BL practice

BL17SU : Instrumentation for Time-resolved Soft X-ray Emission Spectroscopy

1. Introduction

Soft x-ray emission (SXE) spectroscopy is a technique which is applicable to investigation of electronic structure of various systems such as solid, surface adsorbate, gas, liquid and solution. Recently, a time resolving two dimensional position encoder [1] has been applied to the detection system of the SXE spectrometer [2] installed at BL17SU [3]. This enables us to perform time-resolved measurement for SXE spectrometry.

In the course, the participants will learn a principle of the position encoder as well as the soft x-ray emission spectrometer, and gain experience in time-resolved measurements. The course will include alignment and evacuation of the apparatus, sample preparation and introduction to the sample bank chamber and transfer to the main chamber under UHV condition, calibration of the BL monochromator by measuring some absorption spectra of gaseous target, data acquisition with various NIM and CAMAC modules, and measurement of soft x-rays scattered by a Au sample or emitted from unknown materials by the SXE spectrometer. The full menu of the course will last for two days.

2. Outline of the soft x-ray undulator beamline BL17SU and the experimental apparatus

BL17SU is aimed at advancing the spectroscopic studies for mainly solid state physics and materials science using high brilliant soft x-ray undulator radiation. Photoabsorption, photoemission and SXE spectroscopies are adopted to investigate the electronic structure of various kinds of materials. A novel insertion device ID17, called a multi-polarization-mode undulator, has been developed for BL17SU [4], and ID17 can be operated as a helical, elliptical, pseudo-linear or pseudo-vertical undulator. The intense soft x-ray beam of circularly/linearly polarized light or the mixed polarization state of the beam can thus be obtained by changing the operational mode of ID17. The BL has branched beamlines (branch-a and -b) which can be switched by the pre-mirror and used alternatively. Each branch has high resolution and highly stabilized monochromator [3,5] and several end-stations. The available energy is ranged between 300 and 1800 eV. The resolving power $E/\Delta E$ of the monochromator is higher than 10,000 and the flux is of the order of 10^{11} photons/s.

In this course, we will utilize the instruments for time-resolved SXE spectroscopy newly installed at Bc station of the branch-b. A flat field spectrometer developed for the SXE spectroscopy [2] is remodeled for the time-resolved measurement. The apparatus consists of the main chamber equipped with the xyzθ-sample-manipulator, the SXE spectrometer and the sample bank chamber with sample transfer equipments. The squared DLD is mounted as the detector for the SXE spectrometer. Various kinds of NIM and CAMAC modules are prepared, and the position of the dispersed soft x-ray is visualized by encoding all the analog signals from the DLD.

3. Experimental procedure

3.1 Alignment of the apparatus.

By using a laser transit, the apparatus will be aligned to the photon beam axis. At this moment, the apparatus will be under the condition of atmospheric pressure.

3.2 Evacuation of the apparatus.

After the alignment, the apparatus will be sealed and evacuated.

3.3 Calibration of the BL monochromator.

During the evacuation of the apparatus, calibration of the BL monochromator will be performed at the different station, e.g. beam diagnostic station, by measuring some absorption spectra of gaseous target such as Ne and O_2 gas.

3.4 Sample preparation.

Two samples will be used for the course. One is the Au thin film for the adjustment of the SXE spectrometer, and the other one is unknown sample which is a powdered materials. The participants will be asked to prepare the pellet of the powder as a sample. In the menu of 3.6, the participants will examine the unknown materials by measuring the characteristic x-rays emitted from the sample.

3.5 Adjustment of the DLD position encoder.

Preparation of the electronic circuit, such as various NIM modules, will be performed. All the signals from the DLD position encoder are fed into the discriminator and the output NIM signals are fed into the Time-to-Digital Converters (CAMAC TDC).

3.6 Measurements of soft x-ray spectra.

At first, the SXE spectrometer will be calibrated by using the calibrated soft x-rays provided from the BL monochromator. After the calibration of the SXE spectrometer, the participants will transfer the unknown sample from the sample bank chamber to the main chamber under the UHV condition. Then the participants will measure the characteristic x-rays emitted from the unknown sample. The energy of the exciting photon beam will be adjusted appropriately and the participants will be asked to examine the unknown materials.

3.7 Discussion for the available time-resolved measurement.

At the end of the course, we will discuss about the potential use of the time-resolved SXE spectrometer. Several applications will be introduced.

References

[1] Time and position sensitive delay line detector (DLD) with microchannel plates (MCP) ; See, for example, http://www.roentdek.com/index.html

[2] T.Tokushima *et al.*, Surf. Rev. Lett. **9**, 503 (2002).

[3] H.Ohashi *et al.*, AIP Proc. **879**, 523 (2007).

[4] T.Tanaka *et al.*, Rev. Sci. Instrum. **73**, 1724 (2002) ; K.Shirasawa *et al.*, Phys. Rev. ST Accel. Beams **7**, 020702 (2004) ; K.Shirasawa *et al.*, AIP Proc. **705**, 203 (2004) ; M.Oura *et al.*, J. Synchrotron Rad. **14**, 483 (2007).

[5] Y.Senba *et al.*, AIP Proc. **879**, 718 (2007).