BL12XU
NSRRC ID

1. Overview

The contract beamline BL12XU of National Synchrotron Radiation Research Center (NSRRC, Taiwan) has an undulator source and two branches of the mainline and a sideline. A schematic beamline layout is presented in Figure 1. The mainline has been fully operational since 2001 and used by many scientists from all over the world such as Japan, Taiwan, Germany, USA and so on. In 2009, like previous years, inelastic x-ray scattering (IXS) experiments were mainly performed in BL12XU but several other experiments such as high-resolution diffraction or coherent diffractive imaging were also carried out. The sideline is designed to dedicate to the hard-x-ray photoemission spectroscopy (HAXPES). In 2009, a new experimental end station was installed and tested with success.

2. Mainline

2-1 *Instrumentation*

The IXS spectrometer in the mainline is now highly sophisticated. Electronic excitations are studied on various kinds of samples using ~10 keV x-rays. IXS under high-pressure using a diamond anvil cell and a Kirkpatrick-Baez type mirror is one of the most popular experimental setup in this beamline. A diamond phase retarder installed in 2008 is often used to convert the polarization vector from horizontal to other types and will be used for dichroism experiments in the future. In 2009, we started to build a new type of spectrometer utilizing higher energy photons, e.g., of 20 keV, see Fig. 2. This spectrometer is expected to make the IXS applications wider. To maintain the high efficiency in this energy region, we have adopted the bent-Laue type, utilizing the low-angle diffraction. Several test experiments showed promising results. Further improvements will be made to achieve higher count-rates, resolution, and signal-to-background ratio.

Fig.2 Bent-Laue spectrometer for IXS using 20 keV x-rays.

2-2 *Experiments*

In 2009, we had 12 experiments of non-resonant IXS, 8 of resonant IXS, 3 of non-resonant x-ray emission spectroscopy, 9 of resonant x-ray emission spectroscopy, 2 of high-resolution diffraction, and 2 of coherent diffractive imaging. The high-pressure experiment was still popular: 12 experiments were carried out under high-pressure in 2009. Many experiments related to the geo-science were performed. For example, resonant and non-resonant x-ray emission experiments were carried out to study the spin states and valence states of iron ions in $MgSiO_3$ crystals, one of the major compounds in the mantle of the earth interior. Furthermore, solid CO_2, showing a rich structure variation as a function of the temperature and pressure,

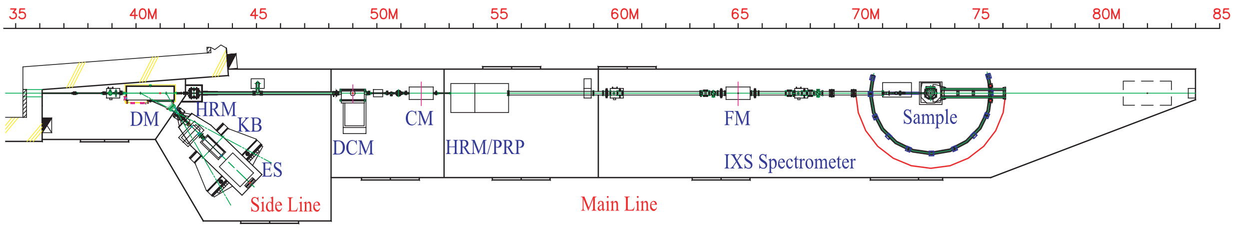

Fig.1 Schematic layout (top view) of the BL12XU: DCM a double crystal monochromator for the main line, CM a collimating mirror, HRM a high resolution (channel cut) monochromator, PRP a phase retarding plate, FM a focusing mirror, and IXS an inelastic X-ray scattering spectrometer. For the side line DM is a diamond monochromator, HRM a high resolution (channel cut) monochromator, KB a Kirkpatrick-Baez X-ray focusing (mirrors) system; ES stands for the HAXPES end station.

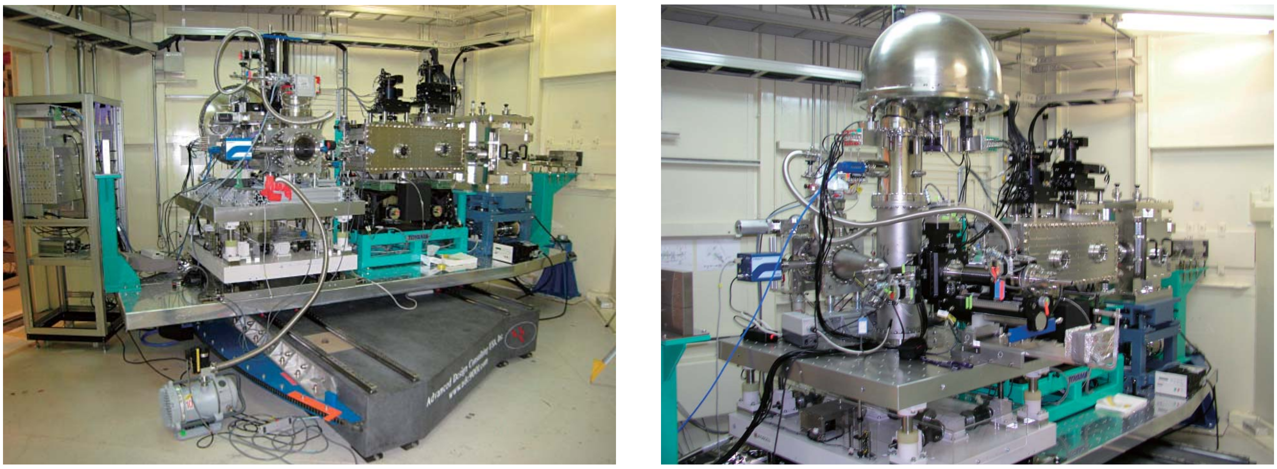

Fig.3　HAXPES End-station in the horizontal geometry (a), and the vertical geometry (b).

was studied by IXS. Moreover, many resonant IXS experiments were carried out on Fe compounds, motivated by the discovery of a new-type of the superconductors of Fe systems.

3. Sideline

An end station for HAXPES was installed in 2009 in collaboration with the Cologne University and Max Planck Institute in Dresden, Germany and tested in two geometries. It composes of a hemi-spherical electron energy analyzer which can be mounted either horizontally to detect photoelectrons along the polarization vector, or vertically to detect photoelectrons normal to the polarization vector. These two geometries are shown in Fig. 3(a) and 3(b) respectively. The horizontal geometry is favored to detect s-orbitals, thus termed s-sensitive; the vertical geometry tends to suppress signals from s-orbitals, thus s-insensitive. This is demonstrated in Fig. 3 on ZnO. The photoelectron spectrum taken at XPS photon energy 1.48 keV shows minimal contribution from 4s, with majority from 3d, as displayed in Fig. 3(a). At 7.7 keV in the horizontal geometry as in Fig. 3(b) the s-component becomes much enhanced relative to the d-component, owing to the much slower decay of cross section of s relative to d as photon energy increases. At 7.6 keV but in the vertical geometry the s-component becomes suppressed again. One can then take advantage of much larger penetration depth with hard x-rays along with detection geometries to distinguish the relative components of s and d for the valence band of 3d transition metal systems often exhibiting strong correlation.

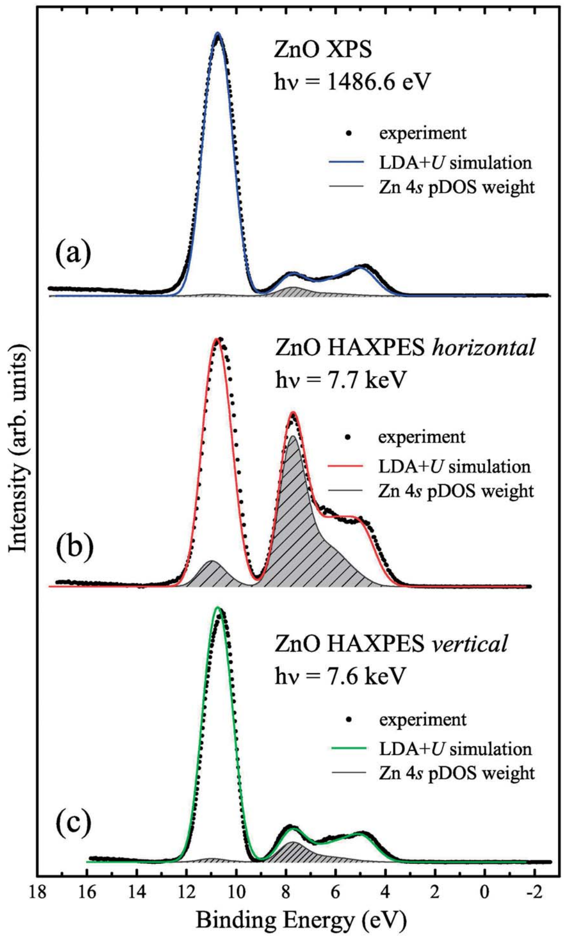

Fig.4　Phtoemission spectra of ZnO detected using XPS source (a), 7.7 keV linearly polarized synchrotron source detected in the horizontal geometry (b), and 7.6 keV linearly polarized synchrotron source detected in the vertical geometry (c).

N. Hiraoka, H. Ishii, C. -C. Chen, C. -Y. Liu and K. -D. Tsuei
NSRRC, Taiwan