30 Status and Prospect of Radiation Processing Technology in Malaysia

KHAIRUL ZAMAN Hj. Mohd Dahlan and NAHRUL KHAIR Alang Md Rashid

Malaysian Institute for Nuclear Technology Research (MINT),
Bangi, 43000 Kajang, Selangor Darul Ehsan, Malaysia

Abstract

Radiation processing technology in Malaysia is gaining acceptance by the local industry. The technology has proven to enhance the industrial efficiency, productivity and improve product quality and competitiveness. For many years, variety of radiation crosslinkable materials based on synthetic polymers have been produced either in the form of thermoplastic resins, polymer blends or composites. Today, effort is being focused towards producing environmentally friendly and biodegradable materials using natural polymers.

The government of Malaysia through the Malaysian Institute for Nuclear Technology Research (MINT) has developed research program to utilize indigenous materials such as natural rubber, palm oil and polysaccharide. Radiation processing technology is used to process (crosslink/grafting/curing) the materials at a competitive cost. This technology can be applied in several industrial sectors such as automobile, aerospace, construction and healthcare.

Keywords: radiation processing, indigenous materials, natural polymer, crosslinking, curing.

INTRODUCTION

Radiation processing is one of the core research programs of the Malaysian Institute for Nuclear Technology Research (MINT). As a government research institute, research activity of MINT is designed to meet the government policies and aspiration

of developing knowledge driven economy (k-economy). It is recognized that knowledge is the main driving force for economic growth of a country. In this connection, R & D program in Malaysia is designed to generate knowledge that can meet market demands and needs.

The Second Malaysian Industrial Master Plan (IMP 2) (1996 - 2005) focuses on the manufacturing strategy and cluster-based development emphasis on the full integration of operations along the value chain R & D and product designs to marketing and distribution. IMP 2 has classified the industries into three groups namely, internationally linked, policy-driven and resource-based groups as shown in Annex 1. Participation of both the public and private sectors in the implementation and monitoring of the plan are necessary. Both parties, government and industry are encouraged to work together as early as in the design and approval of the project budget and to follow through the development until it reaches the market place.

National Priorities

The government supports R & D and technologies that promote growth (increase export & reduce import); enhanced industrial efficiency, productivity and competitiveness; generate home-grown technology with own brands of goods and services; reduce labor with increasing automation and improve quality of life.

Within the manufacturing industry, advanced materials such as composites, either polymer-based, metal-based or ceramic-based are given priority. It is much so, if resource based material can be integrated into the development of advanced materials. In this case, natural rubber and oil palm are the main sources. The by-products of the two resources such as rubber wood, rubber wood fibers, oil palm fronds and empty fruit bunches are the primary materials for further utilization - value added and meeting the zero waste concept. Medium density fiberboard (MDF) made of rubber wood fibers and oil palm fibers is the example of new product emerged in the market recently. The rubber wood MDF increases its popularity rapidly in the furniture industry both locally and internationally.

In addition to composite materials, the modification of resource base materials that have commercial value is also given high priority. Epoxidised natural rubber and thermoplastic natural rubber elastomer are amongst the products that have been developed and commercialized in Malaysia. Modified palm oils such as polyol and epoxidised palm oil are developed and used as starting materials for polyurethane and polyester based resins for various applications.

In the light of IMP 2 and the above strategy, the current industrial application of nuclear technology such as radiation processing fits in well into the country's development program. Radiation processing is one of the industrial processes that can be used for cross-linking, grafting, elimination of microorganisms, modification of organic compounds, etc. The radiation processing technology can be an integral part of the manufacturing line for the production of flame/fire resistant wire and cable, heat shrink tube, hot water tube, heat shrink film for packaging, sleeve, composite materials, viscose rayon and many other profile and molded products. It has been proven as unique and commercially viable process. On the other hand, the materials used for radiation processing are specifically compounded and are not easily available. Therefore, the introduction of radiation processing technology in local industry requires mix strategies as follows;

- Established technology/material/product - development of radiation crosslinkable materials for specific.
- New technology/material/product – development of advanced and modified materials based on indigenous and locally available raw materials

In addition, radiation processing has also been proven as a viable process for cleaning up flue gasses from power station and incinerator. It can also be used for cleaning of volatile organic compounds and drinking water. Therefore, it has great potential to be used for protection of environment.

RADIATION PROCESSING PROGRAMME

Radiation processing projects are formulated by taking into account the national priorities such as manufacturing strategy, resource based clusters and the expected output of the project. The following are some of the possible materials, processes and

out put of the research projects undertaken by the Malaysian Institute for Nuclear Technology Research (MINT);

Materials	Process	Output Product/Application
Natural rubber - SMR (Std.Malaysian Rubber) - Epoxidized natural rubber - Latex - Rubber wood fibers **Oil palm** - crude and refined oil - Expoxidized palm oil - Palm oil fibers **Polysaccharide** - Starch from Sago & Tapioca - Chitosan **Thermoplastic** - Low Linear Density Polyethylene (LLDPE) - Linear Density Polyethylene (LDPE) - Ethylene Vinyl Acetate (EVA) - Polypropylene - Polyvinyl chloride - Polystyrene **Thermoset Composite** - polyester - epoxy - carbon fiber	• Blending/Composite • Modification/synthesis • Compounding • Extrusion • Injection molding • Coating/lamination • Casting • Gamma vulcanization, • Electron beam crosslinking, grafting and curing	• Composite profiles such as panels, frame, flooring for construction industry and aerospace industry. • Continues extrusion tube/hoses, sheet/film, pipe, foam, membrane as industrial products • Continues composite sheet, foam for automotive parts such as window trim, rear shaft and front panel etc. • Injection molding of modified and composite materials for automotive parts • Hydrogel for bio-medical application
Environmental pollution - SOx and NOx from power stations and incinerator.	• Cleaning the gases	• Clean air release to the atmosphere. Fertilizers as by product

The list of projects that are being supported by the government and other related agencies and institutions locally and internationally are shown in Annex 2. As can be seen in Annex 2.0, the established technology/material/product type project will only be carried out if there is an end user. This type of project involves the development of

specific compound to meet the product specifications as required by the company or the development of technology that will be immediately transferred to industry.

For a new technology/material/product type project, it is more for applied science and engineering. Although partnership with industry is not prerequisite, nevertheless, the project must indicate the future application and meeting the government requirement on R & D such as increase export, increase quality, productivity, using local materials etc. The output of the project must be clear and the target application should also be identified. Generally, this type of project is related to material development using indigenous polymer and radiation processing technology for industrial or medical applications.

In addition to R & D on new materials and applications using radiation processing, MINT continues to promote radiation technology as safe and reliable technique for sterilization. Gamma sterilization is well accepted and established technology in this region. The effects of radiation on packaging materials, medical products and others such as herbs, pharmaceutical raw materials, species are well documented and published. There is enough industrial experience in radiation sterilization that it is now become routine industrial services and also highly competitive.

Institutional Linkages

The linkages and networking with other institutions and universities are encouraged to optimize the utilization of manpower-expertise and facilities.

In the case of radiation processing, MINT is the leading institution. Other research institutions and universities in Malaysia have no radiation sources to carry out R & D on radiation processing. However, certain institutions have specific expertise and facilities which can be tapped by MINT such as Malaysian Rubber Board (the source of various type of natural rubber and expertise in natural rubber), Universiti Putra Malaysia (the source of research students and fiber characterization), Forest Research Institute of Malaysia (the source for fibers and preparation of fibers), Palm Oil Research Institute of Malaysia (the source of polyol and epoxidized palm oil) etc.

Regional and bilateral linkages are another means of forming strategic alliances whereby each participating country contributes to the development of science and technology on a wider perspective. Utilization of natural and indigenous polymer is one of a good example for this region to collaborate since this region is rich of under utilized natural resources.

Commercialization

In Malaysia, the commercialization of R & D finding can take place in several ways. The usual approach is through direct negotiation between the inventor and the interested company, who has been identified earlier during market survey. However, there are several venture capital agencies that specialize in providing funds for commercialization and for getting industrial partner. In Malaysia, government has developed several agencies to look into the commercialization aspect of research finding. Malaysian Technology Development Corporation (MTDC) has been established for this purpose. MTDC is also acting as a venture capital agency. It is authorized by the government to manage Commercialization of R & D Fund (CRDF) and Technology Acquisition Fund (TAF) to assist the entrepreneur and the private company in the respective areas. In addition, the Ministry of Science is also providing similar fund in the form of grant called 'Industrial Grant Scheme (IGS)' to assist the company to commercialize the R & D finding. The mechanisms for dissemination of R & D finding to the industry are well in place.

On-Going and Futures Projects

As shown in Table 2, most of the on-going projects, which are categorized under the new technology/material/product, are based on the indigenous materials such as natural rubber, palm oil and polysaccharide. The aim of the research is to develop new materials that can be processed (crosslink/grafting) by electron beam irradiation at a competitive cost and to be used either in automobile, construction, or healthcare industry. Other applications of the new materials are for curing of coatings, adhesive, lamination and printing ink.

For future projects, radiation processing of composite materials for automobile, aerospace and construction industry will be given more attention. Local universities and MINT have initiated research on radiation grafting of membranes for fuel cell (battery) and cellulose fibers for plastic composite and the work will continue. Radiation crosslinking of conductive and magnetic polymer for electronic and electrical industry is also being studied at the local university in collaboration with MINT.

At the same time, MINT continues to promote and assist local industry in adopting the established technology such as heat and fire resistant wire, hot water pipe, heat shrink products and others whenever the need arises. On the other hand, purification of flue gases has received great interest from utility company. Joint project between MINT and utility company is initiated and the EB flue gas purification system is operational.

To facilitate the commercialization of the above research work, a facility for polymer processing is being constructed which is expected to be ready by end of 2000. The facility comprises of offices, testing laboratory, workshop and several testing equipment including pilot cum industrial polymer processing machines such as compounder, extruder and injection molding machine.

As for radiation services such as gamma sterilization, the effort is more on product diversification. Currently there are 3 gamma irradiation service facilities in Malaysia. The number may increase in future. This has created a tough competition on the traditional medical disposable products such as rubber gloves, catheters etc. Therefore, efforts are now focus on non-traditional products such as pharmaceuticals, cosmetics, herbs, medical herbs, species and animal feeds. SINAGAMA-MINT gamma sterilization facility has also been awarded ISO9002 and EN46002 which make it attractive for products to be marketed in USA and Europe.

CONCLUSION

In the past several years, there is a significant progress and development on the application of radiation processing in Malaysia. Government continues to support R &

D on this field by providing the necessary infrastructure, facility, trained manpower and research funds. Various mechanisms for commercialization are also in placed to facilitate the transfer of technology from laboratory to industry.

In the private sector, several units of electron bream machines are in operation such as 3 units for heat shrink films and 1 for crosslinking of wire. A few more are in the planning stage for crosslinking of wire and heat shrink sheet. For gamma sterilization facility, three industrial plants are in operation including one at MINT, and two more are at final stage of implementation. It is envisaged that radiation processing will continue to contribute to the progress and development of industry in Malaysia.

ANNEX 1

CLUSTER-BASED INDUSTRIAL DEVELOPMENT

Internationally –Linked Cluster

Industry Groups	Potential Cluster
Electrical and Electronic	Electrical and Electronic
Chemical	Petrochemical / Pharmaceuticals
Textile and Apparel	Textiles and Apparel

Policy – Driven Cluster

Industry Groups	Potential Clusters	
Transportation	Automotive	Marine
	Motocycles	Aerospace
Chemical	Polymer	Composites
	Metals	Ceramics
Machinery and Equipment	Machinery and Equipment	

Resource-Based Cluster

Industry Groups	Potential Clusters
Resource-Based	Wood-Based Products
	Rubber-Based Products
	Palm Oil-Based Products (Food)
	Oil Palm-Based Products (non-food)
	Cocoa-Based Products
Agro-Based and Food Products	Fish & Fish Products
	Livestock & Livestock Products
	Fruits and Vegetable
	Floriculture

ANNEX 2

1999/2000 LIST OF PROJECTS

Division of Radiation Processing Technology, MINT

Established technology/material/product

- Development of heat shrinkable compounds (flame retardant) – funded by IRPA for 1997 – 1999 and supported by local company
- Development of electron beam facility for processing of heat shrink sleeve and heat shrink tubes – funded by local company in 1999/2000
- Electron beam sterilization of medical items. – trial run on industrial samples.
- Utilization of electron beam technology for purification of flue gases in the applications of electricity supply industry - Research cooperation between MINT and Tenaga Nasional Research Development Sdn. Bhd. from 1998 - 2000. The research fund is partially provided by company.

New technology/material/product

- Enhancement of the properties of thermoplastic natural rubber – funded by IRPA for 1997 – 1999. R & D in cooperation with Malaysian Rubber Board.
- Blending of natural rubber with thermoplastic using liquid natural rubber and other additives as compatibilizers – Collaboration with university and supported by IRPA, 2000 - 2002
- Property enhancement in radiation vulcanized natural rubber latex – funded by IRPA for 1997 – 1999. R & D in cooperation with several natural rubbers dipped product manufacturers.
- Radiation processing of water-soluble polysaccharide – funded by IRPA for 1999 and 2000. This project is part of the bilateral project between MINT and Takasaki Radiation Chemistry Research Establishment, JAERI, 1998 – 2000 entitled Radiation Crosslinking of Starch.
- Radiation processing of indigenous polymer (modification of starch from SAGO for biodegradable foam) – RCA/IAEA funded CRP project, 1998 – 2000.
- Radiation processing of chitin/chitosan – funded by IRPA for 1999 and 2000.
- Development of radiation curable materials from palm oil for pressure sensitive adhesive and other application – in house funding and partly funded by company (1996 –1998)

- Basic study on radiation processing of bio-fibers polymer composite materials – funded by IRPA (UPM). Research cooperation between Universiti Putra Malaysia (UPM) and MINT, 1997 - 2000

Note: IRPA (Intensified Research in Priority Area) is a funding scheme for R & D managed by the Ministry of Science, Technology and the Environment.