BL46XU Hard X-ray Photoelectron Spectroscopy

BL46XU is an undulator beamline dedicated to promote the utilization of synchrotron radiation for industry. The light source of this beam line is a standard in-vacuum undulator in SPring-8 and the X-ray optics adopts a Si (111) direct LN_2 cooling double-crystal monochromator with tunable energy range of 6-35 keV. Two Rh-evaporated mirrors (70 cm length, reflection direction is horizontal) are placed in the most downstream part of the optics hutch to eliminate harmonics. The mirrors can be bent for horizontal beam focus. A Si (111) channel-cut monochromator is placed between the monochromator and the mirrors to get finer energy resolution of incident X-ray for hard X-ray photoemission spectroscopy (HAXPES). The HAXPES systems at this beam line are equipped with VG-SCIENTA hemispherical R-4000 and FOCUS HV-CSA 300/15 photoelectron energy analyzers as shown in Fig. 1 below.

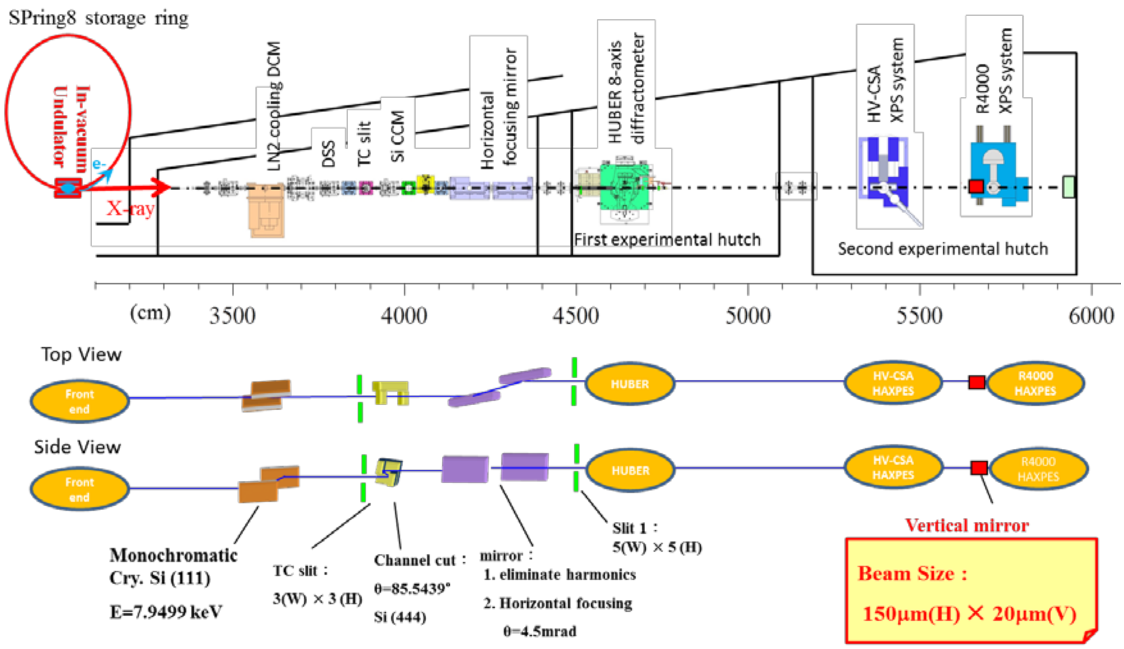

Fig.1 The beam line structures of BL46XU

One of the advantages of HAXPES compared to conventional photoemission spectroscopy is its potential for bulk sensitive measurements in a non-destructive manner. As we know that the probing depths of PES are determined by the inelastic mean free paths (IMFP) of photoelectrons within the solid. The conventional PESs (ultraviolet photoemission spectroscopy and X-ray photoemission) usually utilize radiation 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 detection 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 (as shown in Fig. 2). One of the solutions 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 detection depth of several tens of nanometers (typically, as around 20 nm for 8 keV) is sufficient for the observation of bulk electronic states. Besides standard bulk-sensitive measurements, one can also get deeper core levels as well as a surface-to-bulk profile of electronic states in angle-dependent photoemission spectroscopy experiments where probing depth can be controlled by changing the detection angle of photoelectrons to the sample surface.

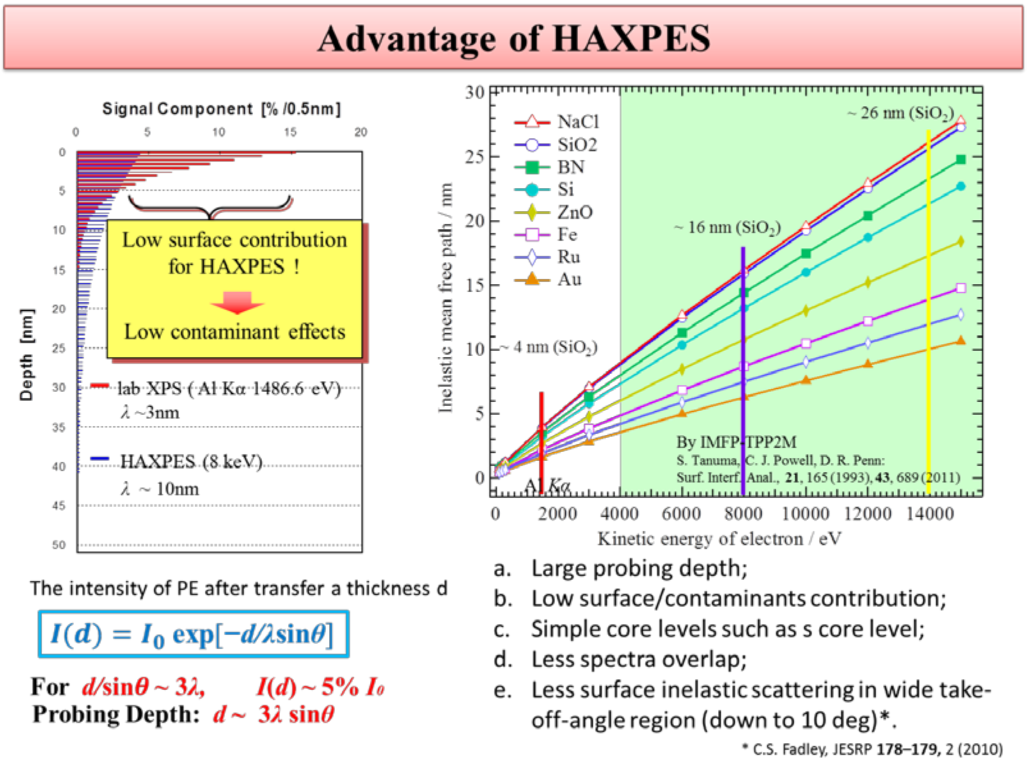

Fig. 2 Advantages of HAXPES

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 systems.
3. Sample preparation.
4. Measurement.
5. Data analysis.