4.5 Applications of Electron Accelerator in Malaysia

Khairul Zaman Hj. Mohd Dahlan

Malaysian Institute for Nuclear Technology Research (MINT),

Bangi, 43000 Kajang, Selangor Darul Ehsan, Malaysia

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 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, improve quality of life and protect & clean the environment.

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

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.

The current industrial application of electron accelerator fits in well into the country's development program. Electron beam processing is one of the industrial processes that can be used for cross-linking, grafting, elimination of microorganisms, modification of organic compounds, etc. The electron beam 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 electron beam processing are specifically

compounded and are not easily available. Therefore, the introduction of electron beam processing technology in local industry requires mix strategies as follows;

- Established technology/material/product - development of radiation crosslinkable materials for specific use.
- New technology/material/product – development of advanced and modified materials based on indigenous and locally available raw materials
- Development of affordable electron beam accelerators for research and industrial use.

In addition, electron beam 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 industrial wastewater Therefore, it has great potential to be used for protection of environment.

CURRENT APPLICATIONS OF ELECTRON BEAM ACCELERATOR

In Malaysia, there are a number of industrial applications of electron accelerators such as given in Table 1. The main applications are for crosslinking of polymer compounds for wire insulation, tubing (flexible and heat shrinkable), plastic films in particular heat shrinkable film. Most of the companies irradiate in-house products. However, Malaysian Institute for Nuclear Technology Research (MINT) is the only establishment that provides electron beam processing services. Currently, a heat-shrinkable tube manufacturer and a flexible tube manufacturer are using MINT's electron beam processing services. For heat shrinkable tube manufacturer, MINT has transferred the technology of compounding the heat shrinkable resins. MINT has also developed a series of heat and fire resistant compounds that electron beam crosslinkable for wire insulation, tubing and other purposes.

Table 1. Electron Beam Irradiation Facilities in Malaysia

No.	Purpose of Irradiation	Machine specification	Manufacturer	Year establ.	Name of company, Address and contact number
1	Electron beam accelerator CURETRON (research and services) – mainly for curing of surface coatings	200 kV, 20 mA	NHV, Japan	1991	Malaysian Institute for Nuclear Technology Research (MINT)
2.	Electron beam accelerator (research and services) for crosslinking of tubes, heat shrinkable tubes, crosslinking of wire insulation	3.0 MV, 30mA	NHV, Japan	1991	Malaysian Institute for Nuclear Technology Research (MINT)
3.	Electron beam accelerator for cross-linking of wires insulation	800 kV, 100 mA	NHV, Japan	1995	Sumitomo Electric Interconnect Products, Johor
4.	Electron beam accelerator for crosslinking of wire insulation	2.0 MeV, 100 mA	NHV, Japan	2001	Sumitomo Electric Interconnect Products, Johor
5.	Electron beam accelerator for cross-linking of heat shrink packaging film	550 kV, 60mA 2 units		1996	W.R.Grace, Kuantan
6.	Electron beam accelerator for cross-linking of plastic packaging film	150 kV, 460 mA	ESI, USA	1997	S.K.Polymer, Klang.

CURRENT AND FUTURE R & D PROJECTS

The following (Table 2) are some of the possible materials, processes and out put of the research projects undertaken by the Malaysian Institute for Nuclear Technology Research (MINT);

Table 2. Indigenous and locally available materials, processes and expected applications

Materials	Process	Output Product/Application
Natural rubber - SMR (Std.Malaysian Rubber) - epoxidized natural rubber - atex - 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	• 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 and furniture 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 • Biodegradable foams and films for packaging • Pressure sensitive adhesive, printing inks and hard coatings
Environmental preservation - SOx and NOx from power stations and incinerator.	• Cleaning the gases	• Clean air release to the atmosphere. Fertilizers as by product
- Organic & inorganic pollutants from dye conversion industry and food beverage industry	• Cleaning industrial waste water	• Clean water

Table 3. List of Projects Division of Radiation Processing Technology, MINT

Established technology/material/product – using electron beam processing
• Development of heat shrinkable compounds (flame retardant) – completed • Development of electron beam processing for heat shrink tubes – completed • Electron beam sterilization of medical items. – trial run completed. • Utilization of electron beam technology for purification of flue gases in the applications of electricity supply industry - Research cooperation between MINT and TNB Research Sdn. Bhd.- completed by June 2002 • Utilization of electron beam technology for treatment of industrial wastewater from dye conversion industry – beginning 2002 • Development of expertise and capabilities in the design and fabrication of electron beam machine – beginning 2002
New technology/material/product - using electron beam processing
• Thermoplastic natural rubber including epoxidised natural rubber and its compatibilizers. • Sago starch for biomedical applications such as hydrogel for wound dressing • Development of water soluble chitosan for biomedical applications • Modification of sago starch and chitosan such as CMS and CMC • Modification of starch from sago starch for biodegradable foam and films by blending and grafting techniques • Synthesis of radiation curable materials from palm oil for pressure sensitive adhesive (PSA) and printing ink applications • Development of formulation for PSA and printing ink using palm oil based resins • Development of high abrasion and scratch resistant coatings • Agro-fibers reinforced polymer composite compounds for automotive and construction industry

CONCLUSION

In the past several years, there is a significant progress and development on the application of electron beam 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, 2 for crosslinking of wire. A few more are in the planning stage for crosslinking tubes and heat shrink sheet. For gamma sterilization facility, four industrial plants are in operation including Sinagama at MINT. It is envisaged that radiation processing will continue to contribute to the progress and development of industry in Malaysia.