BL Practice
BL27SU : Soft X-ray Photoemission and Photoabsorption Spectroscopy

1. Introduction

In this course, the participants will practice experimental methods of soft x-ray photoemission and photoabsorption spectroscopy.

Photoemission spectroscopy (PES) is a technique to study electronic states of solids. One of the advantages of using soft x-rays with photon energies ~ 1keV for the excitation light is to increase bulk sensitivity compared to the use of low energy light (≤ 100 eV). Furthermore, highly energy-resolved soft x-rays obtained by combining the high-brilliance synchrotron light source and high-resolution monochromator of SPring-8 make it possible to observe detailed electronic structures.

Soft x-ray absorption spectroscopy is also useful to study electronic states of various materials, because the energy range of soft x-rays includes many absorption edges of light elements as well as transition and rare-earth metals. For metallic materials, the total electron yield method is conventionally used, where the drain current of samples is measured. This method is, however, not applicable to insulators. In this course, we will try to obtain some photoabsorption spectra by means of the fluorescence yield method which can be applied to insulators.

2. Experiments

2.1. Photoemission spectroscopy

The participants will mount a sample on a sample carrier. Silicon single crystal will be used for the sample. The sample carrier will be installed into the airlock of the ultrahigh vacuum system. After pumping the airlock, the sample carrier will be transferred to the measurement chamber and set on the sample manipulator. For PES measurements, clean surfaces of samples are required. In this course, a clean surface will be obtained by cleaving the sample in the vacuum. A hemispherical-type photoelectron analyzer is used for the PES measurements. Before the measurements, we have to set the parameters of the beamline such as the gap of the undulator, photon energy, and resolving power of the monochromator. This can easily be done with a control software. After setting the beamline parameters, the sample position will be adjusted by the motor-driven sample manipulator to the best position where we can get the maximum photoemission intensity. Then we will observe some valence band and core level photoemission spectra.

2.2. Photoabsorption spectroscopy

A fluorescence yield detector is mounted on the chamber for the PES measurements. The detector is mainly composed of a couple of microchannel plates (MCPs) and a grid placed in front of the MCPs. The grid is used to prevent ions from coming into the MCPs. A negative high voltage is applied on the entrance of the MCPs to repel electrons. Then, the fluorescence can exclusively be detected by the MCPs. This detector is used for measurements by means of the total fluorescence yield. There is also another type of detector called silicon drift detector (SDD) mounted on another chamber of the beamline. By using the SDD, we can measure the partial fluorescence yield, which is effective particularly for elements with low densities in solids like dopants. The partial fluorescence yield method will also be tried in this course. Absorption spectra are measured by scanning the undulator gap as well as the monochromator to keep the maximum intensity of the incident soft x-rays. The drain current of a post-focusing mirror is used to normalize the photon flux.