SAGA-LS ビームラインの状況

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SAGA-LS では, 6 本の県有ビームラインと 3 本の他機関ビームラインの計 9 本のビームラインが順調に稼働している．このうち 2 本が高輝度なシンクロトロン光を利用することのできるアンジュレータを光源とする軟 X 線ビームライン（県有ビームラインと他機関ビームラインがそれぞれ 1 本）と，20keV を超える高エネルギーのシンクロトロン光を利用することのできる超伝導ウィグラーを光源とするビームラインが 1 本設置されている．

県有ビームラインでは，1.5keV から 2.1keV を除き，40eV から 35keV の幅広いエネルギー範囲で，回折や吸収などの基本的な実験から，2 次元イメージングや時間分解測定など，飽くなきユーザーの要望に応えるべく，様々な実験手法の開発を行ってきた．当日は，最近の各種実験装置等の整備状況について紹介する．

（メモ）

SAGA-LSビームラインの状況

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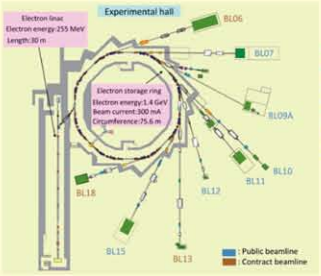
Summary

SAGA-LS has been operated well since February 17th, 2006. Six prefectural (BL07, BL09A, BL10, BL11, BL12 and BL15) and three other agency beamlines are now in operation on the SAGA-LS. The prefectural beamlines as public beamlines are opened for multiple users such as universities, institutes and industries. The light sources of these beamlines are consisted of four bending magnets for BL09A, BL11, BL12 and BL15, an undulator for BL10, and a superconductiong wiggler for BL07, respectively. The bemlines BL11 and BL15 are used as hard X-ray beamlines with the energy of a few keV to more than ten keV. The beamline BL12 is used as soft X-ray beamline with the energy of 40 eV to 1500 eV. The non-monochromatized X-rays, that is white beam, are used at BL09A. On the other hand, adopting the 4T superconductiong wiggler, hard X-rays up to 35keV can be used at the BL07. This beamline has been constructed most recently in our facility. In addition, higher brilliance soft X-rays from an APPLE2 type undulator in the energy ranges from 40 eV to 900eV. Now, we are providing multiple experimental techniques, such as X-ray diffraction, X-ray absorption, X-ray imaging, X-ray photoelectron spectroscopy, X-ray topography, and so on, for users using these beamlines. We will show the present status of our prefectural beamlines and their selected applications in this presentation.

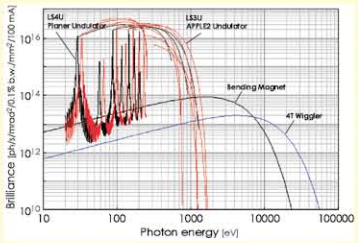
Location of the SAGA-LS

Plan view of the experimental hall



Nine beamlines including one branch are operated at the SAGA-LS storage ring as shown in left figure. Four beamlines are dedicated to research using hard X-rays, with the remaining five beamlines used for studies in the VUV and soft X-ray energy region. Table below summarize the main experiment carried out at the each beamlines. The specifications in terms of optics and performance of each beamline differ according to experimental requirements and metrology.

Brilliance of Light Sources



Synchrotron radiation spectra at the SAGA-LS. Brillianca of radiation vs. photon energy for the bending magnet and the insertion devices (an APPLE2 type undulator, Planer undurator and a 4T superconductiong wiggler). The critical energies of radiation are 1.9 keV for bending magnets and 5.2 keV for the 4T wiggler, respectively. The spectral curve of each undulator is the peak of from the first to 7th harmonics within the allowance range of K-parameter. The APPLE2 undulator and 4T wiggler supply the synchrotron radiation for BL10 and BL07, respectively. The Planer undurator is BL13.

List of Beamlines

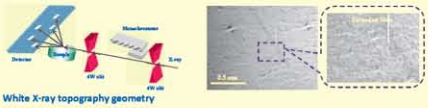
Beamline	Source [a]	Monochromator	Photon energy	Main experiments	Category [b]
BL06	BM	Double crystal	2.1keV - 23keV	XAFS,SAXS	Kyushu U.
BL07	W	Double crystal	5keV – 35 keV	PXD, XAFS, Imaging	Pref.
BL09A	BM	None	White beam	Irradiation, Topography	Pref.
BL10	U	VLS-PGM [c]	40eV – 900 eV	PEEM, ARUPS	Pref.
BL11	BM	Double crystal	2.1keV – 23 keV	XAFS, SAXS	Pref.
BL12	BM	VLS- PGM [c]	40eV – 1500 eV	XPS, XAFS	Pref.
BL13	U	VLS- PGM [c]	15eV – 600 eV	ARPES	Saga U.
BL15	BM	Double crystal	3.5keV- 23keV	XRD, Topography	Pref.
BL18	BM	Multi layered mirror	~92eV	Irradiation	Nikon

a) Source : W, wiggler; BM, bending magnet; U, undulator.
b) Category : Pref., public beamline by Saga Prefecture Government ;
Kyushu U., Saga U. and Nikon, contract beamline by Kyushu University, Saga University. and Nikon Corporation., respectively.
c) VLS-PGM : Varied-line-spacing plane grating monochromator.

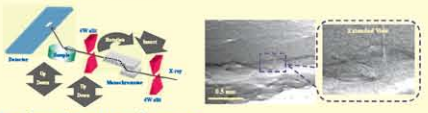
Selected Applications

X-ray topography system with both white X-rays and monochromatic X-ray (BL09A)

We have developed the new X-ray topography system which could change white X-ray topography system and monochromatic X-ray topography system quickly by using Si(111) channel-cut type monochtromator. The following figures and photographs show each X-ray topography geometry., and the high resolution topography at 004 diffraction spots of SiC obtained each topography geometry, respectively.



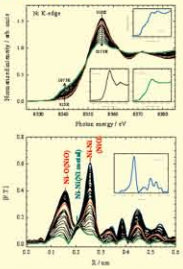
White X-ray topography geometry



Monochromatic X-ray topography geometry

In-situ XAFS observation of the reduction of nickel mono-oxide (NiO) (BL11)

We have developed an in-situ XAFS measurement system within reactant gases and with temperature controlled with between from 15 K up to 1073 K using a cryostat and a furnace. In addition, quick XAFS (QXAFS) measurement system installed in this BL allowed for us to analyze the oxidation-reduction reaction of materials in real time.



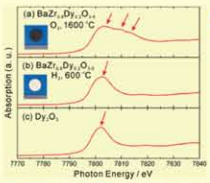
Change of Ni K-edge XANES spectra (upper) and residual distribution functions (lower) around Ni atom in NiO.

In-situ XAFS measurements were done during heating in 2%H_2/N_2 gas. The hearting rate was 10 K a minute.

The spectrum was measured about every one minute. It took 30 seconds for each exafs spectrum.

Tetravalent Dysprosium in a Perovskite-type Oxide revealed by XANES (BL11)

Existence of tetravalent dysprosium in perovskite-type oxide barium zirconate was confirmed in this work. This discovery will stimulate many researchers in diverse fields such as catalysts, solid state ionics, sensors, and fluorescent materials.

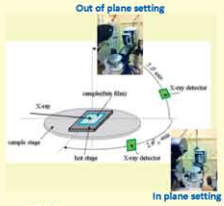


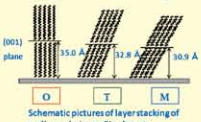
Dy-L_3 XANES spectra of
(a) $BaZr_{0.8}Dy_{0.2}O_{3-\delta}$ heat-treated in O_2 at 1600 °C for 24 h,
(b) $BaZr_{0.8}Dy_{0.2}O_{3-\delta}$ subsequently heat-treated in H_2 at 600 °C for 120 h, after the heat-treatment in O_2 at 1600 °C,
and (c) Dy_2O_3.

Valence states of lanthanides in oxides. Tetravalent state of Dy is the new finding in this study.

In-situ observations of phase transitions in *n*-alkane thin film (BL15)

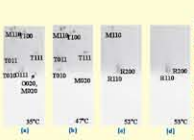
We have newly installed an in-situ XRD system by using two dimensional X-ray detector, PILATUS. This in-situ measurement system allows us to obtain real time two dimensional X-ray diffraction pattern like temperature dependence.



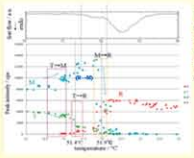


Schematic pictures of layer stacking of *n*-alkane chains on Pt substrate.

Three crystal phases coexist at low temperature region



Two dimensional XRD patterns obtained from each temperature. There are three crystal phases at the lowest temperature. That is, O, T and M crystal phases are observed simultaneously. With increasing temperature, observed crystal phases are decreased. At the end of observation, crystal phase with "R" is only observed.

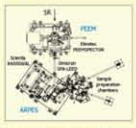


The temperature dependence of each XRD intensities are summarized in this figure. The figure also shows the DSC spectrum together with the diffraction intensities

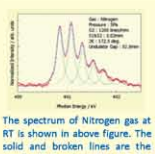
Temperature dependences of X-ray diffraction patterns in side packing region obtained from C26-alkane thin film

Tow dimensional energy band dispersive measurements of Cu(110) surface (BL10)

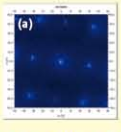
The main components of beamline are consist of four sagittal focusing mirrors (M0, M1, M3-1 and M3-2), one plane mirror (M2), two gratings(G), and two slits (S1 and S2). In order to achieve high energy resolution and high photon flux in a wide energy range, we employed the Monk-Gillieson mounting monochromator with the Varied-line-spacing plane grating (VLSPG) and the variable-included-angle mechanism. The variable range of the included angle is 167 - 176deg. Total length of the beamline is about 33m including the experimental instruments.

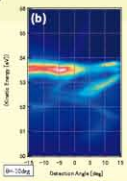


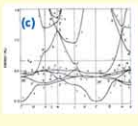
PEEM and ARPES were prepared for the experimental stations. Elmitec PEEMSPECTOR was adopted for the PEEM system. The high-resolution analyzer with a wide acceptance angle lens (SCIENTA R4000WAL) was employed for the ARPES system.



The spectrum of Nitrogen gas at RT is shown in above figure. The solid and broken lines are the result of the peak fitting. The resolving power (E/ΔE) estimated from the spectrum is about 7,500.







We successfully observed the two dimensional energy band dispersive of Cu(110) surface. (a)LEED pattern and (b)ARPES spectrum obtained from Cu(110) surface, and (c) theoretically obtained energy band distributions. The comparison shows the ARPES spectrum in (b) represents Γ-X direction.

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