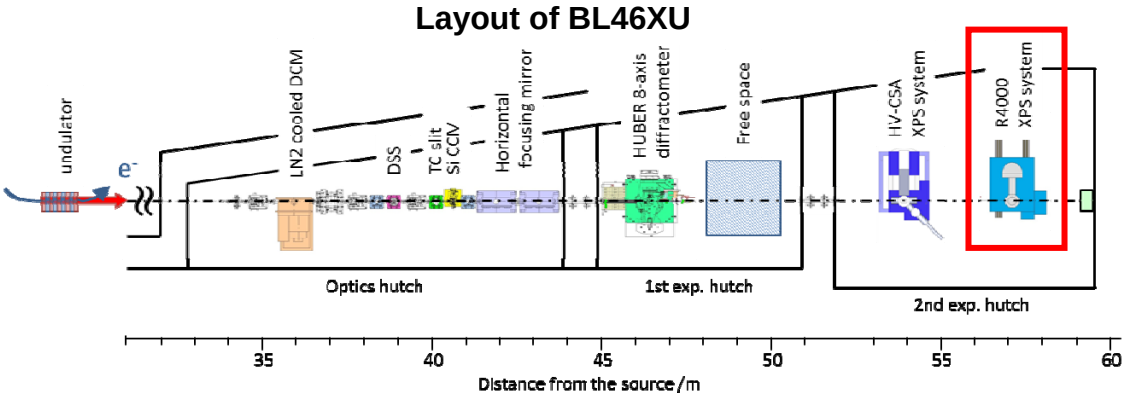
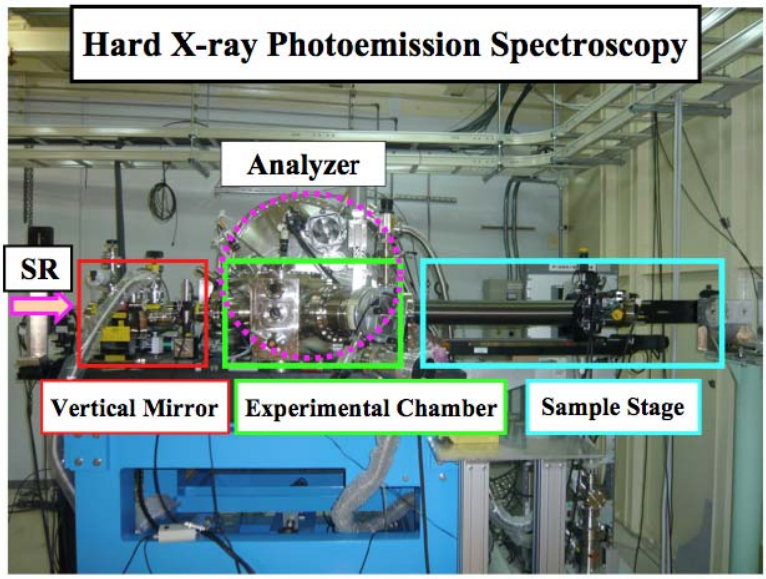
BL46XU Hard X-ray Photoelectron Spectroscopy (HAXPES)

BL46XU is an undulator beamline dedicated to promote the utilization of synchrotron radiation by industry. The light source of this beamline is a standard in-vacuum undulator in SPring-8 and the X-ray optics adopts a Si (111) liquid-nitrogen-cooled double-crystal monochromator with tunable energy range of 6-35 keV. Two Rh-coated bend mirrors (700 mm in length, horizontal deflection) are placed in the most downstream part of the optics hutch to eliminate harmonics and to focus X-ray beam horizontally. A Si (111) channel-cut monochromator is placed between the monochromator and the mirrors to get fine energy resolution of incident X-ray for hard X-ray photoemission spectroscopy (HAXPES). The HAXPES system equipped with a VG-SCIENTA R4000 electron energy analyzer is installed in the second experimental hutch of BL46XU, which will be used in this course.



One of the advantages of HAXPES over conventional photoemission spectroscopies (PESs) is its potential for bulk sensitive measurements in a non-destructive manner. As we know, the probing depth of PES is determined by the inelastic mean free paths (IMFP) of photoelectrons within the solid. The conventional PESs (ultraviolet photoemission and X-ray photoemission spectroscopies) usually utilize the excitation light generated from He discharge tube, synchrotron radiation as well as Al or Mg-anode X-ray tube with energy range of several-ten to several-hundred eV. Their obtained data are strongly dependent on the surface condition of the sample because the probing depth is shallow due to a short IMFP of photoelectrons inside the solid material. Therefore, it has been difficult to observe bulk electronic states that contribute to the solid-state properties. One possible solution for this is so-called depth-profiling with sputtering. However there is a concern about property changes during the sputtering process. The 3rd generation synchrotron radiation of SPring-8 with undulator light source enable us to use high brilliant (photon flux ~10^{11} photons/sec) hard X-ray

(6-8 keV) for high excitation energy photoemission spectroscopy. The large probing depth of several tens of nanometers (typically, around 20 nm for 8 keV) enables us to observe the bulk electronic states. One can also measure the spectra of deeper core levels by HAXPES, which cannot be accessed by the conventional PESs. Furthermore, a surface-to-bulk profile of electronic states can be obtained by angle-dependent photoemission spectroscopy experiments where probing depth can be controlled by changing the detection angle of photoelectrons to the sample surface.



The aim of this course is to learn a principle of HAXPES and gain experience of measuring photoelectron spectra of various materials with 8 keV monochromated X-ray.

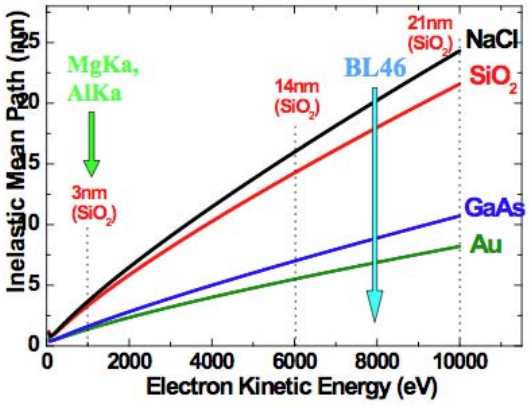
On the practices at the BL46XU, we are planning to conduct the followings.

1. Explanation of the beamline optics of BL46XU.
2. Explanation of HAXPES measurement system.
3. Sample preparation.
4. Measurement.
5. Data analysis.

Advantages of the Hard X-ray Excitation

Inelastic Mean Free Path (IMFP) of electron
http://www.nist.gov/srd/nist71.htm

VUV and Soft X-ray Radiation excitation
: Small probing depth, Surface sensitive



Large Probing Depth
BULK SENSITIVE