Radiation Equipment Fabrication Center and Its Applications

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1. Introduction

Core-technologies of radiation equipment mainly consist of two parts: a radiation detection system and a radiation generation system by using an electron accelerator. The radiation equipment fabrication center at ARTI (Advanced Radiation Technology Institute) is running in 2016 to secure a bridgehead of domestic radiation equipment development and industrialization. In this paper, a status of the Fab. Center together and its applications are addressed.

2. Radiation Equipment Research & Fab. Center

Key infrastructures of the Fab. Center are a crystal growth facility, a semiconductor fabrication process facility, evaluation facility and a radiation equipment test facilities.

Fig. 1. Radiation Equipment Fabrication Center

2.1 Crystal growth facility

There has been a development drift in radiation detector materials from a gas-filled detector to a scintillator and semiconductor. Most of scintillators and compound semiconductors can be growth in a crystal growth facility.

Table I: Summary of crystal growth equipment and their utilization

Furnace	*Utilization*
Vertical Bridgman Furnace	Compound semiconductors (CdZnTe, CdTe, CdMnTe, ZnS, CdS, ZnSe, ZnTe, CdSe, $PbMoO_4$ etc.)
Traveling Heater Furnace	Ccompound semiconductors (CdZnTe, CdTe, CdMnTe, etc.)
Czochroski Furnace	Crystal growth for oxide scinitllators ($Bi_4Ge_3O_{12}$, $CdWO_4$, Lu_2SiO_5 etc.)
Zone Melting Furnace	Purification of compound semiconductors
Vacuum Distillation Furnace	Purification of compound semiconductors and scintillators
Sublimation Purification Furnace	Purification of compound semiconductors and scintillators
Horizontal 3-zone Furnace	Quartz tube preparation etc.

Fig. 2. Crystal Growth Facility

2.2 Semiconductor fabrication process facility

Nominally 1 μm line-width semiconductor process is possible in a semiconductor fabrication process facility. Bulky compound semiconductor such as CdZnTe, CdTe, TlBr, etc. can be processed as well as Si in comparison with other semiconductor process Fab.

Table II. Summary of semiconductor process equipments and their utilization

Fabrication Process Equipment	*Utilization*
Mask Maker	Photo-mask making
Contact Aligner, Mask Aligner	Photolithography
Spin Coater & Baker	Photolithography
Spin Rinse Dryer	Photolithography
Dry Etcher	Etching process
Wet Etcher	Etching process

Oxide Etcher	Oxide etching process
Inductively Coupled Plasma Reactive Ion Etcher	Dry etching process
Plasma Asher	Cleaning
Oxidation Furnace	Oxide formation
Diffusion Furnace	Diffusion
Wet Station	Cleaning, Etching
Plasma-enhanced chemical vapor deposition (PECVED)	Thin film formation
Low Pressure Chemical Vapor Deposition (LPCVD)	Thin film formation
Sputter	Metallization, Radiation converter deposition
Thermal Evaporator	Metallization, Radiation converter deposition
Electron Beam evaporator	Metallization, Radiation converter deposition
Dicing Machine	Semiconductor cutting
Wire Bonder	Signal wiring
Flip-chip Bonder	Pixel-type semiconductor signal extraction
Reflectometer	Thickness measurement

Fig. 3. Semiconductor fabrication process facility

2.3 Evaluation facility

Materials and radiation detectors can be evaluated in evaluation facility.

Table 3. Summary of evaluation equipments and their utilization

Evaluation equipment	*Utilization*
Altitude Test chamber	Temperature and humidity effect test
Atomic Force Microscope	Surface roughness
Optical Microscope	Inspection for single crystal and semiconductor
Optical transmittance measuring system	Scintillator, semiconductor transmittance inspection
Probe station	Semiconductor characterization
Hole measurement system	Semiconductor characterization
Ellipsometer	Dielectric constant, Reflective index
Photoluminescence Measurement system	Photoluminescence Measurement for semiconductor
IR mapper	3D impurity measurement
X-ray fluorescence spectrometer	Elemental analysis
Current source	Radiation detector and electronics evaluation (Electrical response)
Nuclear instrument modules	Radiation detector evaluation (Radiation response)
Oscilloscope	Radiation detector and electronics evaluation
Table-top SEM	Microstructure, EDX characteristics

2.4 Radiation Equipment test facility

Fig. 4. Radiation Equipment test facility

This facility is used high energy radiation equipment test such as a missile inspection system and a radiation therapy system by using electron beam accelerator. High energy radiation up to 15 MeV and 6 feet size of a radiation equipment can be tested in this facility.

2.5 The Fab. Center Application

Radiation detection and radiation generation systems can apply various fields such as atomic energy industry, material/heavy chemical industry, nano-technology, and medicine/biotechnology industry. Developments and its extended products are shown in Table 4. The fab. Center provides one-stop service from the manufacture

of a radiation equipment to performance testing and anyone can use this facilities.

Table 4. Application fields and extended products of radiation equipments

Application Field	*Products*
Atomic energy industry	Radiation Monitoring System (RMS), personnel dosimeter, environmental radiation monitoring in the vicinity of nuclear power plant, radioactive waste storage facilities, and etc
Material/heavy chemical industry	Ssuperfine material, novel material, molecular thin-film processing instrument, polymer reform processing instrument, and etc
Nano-technology industry	Semiconductor physical property device, nano-particle sizing device, nano-particle manufacture device, new material characterization device, neutron image system, and etc
Medicine/bio-technology industry	Positron Emission Tomography (PET), Digital Radiography (DR), Computed Tomography (CT), Mammography, Cyber knife, Intensity Modulated Radio Therapy (IMRT), Tomography, X-ray image system, sterilization of food and medical appliances, plant breeding,, radioactive medicine, and etc

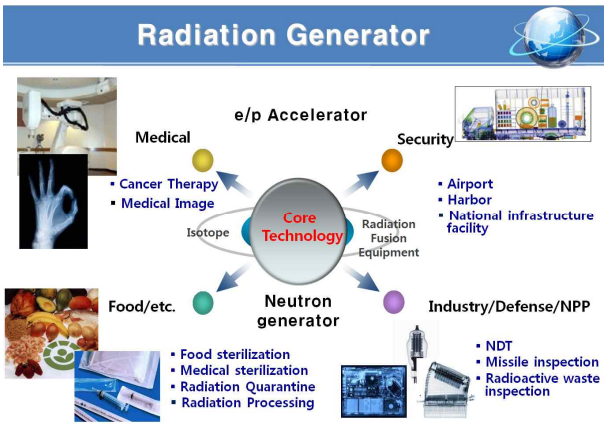

Fig. 5. Applications of a radiation generator

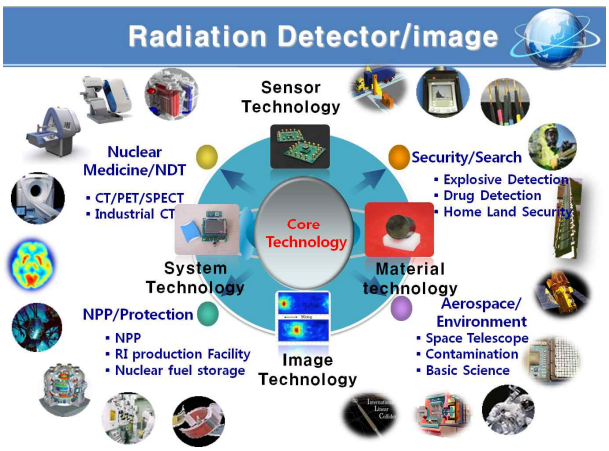

Fig. 6. Applications of radiation detectors/image

3. Conclusions

Most of radiation equipments used in domestic region are imported from foreign country. In this situation, the fab. Center is utilized for the development of bottleneck-technologies and incubation of matured technologies to accelerate the industrialization of radiation equipments. This facility will be an R&D hub combining the human resources of a university, an infrastructure of a research institute, and the market needs of industry. This facility will also contribute to scale-up of the radiation equipment industry through the promotion of technology and contribution to the Cheon-buk R&D-leading innovation cluster.

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