THAI SYNCHROTRON FACILITY: IT'S PAST AND PRESENT

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Abstract

This review provides a brief on Synchrotron Light Research Institute (SLRI), Thailand, the available light source and beamlines. The information is a background to our readers to appreciate the research materials published in various articles in this issue of the journal.

Introduction

Our history started 22 years ago. A group of Thai senior scientists and educators agreed on a submission of a proposal to acquire for a used second-generation synchrotron machine from Japan. This machine was owned by a group of Japanese companies called SORTEC Corp. It was originally designed for an X-ray lithography process for manufacturing of integrated circuits. Since the manufacturing process changed, using synchrotron light was no longer economical. Japan then wanted to donate the machine to a country with a good commitment. Although there were a few countries applied for this synchrotron machine, the Japanese Government granted the opportunity to Thailand. The National Research Council, Chiang Mai University and Suranaree University of Technology were instrumental to the success. Up till now, Synchrotron Light Research Institute has been functioning as a Public Organization specializing in advanced light source. The Institute as one major scientific infrastructure of Thailand provides supports to home, ASEAN and international users. It succeeds to serve the users more than 4000 h annually with an excellent record of 95% availability.

This review gives our readers orientation of Thai synchrotron institute and our light source. This should be an adequate background for the readers to enjoy the scientific materials presented by each article appearing in the issue of the journal.

Historical Remarks

Originally, the machine had a circular electron storage ring. Installation of insertion devices was not possible. Leading by Associate Professor Dr. Weerapong Pairsuwan, the current Permanent Secretary to the Ministry of Science and Technology and the Executive Board Chairman of the Institute, a group of Thai physicists redesigned the storage ring such that it contains several straight sections for installation of insertion devices. This has marked a new era of the second-generation synchrotron machines. The list below shows some of our historical events to be remembered:

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1996: Thai Government accepted the donation of the synchrotron machine by SORTEC Corp., Japan. Its worth was more than 250 million-USDs.

2001: Electron storage ring operated successfully, and the first synchrotron light was observed.

2003: Service to users was launched.

2005: Upgraded the electron storage ring to 1.2 GeV (from the 1.0 GeV energy level).

2008: The Institute gained the status of being Public Organization.

2012: Successful in stabilizing of the electron orbit in the storage ring by using fault tolerant control technique. The orbit has been levelled consistently such that its center is allowed to fluctuate within 4 microns.

2014: Successful in installation and commissioning of a Superconducting Wave Length Shifter and a Multipole Permanent Wiggler Magnet. The synchrotron machine has been able to produce hard x-ray for use.

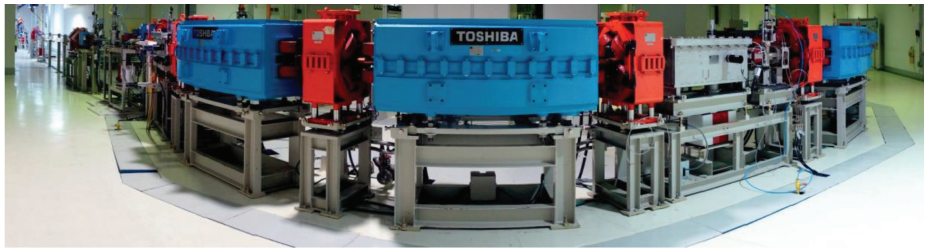
2015: Successful in commissioning two new beamlines, i.e. protein crystallography and IR beamlines, respectively.

Present Status

Synchrotron Radiation Source has been known as the most powerful man-made light source. It can produce Polarized light and collimated photon beam ranging from infrared to hard x-rays. To construct and operate the synchrotron machine properly requires several engineering technologies and skills including ultrahigh vacuum technology, cryogenic technology, high-precision mechanic, microwave and RF technology, electronic and control. The information below provides our readers adequate background about our machine and synchrotron techniques being offered to the users.

Machine

Our synchrotron machine consists of 4 main parts namely (i) electron gun, (ii) linear accelerator or linac, (iii) booster synchrotron or simply synchrotron ring, and (iv) electron storage ring. The machine produces photon by accelerating electrons up to very near the speed of light, and then force them to curve by using magnetic force field such that the being curved electrons emit photon energy in order to preserve their life. The followings are important storage ring specifications: energy 1.2 Gev, stored current



(a)

(b)

Figure 1. (a) Synchrotron booster, (b) storage ring

150 mA, emittance 41 nm-rad, lifetime@100 mA 12 h, injection energy 1.0 GeV and circumference 81.3 m. (For more information, readers should visit our website www.slri.or.th)

Beamlines and Techniques

Synchrotron light is transported from bending magnets of the storage ring through photon beamlines to experimental stations. The photon beamlines must be ultrahigh vacuumed to avoid some kinds of hazardous electromagnetic radiation. Along the beamlines, several optical filters are in operation in order to focus, diffract, and collimate the light beams. Such high-quality light beams reach the experimental stations, where the samples to be investigated are situated. For many years, experimental techniques using synchrotron light have shown their invaluable assets to advanced studies of materials in all forms. In particular, when scientists want to know elemental compositions, atomic and molecular structures of the materials of interests, none of the conventional methods can match the synchrotron radiation techniques.

Summary of the beamlines and their techniques are as follows:

Beamline I: Time-resolved X-ray absorption spectroscopy for in-situ chemical and structural investigation of materials (donated by Bonn University, Germany).

Beamline II: Small/wide angle X-ray scattering for nano-structural investigation of materials and nano-particle size analyses.

Beamline III: Photoemission electron spectroscopy for surface, interface and thin-film material researches.

Beamline IV: Photoemission electron microscopy for surface, interface and thin-film material researches.

Beamline V: Infrared spectroscopy for biomedical, biological and environmental science researches.

Beamline VI: X-ray absorption spectroscopy for chemical and structural investigation of materials (jointly owned by Suranaree University of Technology, National Nanotechnology Center and Synchrotron Light Research Institute).

Beamline VII: Deep X-ray lithography for fabrication of high-aspect-ratio microstructures.

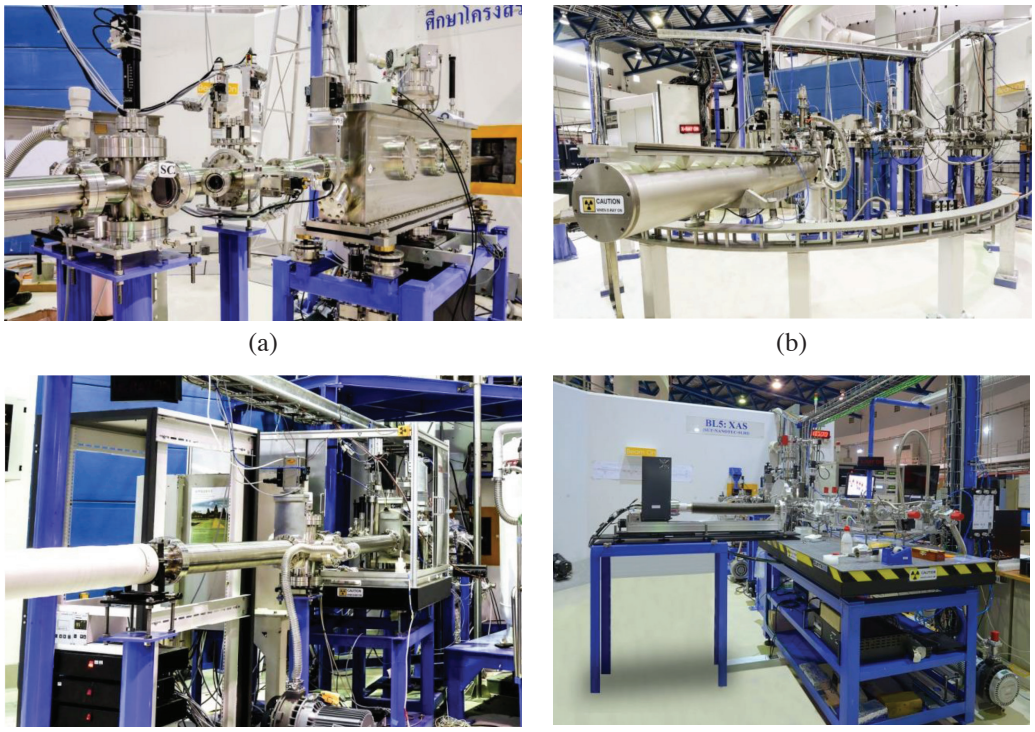
Beamline VIII: Micro-X-ray fluorescence spectroscopy and imaging for elemental composition analysis and mapping.

Beamline IX: Hard X-ray technique for protein crystallography research.

Beamline X: X-ray absorption spectroscopy for chemical and structural investigation of materials.

The institute is expecting two new beamlines to be on service in the near future, i.e. hard X-ray multiple techniques and tomography, respectively. The main users are academic, while the insti-

Figure 2. Experimental hall at Synchrotron Light Research Institute, Korat



(a) (b)

(c) (d)

Figure 3. (a) Small angle X-ray scattering beamline, (b) Time resolved X-ray absorption spectroscopy beamline, (c) Micro X-ray fluorescence spectrocopy/imaging beamline, and (c) SUT-NANOTEC-SLRI beamline

tute has been trying to increase the number of industrial users. In 2014, we were successful to collaborate with industries to provide solutions to their research questions resulting in economic impact of 1900 million baht, approximately.

Conclusions

My short review serves our readers orientation of the only synchrotron light source in Thailand. It is the largest one in ASEAN, and an open facility for all. The institute has been serving Thai, ASEAN and international scientists from around the globe. We annually provide 12-15 trainings of specific synchrotron techniques for our users. Connecting us is very easy through our homepage (www.slri.or.th), where readers can find detailed technical information about our machine and beamlines, and channels to apply for beamtimes or trainings.