BL12B2
NSRRC BM

BL12B2 is one of the two contract beamlines operated by National Synchrotron Radiation Research Center (NSRRC, Taiwan) under collaborative research with Japan Synchrotron Radiation Research Institute (JASRI) and RIKEN. Although this beamline was originally designed for materials science and protein crystallography, because of the completion of the 3-GeV Taiwan Photon Source (TPS) at NSRRC, the beamtime distribution between these research fields has changed. For the last several years, most of the beamtime has been assigned to material science users, about 75% of whom are from Taiwan. The rest of the beamtime is shared between international users from Japan and around the world. Owing to the global COVID-19 pandemic, travel between countries has been severely restricted. Most of the beamtime has been cancelled and shifted to mail-in operation.

Figure 1 schematically depicts the beamline layout. The beamline is equipped with a collimating mirror (CM), a double crystal monochromator (DCM), and a focusing mirror (FM). The measured spot size and total flux of the beam are about 250 μm^2 and 1.5×10^{11} photons at the protein end-station at an incident photon energy of 12 keV, respectively. Five end-stations, EXAFS, projection X-ray microscopy (PXM), X-ray diffraction, X-ray scattering, and powder X-ray diffraction (powder XRD), are equipped tandemly inside the experimental hutch of BL12B2.

EXAFS experiments are performed at the EXAFS table. The EXAFS spectrum can be measured using both transmission and reflection modes. Temperature-dependent powder X-ray diffraction is measured using an image plate at the XRD table. X-ray scattering experiments can be performed using the HUBER six-circle diffractometer. The sample temperature of these two experiments can be changed from 20 to 400 K. In 2018, the PXM end-station was installed at the XRD table. High-pressure X-ray diffraction is performed using a CCD camera at the protein crystallography table.

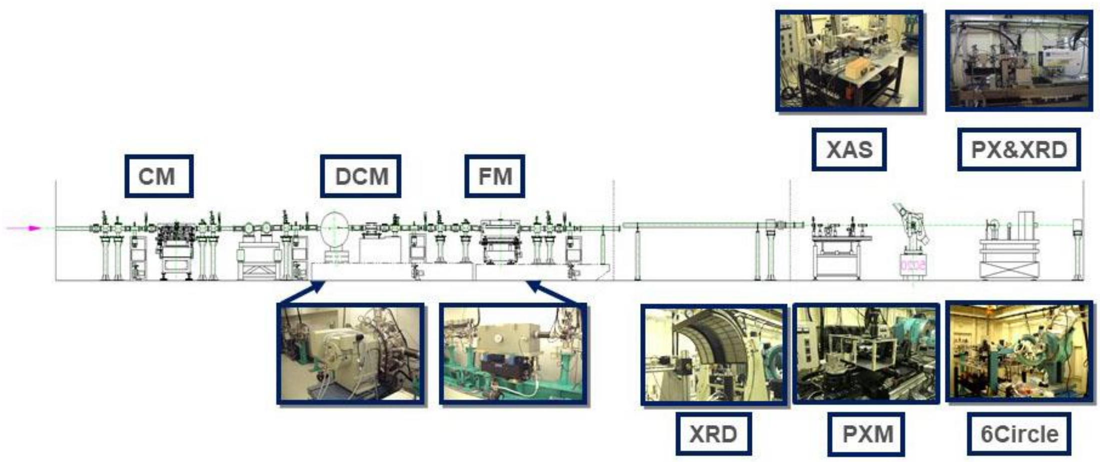

Fig. 1. Schematic layout of BL12B2.

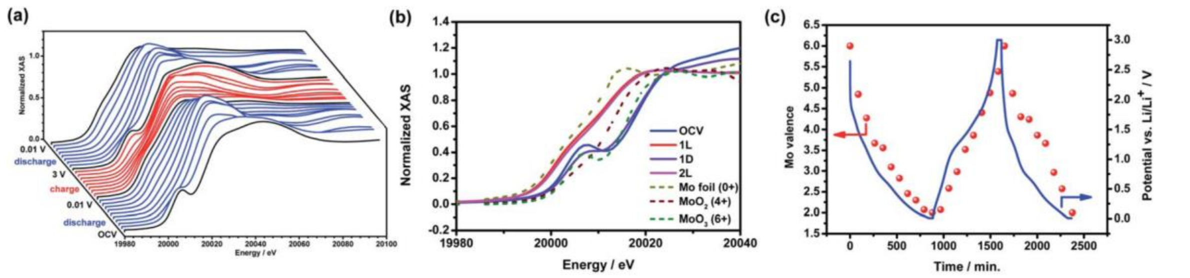

Fig. 2. (a) *In operando* synchrotron Mo K-edge XANES spectra at current density of 100 mA g^{-1}. (b) Normalized *in operando* synchrotron Mo K-edge XANES spectra in the first cycle, with potentials at OCV (2.64 V); 1L (0.01 V); 1D (3 V); and 2L (0.01 V), shown with those of reference materials (MoO_3, MoO_2, and Mo metal foil) [8].

The powder X-ray diffraction end-station, which is equipped with a CCD and a SPring-8 standard auto–sample-changer system, was installed in FY2009 and used for protein diffraction experiments until FY2017. However, beamtime for protein-crystallography users has diminished since FY2017. Currently, the powder XRD end-station is mainly used by material scientists. The user interface software for powder XRD experiments is the SPring-8 standard BSS software. The CCD detector was upgraded to Raynox MX225-HE in FY2014. Electrodes (AUTOLAB PGSTAT204 (Metrohm)) were prepared for in situ electrochemical experiments.

Materials science experiments cover a wide area of topics such as new materials research, energy science, nanoscience, and geophysical science. In FY2020, BL12B2 users published 18 papers in SCI journals [1-18].

BL12B2 is used for *in situ* or *in operando* X-ray experiments for research on electrocatalysis, such as fuel cell [1], battery [8, 9], oxygen reduction reaction [2, 5, 6,], CO_2 conversion [3], and environment [4, 7, 13, 14] research. Prof. Han-Yi Chen's group measured *in operando synchrotron* Mo K-edge XANES and *in situ* EXAFS spectra [8] (Fig. 2).

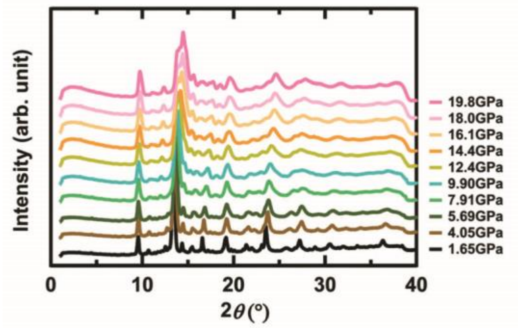

Fig. 3. Pressure-dependent powder XRD patterns of $BaTi_2Bi_2O$ [15].

Other studies have been focused on samples under extreme conditions to investigate a new physical phenomenon. Research on a new type of superconductivity is a hot topic in the field of solid-state physics. Figure 3 shows the pressure-dependent XRD spectrum of a topological insulator, $BaTi_2Bi_2O$, which exhibits superconductivity at 4.33 K at ambient pressure [15]. The same group also studied high-pressure XRD on other samples that exhibit superconducting properties [10, 11, 12, 17].

User support is provided by three local beamline scientists and one engineer.

Y.-F. Liao, M. Yoshimura, T. Tatsumi and H. Ishii*
NSRRC, Taiwan

References:

[1] Liang, J., et al. (2020). *Adv. Energy Mater.* **10**, 2000179.
[2] Kuo, H.-C. et al. (2020). *Catal. Sci. Technol.* **10**, 3949
[3] Birhanu, M. K., et al. (2020). *Electrochim. Acta.* **356**, 136756
[4] Lin, J.-X., e al. (2020). *Glob. Chall.* **4**, 2000025
[5] Bhalothia, D, et al. (2020). *J. Alloy. Compd.* **844**, 156160
[6] Moysiadou, A., et al. (2020) *J. Am. Chem. Soc.* **142**, 11901
[7] Kunene, S. C., et al. *J. Hazard. Mater.* (2020). **383**, 121167
[8] Huang, S.-C., et al. (2020). *J. Mater. Chem. A.* **8**, 21623
[9] Chen, T.-Y., et al. (2020). *J. Mater. Chem. A.* **8**, 21756
[10] Yang, X., et al. (2019). *Adv. Mater.* **31**, 1903909
[11] Li, H., et al., (2020). *J. Phys. Condens. Mat.* **32**, 395704
[12] He, T., et al. (2020). *J. Phys. Condens. Mat.* **32**, 465702
[13] Wang, Q., et al. (2020). *Nat. Commun.* **11**, 4246
[14] Jiang, L., et al. (2020). *Nat. Nanotechnol.* **15**, 848
[15] Wang, Y., et al. (2020). *Phys. Chem. Chem. Phys.* **22**, 23315
[16] Chang Chien, W.-H., et al. (2020). *Phys. Status Solidi, Rapid Res. Lett.* **14**, 2000223
[17] Li, H., et al. (2020) *RSC Adv.* **10**, 26686
[18] Tung, C.-W., et al. (2020). *Solar RRL* **4**, 2000028