BL15XU
(WEBRAM)

1. Introduction

BL15XU, which is officially referred to as WEBRAM (Wide Energy Beamline for Research in Advanced Materials), is the contract beamline of the National Institute for Materials Science (NIMS). Our mission is to support users inside and outside of NIMS and to promote the development of new functional materials research. Users conduct the following studies: 1) hard X-ray photoelectron spectroscopy (HAXPES) of the electronic structures up to a 20-nm probing depth, 2) high-resolution X-ray powder diffractometry of crystallographic structures, and 3) X-ray diffractometry of lattice structures of functional thin films.

2. Beamtime use and publications

Public use of the NIMS beamline is classified into two groups: NIMS researchers and outside users. In FY2018, 67 proposals were accepted. (In FY2017, 69 proposals were accepted.) Of these, 34 were for NIMS researchers and 33 for outside users including joint research.

The beamtime utilization ratio was 44% for HAXPES, 37% for thin-film X-ray diffraction, and 19% for high-resolution X-ray powder diffraction (including X-ray total scattering methods). In recent years, the percentage of beamtime for X-ray diffraction methods shows a slightly increasing trend.

In FY2018, 46 peer-reviewed articles were published. This number is similar to the number of published papers in FY2017.

3. Improvement of experimental apparatuses

3-1. Installation of a DAC diffractometer

For high-pressure *in situ* X-ray diffraction experiments at BL15XU, we installed a newly designed X-ray diffractometer (Fig. 1) in collaboration with the High Pressure Group of NIMS. The diffractometer has a rotating oscillation axis for DAC and a flat imaging plate cassette equipped with a positioning system.

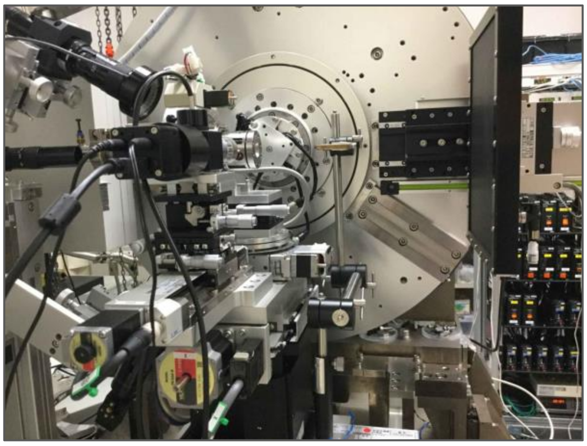

Fig. 1. DAC diffractometer with a flat imaging plate cassette.

During a trial of the DAC diffractometer, the determination of the bulk moduli of incompressible super hard materials was partly successful. This diffractometer realizes precise measurements of the lattice constant under high pressure, but X-ray collimation of the diffractometer remains insufficient compared to the sample in DAC. This insufficiency limits the sample size. For high-pressure experiments using DAC, the preferable size of the incident X-rays is less than a 30 μm square. In the near future, we plan to introduce a micro-collimator system to perform more sophisticated diffraction experiments under high pressure in BL15XU.

3-2. Time-resolved X-ray diffraction

Since FY2017, we have been preparing a time-resolved X-ray diffraction system at BL15XU. We installed a two-dimensional detector on the thin-film diffractometer and established a sub-microsecond time-resolved diffraction system using a combination of a pulse generator and a delay generator. In FY2018, we established a more sophisticated time-resolved diffraction experimental system using a synchrotron clock signal with synchronized focused X-rays onto a device under an applied electric field. The X-ray pulse was synchronized with an electrical pulse signal and a Pilatus detector through a delay generator and pulse generator. We successfully observed shifts of the 222 Bragg peak in 750-nm-thick $Pb(Zr, Ti)O_3$ films near time zero under a unipolar rectangular wave at 24 V [1]. Such a time-resolved diffraction measurement system should play an essential role in understanding ultrafast phenomena through the structural parameter dynamics of functional piezoelectric materials (*e.g.,* the piezoresponse, lattice dynamics, and domain switching).

Acknowledgments:

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Reference:

[1] O. Seo et al., *Rev. Sci. Instrum.* **90**, 093001 (2019).