers
Commercialization of Nuclear Malaysia Radiation Processing R&D Outcome
Commercialization of Sago Hydrogel for Health Care Application

Bio Essence from Biodiversity

Technology Platform

Sago Hydrogel as CARRIER of Bio Essence from the BIODIVERSITY
Rumbia Bio-Tech Pilot GMP Cosmetic Certified Plant:
Production of Starch Hydrogel at Nuclear Malaysia Technology Park

Renewal Resources

Extraction Sago starch

Mixing Sago Gel

Coating Sago Gel

EB Accelerator
Irradiation Source

Crosslink Process Sago Gel

Health Care Sago Hydrogel

Packaging

Mixing Sago Gel

Coating Sago Gel
EB Processing: Crosslinking and Sterilization

Products outside EB irradiation chamber prior for irradiation

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

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

ACNE Treatment

TESTIMONIAL For Acne Treatment

Early Stage Evaluation Product Performance

Rumbia Future Potential

1 piece/day for 15 days

Testimonial Patient Proven Sago Hydrogel Performance

SAGO Hydrogel on Infected Burned Wound Without Anti Biotic

1st Day

18th Day

Serious Electrical Burnt Patient 15 Days after Application of SAGO Hydrogel
Commercialization of Rubber Vulcanize Natural Rubber Latex (RVNRL) Finger Coat
## Manufacturing of RVNRL

<table>
<thead>
<tr>
<th>Year</th>
<th>Production (Kg)</th>
<th>Company</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>27,325</td>
<td>2</td>
</tr>
<tr>
<td>2007</td>
<td>35,847</td>
<td>2</td>
</tr>
<tr>
<td>2008</td>
<td>27,310</td>
<td>2</td>
</tr>
<tr>
<td>2009</td>
<td>31,430</td>
<td>2</td>
</tr>
<tr>
<td>2010</td>
<td>72,500</td>
<td>2</td>
</tr>
<tr>
<td>2011 (until August)</td>
<td>49,140</td>
<td>2</td>
</tr>
</tbody>
</table>
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

12 days after transplant

Treated with commercial products

Treated with oligochitosan
Commercialization of Chitosan Derivative for Wound Dressing

Hydrogel Paste

Hydrogel Sheet

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

Paste

Day 6

Day 21

Day 27
Commercialization of Heat Shrinkable Tube

NDA Signing Agreement with Toplink

Heat Shrinkable Tube

Break Lining 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
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 CURABLE PALM OIL BASED RESINS

UV curing process of overprint varnishes (OPV)

Pressure Sensitive Adhesive (PSA)

Printing inks

Resins

UV curable floor panels
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
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).
Prototype: Chocolate Tray
Radiation Crosslinkable Thermoplastic Elastomer (TPE) from Waste Rubber

Partners

Research & Development

Technology Recognition / Project Funder

PREPARED BY

Revocomm Technologies Sdn Bhd
**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.
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 hydrodynamic 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.
Failure & Disadvantages of Natural Mangrove (Bakau) Piling
PROPOSAL FOR NEW BLUE OCEAN STRATEGY INITIATIVE (NBOS):

DEVELOPMENT OF MODULAR FLOATING CAGE FROM NANOHYBRID BIOCOMPOSITE MATERIAL FOR AQUACULTURE APPLICATION (FISH FARMING)
Prototype Design & Mould Development
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 an 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 achieved 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)