

Abstract:

Beamline BL13XU is dedicated for surface/interface structural studies using diffraction and scattering techniques which is, in particular, called surface x-ray diffraction. Precise determination of surface-atom arrangement calls for typically recording several hundred rocking curves of in-plane diffraction and collecting intensities of crystal-truncation-rod (CTR) scattering emanating from a reconstructed surface or surface-adsorbed system of a sample in ultra-high vacuum (UHV).

Such measurements require us to precisely control two angular parameters: incidence angles from its physical surface of the sample and Bragg planes of interest. Thus it is necessary to orient the physical surface and crystallographic planes of the sample in UHV. The intensities are extremely weak compared with that obtained from a thin film, of course a bulk crystal. Thus surface x-ray diffraction measurements need not only a powerful x-ray source like the SPring-8 standard undulator, but also proper control of a BL monochromator and mirror to make an incident-beam intensity maximum and stable.

A plan for training at Cheiron School is to learn how to orient a sample in UHV and successively make surface x-ray measurements. A principal facility available for this training is a 1-ton UHV chamber mounted on a 2 + 2 type diffractometer for high-angular resolution measurements. We would like to quickly show how to align the beamline optics to tune incident x-rays desired as well.

Schedule:

1) Guidance (15 min)

2) Introduction of beamline BL13XU [1][2] . (30 min)

Quick tour from the optics hutch to experimental hutch 3 to watch the Lq. N2 cooled monochromator, mirrors for rejecting higher harmonics, and typical facilities like diffractometers for in-air or in-solution measurements and for ultra-high vacuum measurements.

3) Brief review on surface x-ray diffraction (30 min)

Presentation on what surface x-ray diffraction is and what kind of information we can achieve. [3,4,5] Typical results and outcomes obtained at BL13XU [2]

4) Quick practice for tuning the beamline optics using the BL13XU workstation . (60 min)

- i) SPring-8 standard undulator,
- ii) Lq. N2 cooled monochromator.
- iii) Mirrors for rejecting higher harmonics.

5) Alignment of surface diffractometer (60 min)

- i) Diffractometer control with software SPEC [6].
- ii) Sample alignment by a laser method

iii) Alignment of surface diffractometer with a pinhole assembly.

Lunch time (60 min)

6) Determination of orientation matrix for a sample surface (60 min)

7) Measurement of surface diffraction data (120 min)

i) Measurement of in-plane diffraction after making sure of a reconstructed surface using RHEED.

ii) Measurement of CTR.

8) Data analysis (15 min)

9) Discussion (60 min)

References:

[1] BL13XU outline, URL:http://www.spring8.or.jp/wkg/BL13XU/instrument/lang-en/INS-0000000394/instrument_summary_view

[2] BL13XU SPring-8 Beamline Review Report, URL:http://www.spring8.or.jp/en/support/download/bl_review/2006/bl13xu.pdf

[3] I.K. Robinson and D.J. Tweet, Reports on Progress in Physics, 55 (1992) 599-651.

[4] E. Vlieg, Surface Science, 500 (2002) 458-474.

[5] J. Als-Nielsen and D. McMorrow, "Elements of Modern X-ray Physics" (John Wiley and Sons, 2001).

[6] SPEC software, URL: <http://www.certif.com/>