Hyogo Beamline (BL24XU)

The Hyogo beamline BL24XU has been constructed for protein crystal structure analysis, surface/interface analysis of inorganic materials, X-ray microbeam analysis, and the development of X-ray imaging. To perform these studies simultaneously, this beamline has three experimental hutches (A, B and C) with employing a "figure-8" undulator and "troika" conception. In the present operation mode, the undulator gap is fixed at 11.3 mm, and X-rays with an energy of 15/10 keV (1.5/1 harmonics) are provided to experimental hutches A/B.

In 1999, we installed an X-ray diffractometer for industrial application in hutch B in collaboration with Kawasaki Heavy Industries, Ltd. Figure 1 shows a photograph of the equipment. This diffractometer can be used for grazing incidence X-ray diffraction and the internal stress measurement of inorganic materials. The maximum load on the sample stages is designed to be greater than 10kgf, and so the various apparatuses for controlling the sample environment can be adapted. One-dimensional PSPC detector mounted on the θ arm is available for *in-situ* measurements. The performance of this goniometer is summarized in Table 1.

Now the following three studies are being carried out with this equipment by the New Industry Research Organization (NIRO).

1) An analysis procedure for thermal barrier coating
2) *In-situ* analysis of surface film structure on metal substrates during oxidization or corrosion
3) Observation of the surface structures of ion-implanted molds for rubber

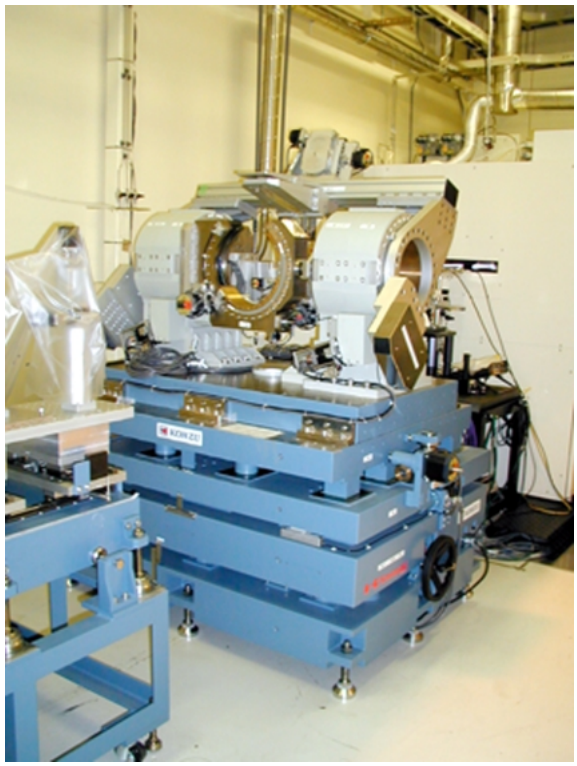

Fig. 1. X-ray diffractometer for industrial application in hutch B.

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Table 1. The performance of the goniometer

	Stage	Range	Minimal Step	Load/kg
Sample Stages	*x, y*	±10 mm	0.5 μm	10
	z	±10 mm	1 μm	15
	ϕ	±180˚	1.8"	20
	χ	0 ~ 90˚	0.288"	50
	ω	-20 ~ +100˚	0.144"	110
Detector Stages	θ	-100 ~ +80˚	0.288"	100
	δ	±5˚	7.2"	7
	x_d	-10 ~ 50 mm	1 μm	25
Base Stages	α	±3˚	0.144"	2000
	Base Z	±50 mm	0.11 μm	2000
	Base X	-80 ~ +20 mm	1 μm	2000

Light Source	
Type	in-vacuum Figure-8
period	26 mm
Number	172
brilliance	4×10^{19} ph/s/mrad^2/mm^2/0.1%b.w. (E=8.6 keV, @100mA)
Total power	6.8 kW (E=8.6 keV, @100mA)
Power density	133kW/mrad^2 (8.6keV,@100mA)

X-rays at sample	
Energy range (fixed gap)	15 keV (hutch A) 10 keV (hutch B) > 10 keV (hutch C)
Energy resolution (dE/E)	6.4×10^{-5} (hutch A) 5.9×10^{-5} (hutch B) 1.7×10^{-4} (hutch C, @10 keV)
Photon flux (measured)	3×10^{11} ph/s (hutch A) 1×10^{11} ph/s (hutch B) 3×10^{12} ph/s (hutch C, @10keV)
Beam size	1.8mm(H)×0.5mm(V) (hutch A) 2.7mm(H)×0.8mm(V) (hutch B) 3.1mm(H)×0.9mm(V) (hutch C)

Facilities in Experimental Station

(hutch A)

- An oscillation camera with an imaging plate (Rigaku R-AXIS IV) and a one-axis goniometer.

(hutch B)

- An X-ray surface analysis equipment for inorganic materials. It consists of a sample chamber, SSD, curved PSPC and flat PSPC combined with analyzing crystals.
- An X-ray diffractometer for industrial application.
- An in-situ grazing incidence X-ray diffraction apparatus. It consists of a crystal growth reactor by organometallic vapor phase epitaxy and a high-precision goniometer.

(hutch C)

- An experimental table for formation of a parallel microbeam.
- An experimental table for formation of a focussed microbeam.

Following equipments can be installed in these tables

- High-precision θ tables (resolution:0.01"/pulse), θ-2θ goniometers (full rotation), *xz* tables, *xyz* tables, four-quadrant slits

Detectors

- X-ray zooming tube, X-ray CCD, X-ray camera, solid-state detector, scintillation counter, ion chamber