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 powerful technique for studying electronic states in solids. Using soft x-rays with photon energies ~ 1keV for the excitation light has the advantage of increased bulk sensitivity compared to the use of low energy light (≤ 100 eV). The high energy resolution and high flux obtained at SPring-8 by combining the high-brilliance synchrotron light source with a high-resolution soft x-ray monochromator make it possible to observe electronic structures with unprecedented detail. During the course we will record photoemission spectra at the high-resolution soft x-ray beamline BL27SU.

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

2. Experiments

2.1. Photoemission spectroscopy

Firstly, the participants will mount a sample onto a sample carrier which is a copper plate sample carrier, which has with a size of about 2 × 2 cm. A NiO single crystal will be used for the sample. The sample carrier will be installed into the airlock of the ultrahigh vacuum system. After evacuating the airlock, the sample carrier will be transferred to the measurement chamber with a transfer rod, and attached to the sample manipulator. For PES measurements, a clean sample surface is required. This will be obtained by cleaving the sample in the ultrahigh vacuum chamber. A hemispherical-type photoelectron analyzer will be used for the PES measurements. Before the measurements, we have to set the parameters of the beamline such as the undulator gap, photon energy, and resolving power of the monochromator. This can easily be done using the system control software in place at the beamline. After setting the beamline parameters, the sample position will be adjusted using a motor-controlled sample manipulator to the position of maximum photoemission intensity. Then we will record some valence band and core level photoemission spectra.

2.2. Photoabsorption spectroscopy

The fluorescence yield detector is also mounted on the same chamber used for the PES measurements, so we can measure photoabsorption spectra for the same sample without breaking the vacuum. A micro-channel plate detector (MCP) is used for the fluorescence yield detection, which is carried out by the pulse counting of MCP signals. The sample position will be re-adjusted for maximum count rate. Photoabsorption spectra are measured by simultaneously scanning both the monochromator postition and the undulator gap. The drain current of a post-focusing mirror is also monitored to allow normalization to the incident photon flux. We will record the Ni 2p and O 1s absorption spectra of NiO.

The experimental setup, viewed from above.