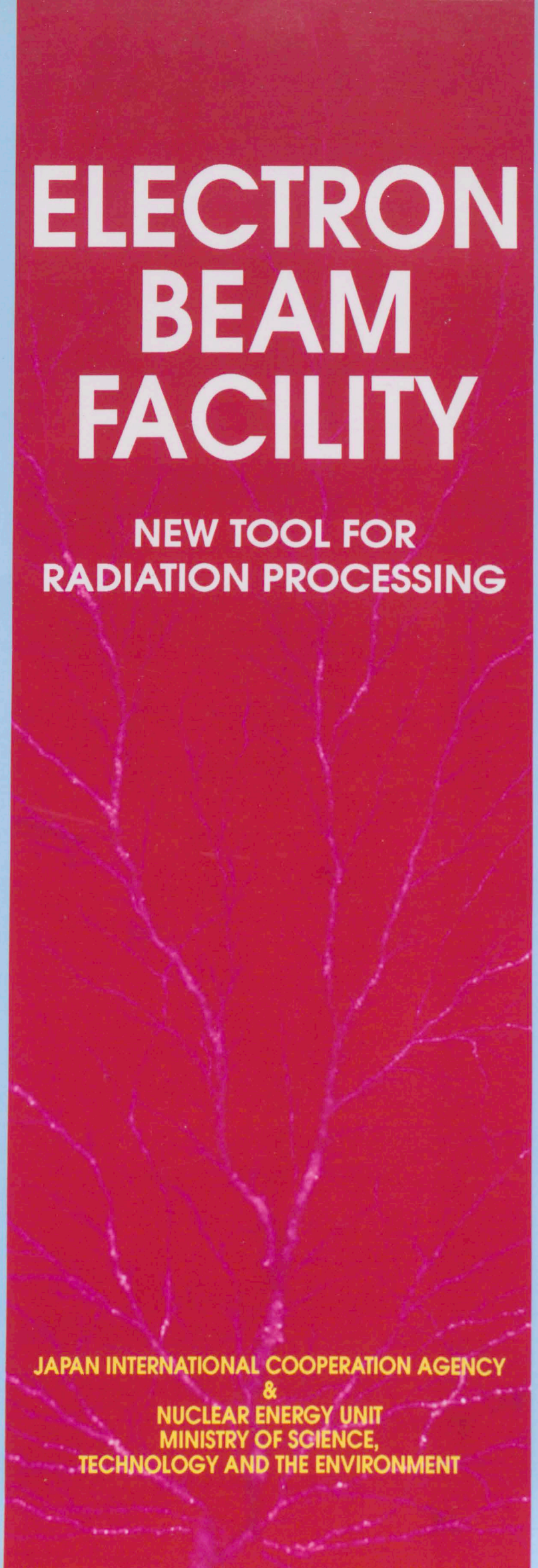
ELECTRON BEAM FACILITY

NEW TOOL FOR RADIATION PROCESSING



JAPAN INTERNATIONAL COOPERATION AGENCY
&
NUCLEAR ENERGY UNIT
MINISTRY OF SCIENCE,
TECHNOLOGY AND THE ENVIRONMENT

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MESSAGE

Technology is an important strategic variable for national development. Malaysia therefore needs technology to consolidate the process of industrialisation and give its areas of natural advantage a competitive edge. As a national research organization, the Nuclear Energy Unit (UTN) shares the vision for the future in that of a nation aspiring to become an industrially-advanced and developed nation.

In our national context, radiation technology can therefore be considered as a new and advanced technology having a great potential in contributing towards our industrial development. In this regard, I am thankful to the Japan International Cooperation Agency (JICA) for its contribution in providing the electron beam machines (EBM), research equipment, expert assistance and including the training of our personnel.

Insofar as the cooperation is concerned I can confidently express that we have successfully implemented the various projects as agreed in the overall programmes. However in realising the real advantages of this technology more efforts and hard work are needed in the subsequent years.

The radiation technology has been developed in many industrialised countries including Japan. The EBM which generates and accelerates electrons is a very useful tool for industry. It can be used in manufacturing process, i.e. to induce chemical and biological changes, in the modification of materials and for sterilisation. The Nuclear Energy Unit is therefore fortunate to have been able to cooperate with JICA in this field. Under this cooperation programme, two projects have been identified for implementation namely EB-curing of surface coatings and sterilization of medical products.

Let me take this opportunity to thank JICA and also those who are involved in this cooperation programme which is beneficial to UTN in particular and to the nation in general. Your efforts are greatly appreciated.

(DR. AHMAD SOBRI BIN HJ. HASHIM)
Director General,
Nuclear Energy Unit.

MESSAGE

The Radiation Applications Project started in 1989 as the first bilateral cooperation project in the field of radiation processing under the Japanese Government technical cooperation program through JICA (Japan International Cooperation Agency). The idea to set up this project was first conceived in 1985, shortly before the start of Fifth Malaysia Plan which emphasied the importance of Research and Development. This project, established in line with the Nation's policy to promote Science and Technology, is of essential character for Malaysia's overall socio-economic advancement, and thus it has been given full support to ensure successful implementation.

Toward this Project, JICA has been extending various forms of assistance such as dispatch of Japanese advisors and reseachers, acceptance of Malaysian counterparts for training in Japan, and provision of equipment including 3 MV and 200 KV electron beam machines. UTN (Nuclear Energy Unit), on the other hand, completed two buildings in its Dengkil Complex to place the electron beam machines, experimental equipment and other facilities for the Project. Assignment of the counterparts and their performance also show the very positivie commitment by UTN to the Project. I am sure that contribution and collaboration by both JICA and UTN will continue and produce a significant result.

I wish to express my sincere appreciation to Dr. Ahmad Sobri, the Director General UTN, and all others who are engaged in the Project, for their every effort to make the Project a success. I hope the Proejct will accomplish its purpose and contribute to the future development of science and technology and thus to the realization of the Vision 2020 in Malaysia.

KAYOKO MIZUTA
Resident Representative
Japan International Cooperation Agency in Malaysia

JICA - UTN COOPERATION PROGRAMME

RADIATION APPLICATIONS PROJECT

Period:
1989 - 1994, 5 Years

Objective:
To establish radiation processing technology using electron beam machine (EBM) at UTN.

RESEARCH SUBJECTS

* Sterilization of medical products using EBM
* EB-curing for surface coatings

CONTENT OF COOPERATION

Provision of equipments:
3.0 MV EBM
200 kV EBM (Curetron)

Training of UTN staff:
3 persons per year

Despatch of experts:
Several short team experts per year

SPECIFICATION OF 3.0 MV EBM

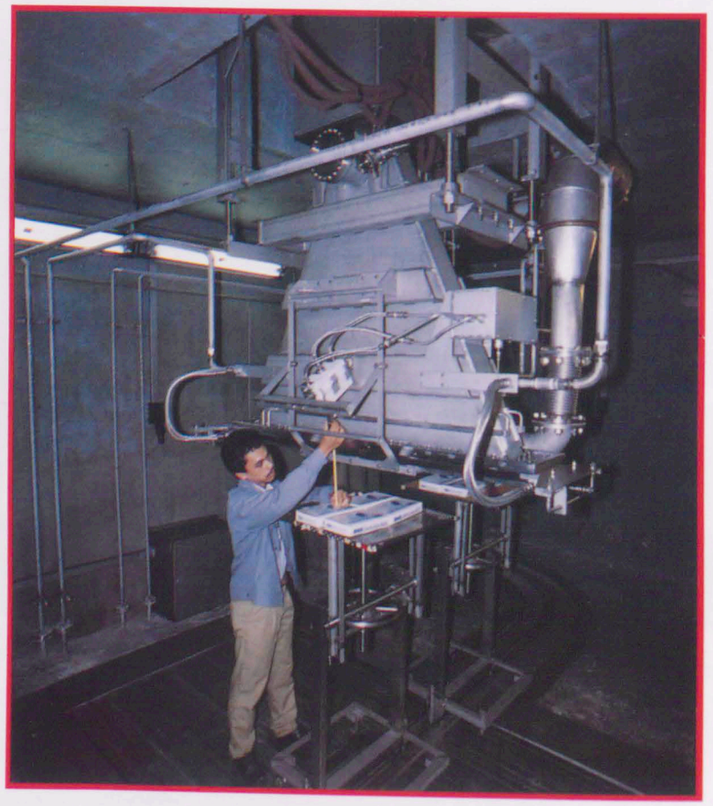
Accelerator Voltage	:	3 MV (0.5 - 3.0 MV) Stability ±2%
Beam Current	:	30 mA (1 mA - 30 mA) Stability ± 2%
Beam Width	:	120 cm (30 - 120 cm)
Dose Uniformity	:	± 5%
Conveyor Speed	:	1 - 20 m/min

SPECIFICATION OF CURETRON

Accelerator Voltage	:	200 kV (150 - 200 kV)
Beam Current	:	20 mA (1 - 20 mA)
Beam Area	:	15 x 15 cm
Dose Uniformity	:	± 10%
Conveyor Speed	:	3 - 30 m/min
Oxygen Concentration	:	< 500 ppm
X-ray Leakage	:	< 0.6 µSv/hr

200 kV EBM (Curetron)

3.0 MV electron beam accelerator in the accelerator room



Scanning horn and conveyor cart in the irradiation room

PROJECT IMPLEMENTATION

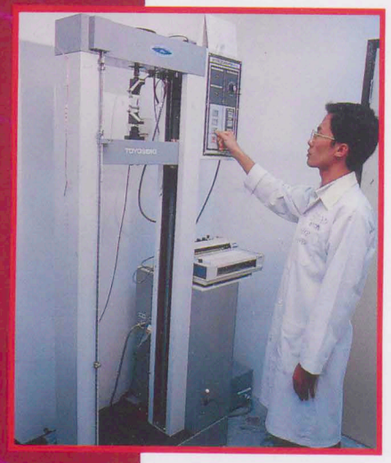
In order to ensure the successful implementation of the project:

* two JICA personnel are stationed at UTN.
  - a team leader
  - a coordinator

* JICA provides several major research equipments
  - CTA film dose meter
  - Gel permeation chromatograph
  - Current density meter
  - EBM operation data recorder
  - Weater-o-meter
  - Geer oven
  - Chemiluminescence
  - Izod impact tester
  - Tensile strength tester
  - Roller coater
  - Laminator
  - Curtain coater
  - Melt flow indexer
  - Crystallization rate analyzer
  - Abrasion tester
  - Infrared spectrophotometer
  - Dynamic mechanical analyser
  - Three roll mill
  - Two roll mill

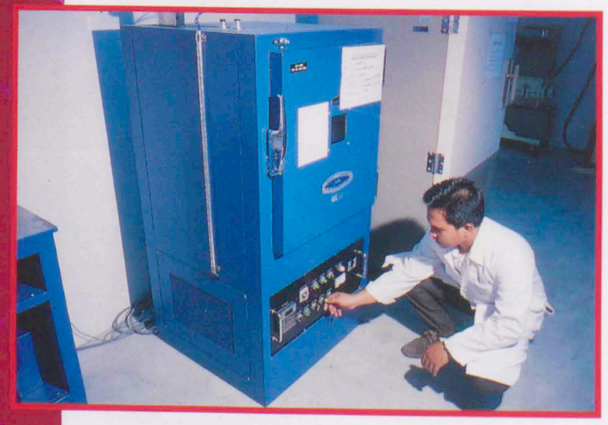
* UTN provides two new buildings, one for the EBM and the other concerned radiation technology laboratories, as well as related research equipments and manpower to carry out the project.

Control room of the EBM has a finished rubber wood parquet floor coated with palm oil & liquid natural rubber acrylate resin which were cured by using EB Irradiation.

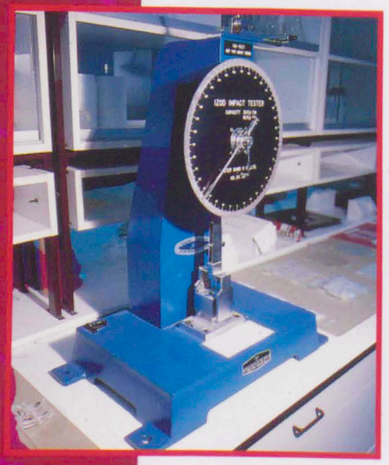


Tensile strength tester

Crystallization rate analyzer



Geer oven



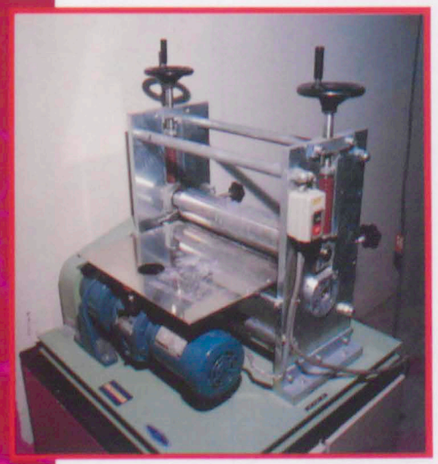
Impact tester

Abrasion tester

Refrigerated contrifuge

Autoclave

Dynamic mechanical analyer



Laminator

Infrared spectrophotometer

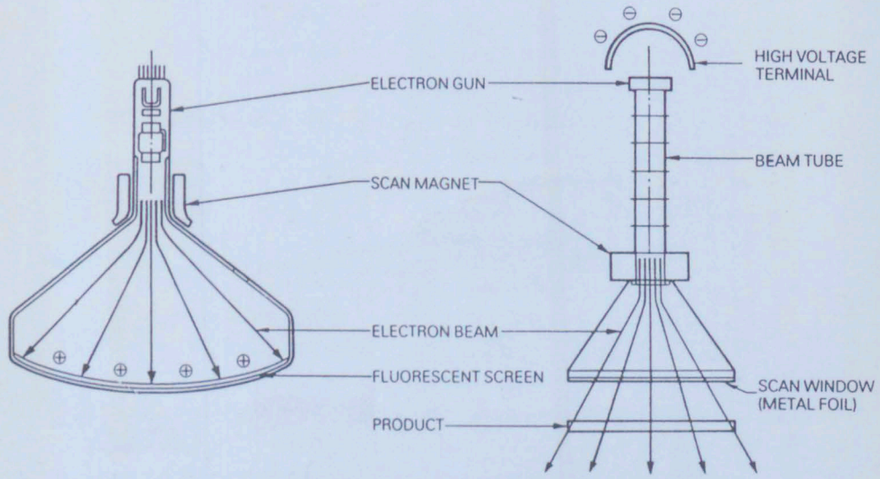
Roller coater

Weather-o-meter

Curtain coater

Two roll mill

PRINCIPLE OF ELECTRON ACCELERATION

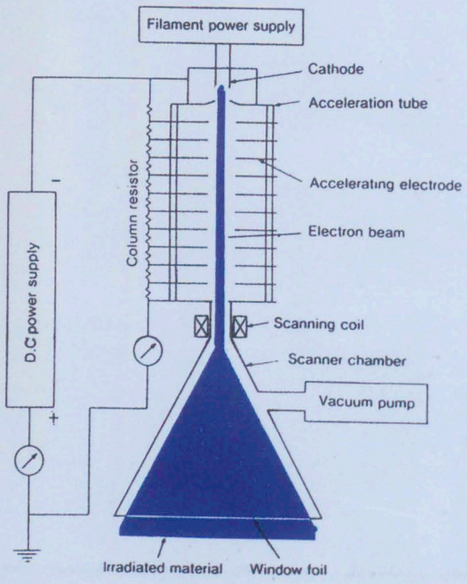


TV TUBE

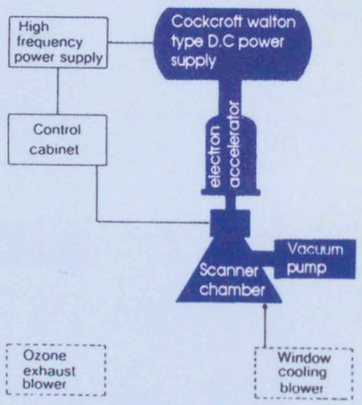
SCANNED BEAM ELECTRON ACCELERATOR

The principle pertaining to electron acceleration in EBM is similar to that of the TV. Thermal electrons generated from the Tungsten filament are accelerated through a vacuum tube by the force of high voltage (a voltage of 25 kV is for TV whereas a voltage of 3000kV is for EBM). The accelerated electrons pass through the metal foil of the scan window and subsequently irradiate products that pass beneath the scan horn. The higher the voltage of the EBM, the deeper the penetration of electrons into the product. The beam current is an indication of the number of electrons being accelerated. In TV, beam current is in the order of several microamps whereas of EBM, the beam current is in the range of 1 to 30 milliamps.

STRUCTURE OF EBM



Construction of EPS



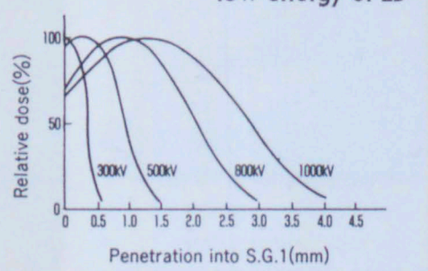
CHARACTERISTICS OF ELECTRON BEAM

- High dose rate : 100 kGy/sec, 36,000 times higher than Co-60 facility.
- High efficiency : beam irradiates only desired area for processing.
- Finite absorption : EB has a limited penetration that varies with energy.
- Operation safety : can be turned-on and turned off. No radioactive contamination.
- Simple operation : fully computer control. Preset operation parameters.

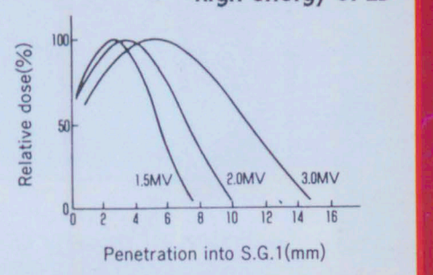
Depth-dose curve

Energy deposition of EB varies with depth in the sample. In order to determine the penetration capability of the electrons, depth-dose curves are used to illustrate the relationship between penetration depth in material of specific gravity and relative energy given to the material.

low energy of EB



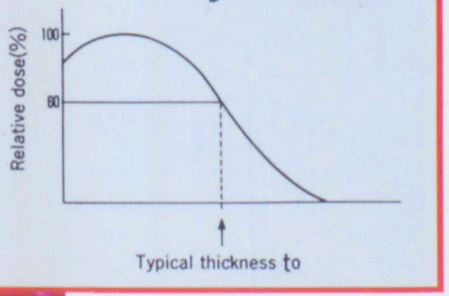
high energy of EB



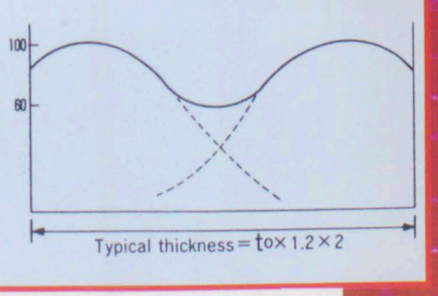
Double side irradiation

For a thick sample, irradiation is done for both side. This technique increase the processability of thicker samples and improves dose uniformity.

single side irradiation

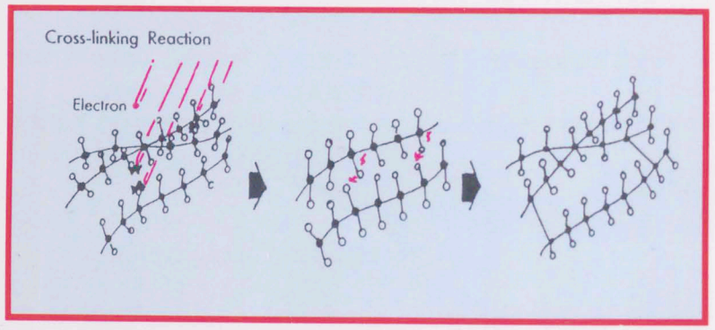


double side irradiation

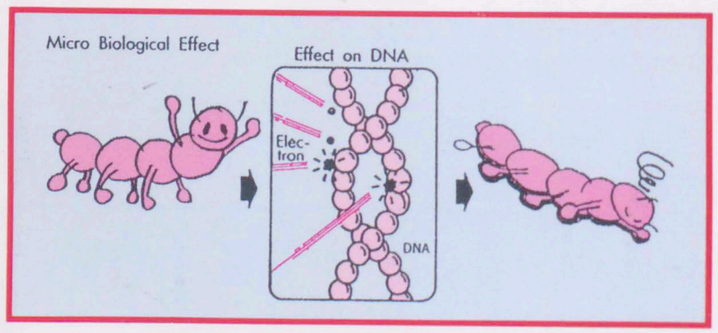


EFFECTS OF IRRADIATION

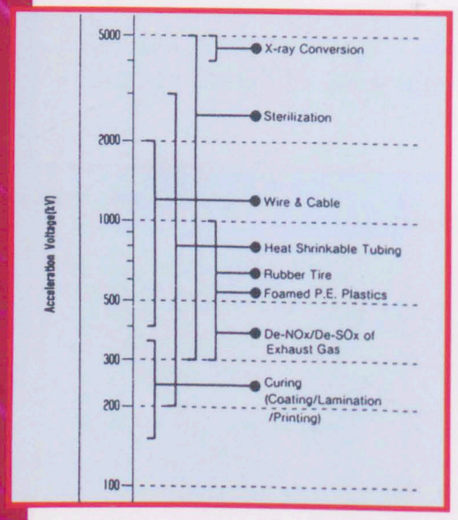
Chemical effect: Crosslinking, degradation and polymerization

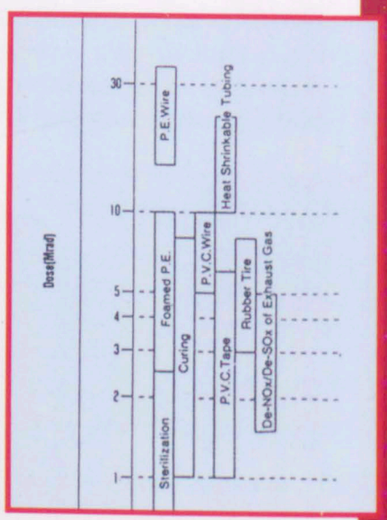


Biological effect: Sterilization



Selection of energy and dose
The most suitable EB energy and dose have to be selected for each application.



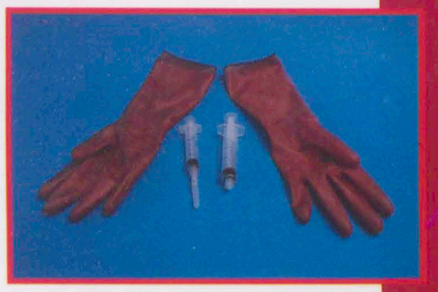


APPLICATION OF EBM

EBM is used in various industrial production.

STERILIZATION

- Sterilization of medical products such as
  surgical rubber gloves
  catheters
  syringes
  etc.



- Sterilization of food packaging container
- Drinking water

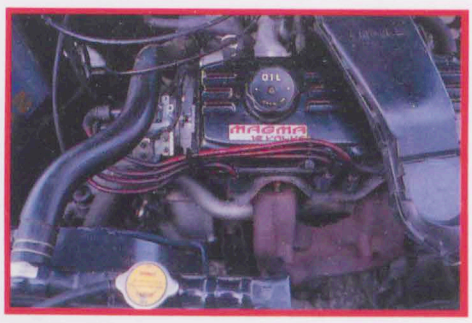
COATINGS

- Coating of plywood
- Coating of decorated tiles
- Glossy paper
- Printing ink
- Laminating

- Coating of floppy disk/magnetic tape
- Printed circuit board
- Coating of steel sheet/ coil

CROSSLINKING

- Heat resistant insulating wire and cable
- Heat shrinkable tubing/sheet
- Heat shrinkable film



- Improved green strength for rubber tyres
- Foamed polyethylene

ENV IRONMENTAL PRESERVATION

- Treatment of flue gases/NOx and SO2

- Disinfection of sewage sludge

NUCLER ENERGY UNIT,
MINISTRY OF SCIENCE, TECHNOLOGY AND THE ENVIRONMENT,
KOMPLEKS PUSPATI, BANGI,
43000 KAJANG.
TEL: 03-8250510 TELEFAX: 03-8258262

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