Abstracts

The 28th Hiroshima International Symposium on Synchrotron Radiation

Materials Science using VUV-SX Synchrotron Radiation
Towards the future HiSOR-II project

March 14- 15, 2024

Faculty Club, Hiroshima University

Hiroshima Synchrotron Radiation Center, Hiroshima University

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Program

Oral Session

DAY 1 ・Thursday, 14 March, 2024

	Opening (Chairperson: T. Okuda)
09:30 – 10:05	Greeting **Takeshi YAMAMOTO** *(Deputy Director, University Research Facilitation Division, Research Promotion Bureau, Ministry of Education, Culture, Sports, Science and Technology (MEXT), Japan)* Greeting **Atsushi SUGETA** *(Executive Vice President(Research), Executive Vice President, Hiroshima University, Japan)* Overview of HiSOR Activities **Kenya SHIMADA** *(Director, Synchrotron Radiation Center, Hiroshima University, Japan)*
10:05 – 10:30	Symposium Photo
10:30 – 10:40	Coffee break

	Oral Session 1 Spin ARPES (Chairperson: T. Okuda)
10:40 – 11:15	**Han Woong YEOM** （*POSTEC, Korea*） "Spin-resolved ARPES at Pohang Light Source and the future of Korean ARPES activity based on synchrotron"
11:15 – 11:40	**Kouji MIYAMOTO** （*Hiroshima University, Japan*） "Spin-resolved photoelectron spectroscopy at HiSOR ~present status and future prospect~"
11:40 – 13:30	Lunch

Poster Session (Chairperson: H. Sato)	
13:30 – 14:30	Student Short Oral Session (1~2 min/each)
14:30 – 16:20	Poster Session
16:20 – 16:30	Coffee break

Oral Session 2 Soft x-ray magnetic circular dichroism of nanomaterials (Chairperson: X. Hou)	
16:30 – 17:05	**Manuel VALVIDARES** (*ALBA Synchrotron Lighe Source, Spain*) " ALBA Synchrotron radiation techniques for oxide, 2D-vdW and other spintronic materials "
17:05 – 17:40	**Naoyuki MAEJIMA** (*Institute for Molecular Science, Japan*) "Magnetic and Electronic property of transition metal phosphides interface of NixP/Fe2P"
17:40 – 18:05	**Xueyao HOU and Masahiro SAWADA** (*Hiroshima University, Japan*) "Recent status of HiSOR BL-14 ~Magnetic interaction intermediated through a monatomic insulating layer, studied by XMCD experiment and computational method~"
Reception (Chairperson: M. Ibrahim)	
18:15 – 19:45	Welcome Reception LA Bohème(Faculty Club)

DAY 2 ・Friday, 15 March, 2024

Oral Session 3 High-resolution ARPES (Chairperson: K. Sumida)	
09:00 – 09:35	**Daniel S DESSAU** (*Colorado University, USA*) "Superconductivity and Flat Bands at the Fermi Level"
09:35 – 10:10	**Walid MALAEB** (*Lebanese American University, Lebanon*) "Annealing effects in topological alpha-Sn/InSb heterostructures revealed by photoemission spectroscopy"

10:10 – 10:35 **Shin-ichiro IDETA** (*Hiroshima University, Japan*)
"Recent Developments of ARPES Studies at HiSOR BL-1"

10:35 – 10:45 Coffee break

Oral Session 4 VUV-CD spectroscopy of biomolecules
(Chairperson: M. Ibrahim)

10:45 – 11:20 **Frank WIEN** (*SOLEIL, France*)
"SRCD/OCD at DISCO overview and highlights"

11:20 – 11:45 **Koichi MATSUO** (*Hiroshima University, Japan*)
"Recent Advancements in HiSOR-VUVCD Spectrophotometer for Characterizing Biomolecule Structures"

11:45 – 11:55 Coffee break

Oral Session 5 Light source accelerators and insertion devices
(Chairperson: Y. Lu)

11:55 – 12:30 **Shaukat KHAN** (*Technische Universitaet Dortmund, Germany*)
"DELTA – a university-based synchrotron light source"

12:30 – 12:55 **Masahiro KATOH** (*Hiroshima University, Japan*)
"Compact synchrotron light source HiSOR – present status and future prospects –"

Closing Session (Chairperson: H. Namatame)

12:55 – 13:10 Awarding of Student Poster Prizes and Closing Ceremony

Closing Remarks

Oral Session

-Oral Session-

O01 Spin-resolved ARPES at Pohang Light Source and the future of Korean ARPES activity based on synchrotron

Han Woong Yeom

Center for Artificial Low Dimensional Electronic Systems,
Institute for Basic Science & Department of Physics, POSTECH

O02 Spin-resolved Photoelectron Spectroscopy at HiSOR ~Present Status and Future Prospect~

Koji Miyamoto

Hiroshima Synchrotron Radiation Center (HiSOR), Hiroshima Univ., Japan

O03 ALBA Synchrotron radiation techniques for oxide, 2D-vdW and other spintronic materials

Manuel VALVIDARES

ALBA Synchrotron Lighe Source, Spain

O04 Magnetic and Electronic property of transition metal phosphides interface of Ni_xP/Fe_2P

Naoyuki Maejima[a,b,c], Yuma Kuwabara[a], Tomoya Yoshida[a], Takahiro Ota[a], Yuki Shimato[a] and Kazuyuki Edamoto[a,b]

a Coll. Sci., Rikkyo Univ., Japan.
b Research Center for Smart Molecules, Rikkyo Univ., Japan.
c Institute for Molecular Science, Japan.

O05 Recent status of HiSOR BL-14

Xueyao Hou and Masahiro Sawada

Hiroshima Synchrotron Radiation Center (HiSOR), Hiroshima Univ., Japan

O06 Superconductivity and Flat Bands at the Fermi Level

Dan Dessau

University of Colorado, USA

O07 Annealing Effects in Topological α-Sn/InSb Heterostructures Revealed by Photoemission Spectroscopy

Walid Malaeb[a], Kohdai Inagaki[b], Masaaki Tanaka[b,c], Le Duc Anh[b,c] and Masaki Kobayashi[b,c]

a Department of Natural Sciences, Lebanese American University, Lebanon
b Department of Electrical Engineering and Information Systems, The University of Tokyo, Japan
c Center for Spintronics Research Network (CSRN), The University of Tokyo, Japan

O08 Recent Developments of ARPES Studies at HiSOR BL-1

Shin-ichiro Ideta[a,b], Masashi Arita[b], Shiv Kumar[c], Yudai Miyai[a], Yogendra Kumar[a], Amit Kumar[d], Kenya Shimada[a,b]

a Graduate School of Advanced Science and Engineering, Hiroshima Univ., Japan
b Hiroshima Synchrotron Radiation Center (HiSOR), Hiroshima Univ., Japan
c Institute of Microelectronics (IME), Agency for Science, Technology and Research, Singapore
d Max Planck Institute of Molecular Plant Physiology, Germany

O09 SRCD/OCD at DISCO overview and highlights

Frank WIEN

SOLEIL, France

O10 Recent Advancements in HiSOR-VUVCD Spectrophotometer for Characterizing Biomolecule Structures

Koichi Matsuo & Mohamed Ibrahim

Hiroshima Synchrotron Radiation Center (HiSOR), Hiroshima Univ., Japan

O11 DELTA - a university-based synchrotron light source

Shaukat Khan

Center for Synchrotron Radiation (DELTA) and Department of Physics,
TU Dortmund University, Germany

O12 Compact synchrotron light source HiSOR
- Present status and future prospects -

Masahiro Katoh

Hiroshima Synchrotron Radiation Center (HiSOR), Hiroshima Univ., Japan

Spin-resolved ARPES at Pohang Light Source and the future of Korean ARPES activity based on synchrotron

Han Woong Yeom
Center for Artificial Low Dimensional Electronic Systems, Institute for Basic Science & Department of Physics, POSTECH
email : yeom@postech.ac.kr

In this talk, we review the construction and the activity of the spin-resolved ARPES endstation in Pohang Light Source (PLS) and the future plan of the ARPES beamline in Korea's new synchrotron radiation source under construction. The spin-resolved ARPES endstation was planned in 2013 by the Center for Artificial Low Dimensional Electronic Systems of the Institue for Basic Science as an addition to the PLS's only one ARPES beamline (BL-4A) following the upgrade of PLS into PLS-II (3 GeV 250 mA top-up operation with 6 nmrad vertical emittance) in 2010. It involved the installation of an elliptically polarized undulator in 2015 and the construction of an ARPES facility based on a DA-30 Scienta analyzer in 2016. Since then, the system has been actively used by Korean ARPES groups. The attachment of a VLEED-type spin detector was progressed during 2018-2021 in collaboration with the HiSOR group. The characteristics of the system will be introduced with a few recent highlighted works such as the detection of photoelectrons from spontaneously formed excitions of an excitonic insulator [1, 2] and the *in-situ*-controlled quantum phase transitions of a 2D Mott insulator [3]. On the other hand, Korea started to build a 4^{th} generation synchrotron radiation source (3 GeV 400 mA with 60 pmrad vertical emittance) at Ochang in 2022, which will host a nano-ARPES beamline as one of its first batch beamlines. This plan will be introduced briefly.

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BL-9B

Spin-resolved Photoelectron Spectroscopy at HiSOR ~Present Status and Future Prospect~

Koji Miyamoto[a]

[a]Hiroshima Synchrotron Radiation Center, Hiroshima University, 2-313 Kagamiyama, Higashi-Hiroshima, 739-0046, Japan

Keywords: SARPES, Spin dependent electronic structure, Topological insulator

Our developed spin- and angle-resolved photoemission apparatus (SARPES) equipped with two high-efficiency VLEED-type spin detectors is installed at the branch beamline BL-9B of the APPLE-II undulator in 2013[1]. The double highly efficient spin detector is installed in a 90-degree configuration to enable direct observation of three-dimensional spin orientation. Up to now, through joint research and our own research, we have clarified the peculiar spin-dependent electronic structure of various materials (topological materials, Rashba materials, and magnetic materials etc.) using our SARPES and elucidated the properties of materials from their electronic structure.

Recently, three new improvements were done in our apparatus at BL-9B. Firstly, a elliptical focusing mirror is installed, to improve the large beam size (3000(H)x500(V) μm). As a consequent, the beam size has been reduced to 500(H)x100(V) μm, i.e., one-sixth smaller than previous one. Secondly, the two slits and diffraction gratings in our beamline, which were operated manually, can now be changed automatically by installing a stepping motor. This has transformed the system into a more user-friendly one. Thirdly, toward the operando measurement, we developed the manipulator with eight electrodes that can contact the electrodes on a special sample holder.

In this presentation, we will briefly report on the current status of SARPES at BL-9B and the obtained experimental results for the period 2018-2023. In addition to the BL-9B instrument, we will also report on the status of the μ-laser-SARPES instrument that was recently successfully developed[2]. Future prospects for these instruments will also be presented.

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ALBA Synchrotron radiation techniques for oxide, 2D-vdW and other spintronic materials

Manuel Valvidares[a]

[a]*ALBA Synchrotron Light Source, Cerdanyola del Vallès, 08290 Barcelona, Spain*

The talk will cover capabilities at ALBA synchrotron for investigating current aspects on oxide, bidimensional van der Waals materials and other spintronic relevant materials. First, a quick overview of ALBA and the Electronic and Magnetic structure of matter section will be given, including details of its core beamlines and instruments: the X-ray Photoemission Electron Microscope (X-PEEM) at CIRCE beamline[1], the X-ray Absorption Spectroscopy and Magnetic Circular Dichroism (XMCD) cryomagnet and the multipurpose reflectometer for soft x-ray resonant and coherent scattering (RSXS, XRMS, GISAXS, Holography/CDI) at BOREAS beamline[2], and the more recent soft X-Ray angle-resolved photoemission electron spectroscopy (ARPES) instrument at LOREA beamline [3]. On a second part, recent highlights on the investigation of spintronic and quantum materials will be shown, and recent and on-going instrumental developments will be quickly presented.

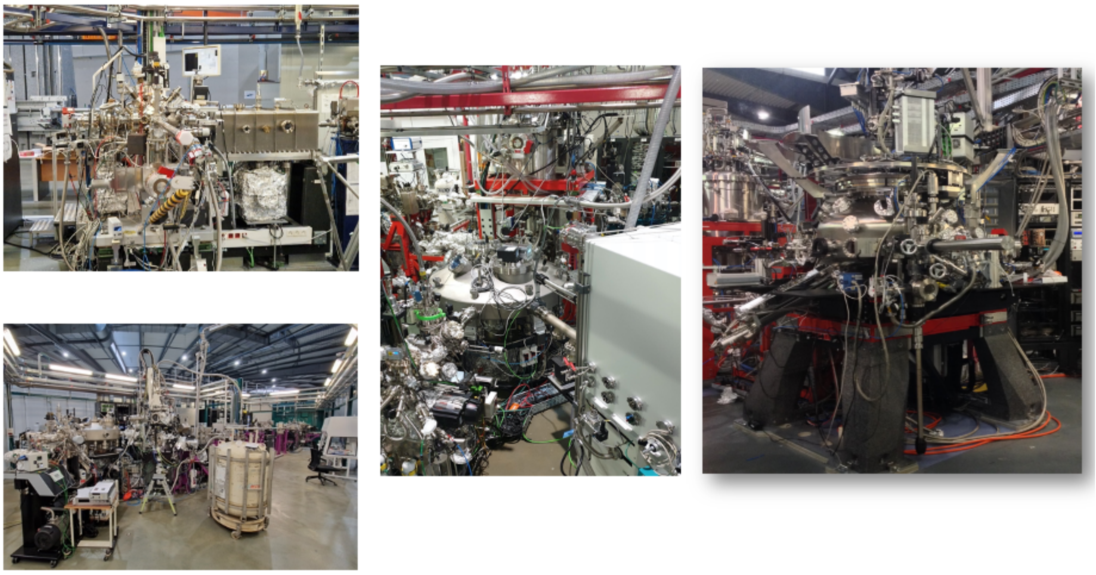

FIGURE 1. Core instruments of the electronic and magnetic structure section of the ALBA synchrotron: (left top) PEEM microscope endstation; (left bottom) view of ARPES instrument and LOREA beamline; (mid) XMCD endstation and off-line surface science instrumentation and glove box; (right) SXRS endstation

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3. M. Tallarida et al. *LOREA, the ARPES beamline at ALBA synchrotron (under preparation)*

Magnetic and Electronic property of transition metal phosphides interface of Ni_xP/Fe_2P

Naoyuki Maejima[a,b,c], Yuma Kuwabara[a], Tomoya Yoshida[a], Takahiro Ota[a], Yuki Shimato[a] and Kazuyuki Edamoto[a,b]

[a] Coll. Sci., Rikkyo Univ., Tokyo 171-8501, Japan.
[b]Research Center for Smart Molecules, Rikkyo Univ.,Tokyio 171-8501, Japan.
[c] Institute for Molecular Science, Okazaki 444-8585, Japan.

Transition metal Phosphide with Fe_2P-type structure is promising candidates for magnetic refrigerant materials.[1] $(Fe_{1-x}Ni_x)_2P$ exhibit ferromagnetic properties at room temperature for $x < 0.8$. The Curie temperature decreases with increasing x and it exhibit a Pauli paramagnet behavior for x>0.5. [2] The Curie temperature can be controlled by adjusting the ratio of Fe and Ni. Additionally, experimental and computational studies suggest that the magnetism of $(Fe_{1-x}Ni_x)_2P$ involves mainly the Fe sites and little or no Ni sites. [3] The change in the magnetic properties is consider to involve a change in electronic state due to the Fe and Ni substitution. However, there are few experimental investigations of magnetic properties and electronic states about the same system.

Recently, we have succeeded in fabricating Ni phosphide thin films on Fe_2P substrates. In generally, surfaces and interfaces often exhibit different magnetic properties from those in the bulk. It is interesting that the new magnetic properties will appear or not in this transition metal phosphide thin film and interface, however there is few reports about the magnetic properties of this kind of materials. In this study, we investigated the magnetic and electronic properties of the thin films and interfaces of Ni_xP/Fe_2P samples using X-ray magnetic circular dichroism (XMCD) and X-ray photoelectron spectroscopy (XPS) measurements.

Fe_2P(10-10) were cleaned by cycles of Ar^+ ion spattering (0.5 keV) and 750°C annealing. The cleaned surfaces showed c(2x2) Low energy electron diffraction (LEED) patterns. Ni atoms were deposited on the Fe_2P clean surface at 500°C, which induces phosphorization of the film owing to surface segregation of P atoms from the bulk.[4] The thickness of thin film was controlled by amount of Ni. Prepared Ni_xP/Fe_2P samples exhibit c(2x2) LEED pattern. The XMCD measurement of Fe_2P(10-10) and Ni_2P(10-10) clean surfaces and Ni_xP/Fe_2P thin film samples were performed at BL14 of HiSOR at room temperature. The XPS measurement of those samples were performed at BL5U of UVSOR and BL3B of PF.

Firstly, we measured Fe L edge and Ni L edge XMCD spectra of the Ni_xP/Fe_2P sample. The thickness of nickel phosphide layer was estimated 5Å. The Fe Ledge XMCD signal obtained from the Ni_xP/Fe_2P sample was significantly increased from that of clean Fe_2P substrate sample. Ni phosphides such as Ni_2P, Ni_3P, and NiP_3 are paramagnetic,[5] and Ni_2P substrates did not show XMCD signals. On the other hand, Ni_xP/Fe_2P samples showed XMCD signals at the Ni L edge. The peak top energy of the Fe L_3 edge of the thin film sample is lower than that of the Fe_2P clean surface and the peak top energy of the Ni L_3 edge of the thin film sample is higher than that of Ni_2P clean surface.

Secondly, we measured Fe L edge XMCD spectra obtained from various thickness Ni_xP/Fe_2P samples as shown in Figure1. Thickness dependence of XMCD signal was confirmed. These results indicated that the interaction between the thin film and the substrate changed the Curie temperature of the substrate and magnetic property of Ni phosphide thin film.

Combining XMCD and XPS results, we will discuss about this relationship of magnetic and electronic properties Ni_xP/Fe_2P samples.

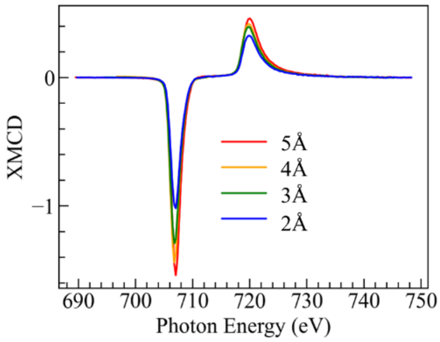

FIGURE 1. Fe L edge XMCD spectra obtained from various thickness Ni_xP/Fe_2P samples.

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Recent status of HiSOR BL-14

Magnetic interaction intermediated through a monatomic insulating layer, studied by XMCD experiment and computational method

Xueyao Hou and Masahiro Sawada

Hiroshima Synchrotron Radiation Center, Hiroshima University, 2-313 Kagamiyama, Higashi-Hiroshima, 739-0046, Japan

HiSOR-BL14 is a soft X-ray beamline whose energy range is between 400 and 1200 eV, aimed at X-ray absorption spectroscopy and related dichroic experiments for transition metals and their compounds [1, 2]. In recent several years, we have especially devoted our activity to X-ray magnetic circular dichroism (XMCD) experiment, which is a powerful tool to study magnetic properties and to analyze the local magnetic moment element-specifically for magnetic layers grown on single crystal surfaces. To extract the intrinsic nature of magnetism without influence of oxidation or surface contamination, we have constructed an *in-situ* experiment system at HiSOR-BL14, where all experiments of a sample fabrication, characterization and XMCD measurements can be conducted under ultra-high vacuum (UHV) at the same time [3].

Magnetic tunnel junction (MTJ) is one of important magnetic layered structures related to device applications. Epitaxial MTJ with well-ordered interfaces shows high-performance in tunneling magnetic resistance (TMR) effect, since coherent tunneling between the magnetic electrode layers is realized with keeping orbital symmetry of the wave function of the tunneling electron. Epitaxial MTJ with an ultrathin burrier layer is a good solution compatible with both high-MR-ratio and high-speed-access, ensured by impedance low enough against minimized cross section in highly integrated TMR memory cell. Hexagonal boron nitride (h-BN) is one of ideal monolayers as candidate for the ultrathin burrier layer in TMR devices.

Essentially, magnetic state at the MTJ interface affects device performance in the TMR memory cell, and besides, interlayer magnetic interaction is crucial in the control of memory bit and exchange bias effect. We have focused on the interfacial and interlayer magnetic properties in the monatomic layers of Co/h-BN/Ni(111), Fe/h-BN/Ni(111) [4], and FeMn/h-BN/Ni(111), using our *in-situ* XMCD system. In all the cases, antiferromagnetic (AFM) coupling between both sides of magnetic layers were found through the monolayer of h-BN, and the AFM coupling energies were depending on magnetic elements of the top layer.

The electronic structure calculation is a powerful tool to know microscopic origin of specific magnetic and electronic properties emerge in artificial layers and interfaces [5]. We have adopted first principle calculation (VASP) for a realistic slab model corresponding to the ultrathin TMR structure of Co/h-BN/Ni(111). The computational analysis shows a magnetic interaction chain of spin-polarized bonding orbital plays essential role in the AFM coupling through a monatomic layer of h-BN.

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Superconductivity and Flat Bands at the Fermi Level

Dan Dessau

University of Colorado, Boulder, Colorado, 80309, USA
Dessau@Colorado.edu

I discuss a few interesting superconductors with either very flat bands at the Fermi level or suspected flat bands at the Fermi level, with measurements from high resolution ARPES. I will focus on the case YFe_2Ge_2 that we showed has very heavy bands (m_{eff}~25me) within ~10meV of the Fermi level, which is extremely high for a non-f electron system [1]. I will discuss the origins and implications of such flat bands in these and other materials.

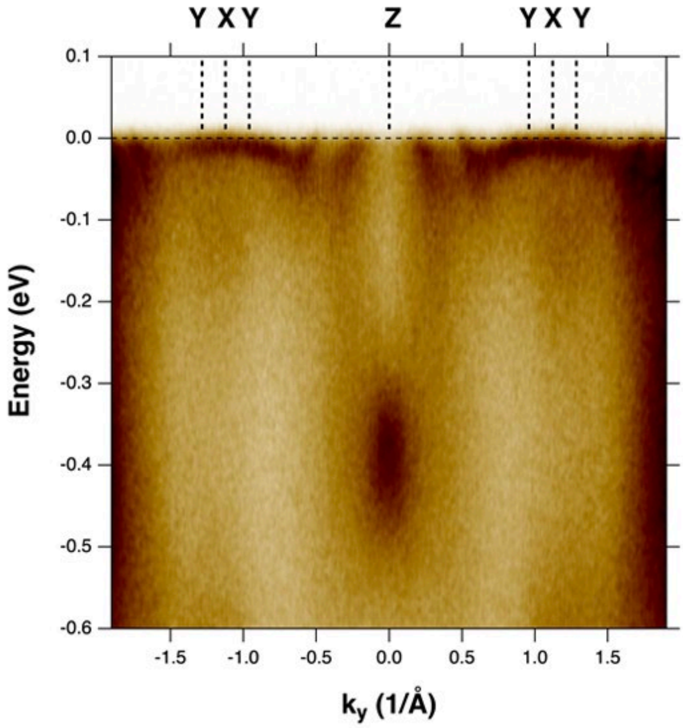

FIGURE 1. Very flat bands at E_F in the anomalous superconductor YFe_2Ge_2.

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Annealing Effects in Topological α-Sn/InSb Heterostructures Revealed by Photoemission Spectroscopy

Walid Malaeb[a], Kohdai Inagaki[b], Masaaki Tanaka[b,c], Le Duc Anh[b,c] and Masaki Kobayashi[b,c]

[a]*Department of Natural Sciences, Lebanese American University, 1102-2801 Beirut, Lebanon*
[b]*Department of Electrical Engineering and Information Systems, The University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-8656, Japan*
[c]*Center for Spintronics Research Network (CSRN), The University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-8656, Japan*

There has been much interest recently in exploring the electronic structure of novel topological materials due to their exotic underlying physics and great potential for applications. In particular, α-Sn has gained much attention due to its simple elemental structure, non-toxic nature and the diverse tunable topological phases it can reveal ranging from a topological insulator (TI) to a topological Dirac semimetal (TDS) depending on the applied strain [1]. Angle-resolved photoemission spectroscopy (ARPES) has uncovered various aspects of the electronic structure of α-Sn including the predicted linear bands and Dirac cones [2]. However, there is an urging need to explore the stability of this compound under various conditions which is an important requirement for successful use in applications especially in spintronic devices.

In this talk, we will mainly discuss about the annealing effects on the electronic structure of α-Sn/InSb heterostructures as revealed by x-ray photoemission spectroscopy (XPS). Interestingly, our XPS results demonstrate the thermal stability of α-Sn thin films over InSb substrates up to 350 °C. By studying both core-level and valence-band spectra, it was concluded that no dramatic evaporation and no α to β phase transition has occurred in the α-Sn thin films. This presents robust evidence for the reliability of using this compound in devices up to high temperatures.

We will also present an overview on our previous work and our future perspectives for using HiSOR for high-resolution ARPES studies on high-T_c superconductors and other novel materials.

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Recent Developments of ARPES Studies at HiSOR BL-1

Shin-ichiro Ideta[a,b], Masashi Arita[b], Shiv Kumar[c], Yudai Miyai[a],
Yogendra Kumar[a], Amit Kumar[d], Kenya Shimada[a,b]

[a] *Graduate School of Advanced Science and Engineering, Hiroshima Univ., Higashi-Hiroshima 739-0046, Japan*
[b] *Hiroshima Synchrotron Radiation Center (HiSOR), Hiroshima Univ., Higashi-Hiroshima 739-0046, Japan*
[c] *Institute of Microelectronics (IME), Agency for Science, Technology and Research, 138632, Singapore*
[d] *Max Planck Institute of Molecular Plant Physiology, Am Mühlenberg 114476 Potsdam Brandenburg, Germany*

Keywords: Angle-resolved photoemission, electronic structure, synchrotron radiation, laser

The Hiroshima Synchrotron Radiation Center (HiSOR) is the synchrotron radiation facility established at Hiroshima University. A compact 700 MeV electron-storage ring produces synchrotron radiation in the ultraviolet (VUV) and soft x-ray range. Tunable photon energy in this range is indispensable and valuable for studying the fine electronic structures of novel materials such as superconductors, topological insulators, and Weyl semimetals etc., employing high-resolution angle-resolved photoemission spectroscopy (APRES).

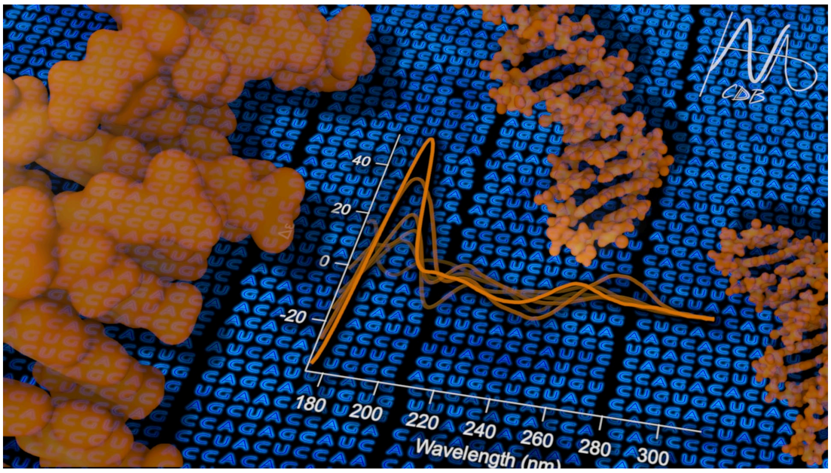
Recently, to perform surface mapping in synchrotron radiation, based on the research and developments, we have reduced the beam size of the synchrotron radiation by using a focusing mirror and to perform detailed measurements by improving the accuracy of the manipulator system. In BL-1 (high-resolution ARPES beamline), the beam size of the synchrotron radiation is reduced by order of magnitude (beam size: ~50-60 μm). In addition, we have installed new analyzers for the beamline of BL-1 to realize fast Fermi surface mapping. In near future, we install the laser ARPES system at the endstation of BL-1 and will open soon.

In this presentation, we will show the details of recent developments in HiSOR beamline (BL-1) towards the HiSOR-II projects.

SRCD/OCD at DISCO overview and highlights

Frank Wien[a]

[a] *Synchrotron SOLEIL, DISCO Beamline, L'Orme des Merisiers, Départementale 128, 91190 Saint-Aubin, FRANCE*



Synchrotron Radiation Circular Dichroism and Orientated Circular Dichorism spectroscopy at DISCO beamline (Synchrotron SOLEIL) measures the differential absorption of circular right and left polarized light in the Ultra-Violet range by chiral molecules, like nucleic acids and proteins for instance. In the spectral range between 7 and 4 eV, electronic transitions (n-π*, π -π* and charge transfer) are at the origin of the UV-light absorption. Characteristic absorption bands of circular (right or left) polarized UV light allow to distinguish different types of folding of these complex biological macromolecules. Their spatial arrangement correlates with the CD spectra and ultimately aids to determine the folding of proteins, nucleic acids and their complexes.
For the past two decades biologists have collected, deposited and screened CD spectra obtained from proteins (Ref. **PCDDB**) permitting them to successfully determine secondary structure content (alpha helices, beta sheets and random coils) for amyloids, membrane proteins and protein-protein complexes notably. Reference (Ref. **BeStSel**)

For Nucleic acids, scientists have published spectra dating back as far as the late 50's. Our first goal has been achieved now by systematically digitalizing nucleic acid CD spectra from the literature. In addition, data collected recently at the DISCO beamline at SOLEIL Synchrotron have been added including hundreds of Synchrotron Radiation Circular Dichroism (SRCD) spectra. All these spectra have now been deposited in a public repository (Ref. **NACDDB**), which archives and freely distributes the experimental data including metadata (sample conditions like pH, salinity and temperature), structural models and links to the corresponding references, extending the CD spectroscopy and structure information publicly accessible through the internet in contrast to time consuming literature research and visual comparison. It is our aim to create an algorithm allowing to determine the folding of nucleic acids (RNA and DNA) similar to BeStSel for proteins.

PCDDB: Ramalli SG et al. J Mol Biol 167441 (2022)

BeStSel: Micsonai A et al. Nucleic Acids Res. gkac345 (2022)

NACDDB: Cappannini A, et al. Nucleic Acids Res. gkac829 (2023)

Recent Advancements in HiSOR-VUVCD Spectrophotometer for Characterizing Biomolecule Structures

Koichi Matsuo & Mohamed Ibrahim

Hiroshima Synchrotron Radiation Center, 2-313 Kagamiyama, Higashi-Hiroshima, Hiroshima, 739-0046, Japan

Circular dichroism (CD), which refers to the difference in absorbance between left- and right-circularly polarized light, is a well-established technique for monitoring the steric structures of chiral molecules, particularly biomolecules (e.g., natural products, proteins, DNA, and polysaccharides). The usage of synchrotron radiation (SR) as a light source has further enhanced the usefulness of this spectroscopic method. This enhancement includes extending the wavelength range of CD spectra into vacuum-ultraviolet (VUV) region (down to 140 nm) [1, 2], developments of new VUV-CD analytical methods combined with computational science, and the installation of the linear dichroism (LD) and spatial- and time-resolved measurement systems. In this study, we introduce the recent progress in VUVCD techniques using SR in HiSOR for characterizing the structures of biomolecules.

The relationship between chromophores of steric configurations and their substituents in organic compounds or natural products can be analyzed based on the sign of CD (positive or negative). For instance, the absorption of allene occurred around 180 nm, and the absolute configuration of its substituents was determined from the CD sign in the VUV region [3]. Similarly, acetal bonds and hydroxyl groups of sugars also exhibited CD peaks around 170 nm. However, determining configurations from the CD sign was a challenge, as even mono-saccharides exist in an equilibrium state composed of six isomers. While molecular dynamics simulation and time-dependent density functional theory have successfully reproduced the unique CD of each isomer, disclosing their steric configurations including intra- and inter-molecular hydrogen bonding network [4].

The CD analysis of globular proteins combined with bioinformatics and LD enables estimating of the contents, numbers of segments, sequences, and orientations of secondary structures of proteins. This combination method was applied to elucidate the mechanism of protein-membrane interaction related to drug transportation into cell, myelin formation around neuron cells, and antimicrobial activity in immune system [5,6,7]. Further, the time-resolved system installed into the CD instrument realized the kinetics analysis of conformational changes of protein during membrane interaction processes. The use of micro beam with Schwarzschild objective or lenses enables CD measurement of microvolume rare sample and position-dependent CD. This system facilitated elucidating the mechanism of DNA damage response in X-ray irradiated human HeLa cells [8] as well as measuring the spatial-resolved CD of liquid and solid samples.

VUVCD analysis was extended to investigate the structuration of microbial exopolysaccharides (EPS) sourced from the marine environment, along with biocompatible polymers (i.e., bioplastics) synthesized by bacteria. Structural variations due to sample sources, concentrations, and pH levels, as well as their compatibility with cell membranes, were examined to compare their distinct biological functions, such as proinflammatory activity [9,10].

The CD technique with SR light source would further enhance the performance of chiral spectroscopy and open a pathway of next-generation of molecular chirality research.

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DELTA - a university-based synchrotron light source

Shaukat Khan

Center for Synchrotron Radiation (DELTA) and Department of Physics
TU Dortmund University, Maria-Goeppert-Mayer-Str. 2, 44227 Dortmund, Germany
shaukat.khan@tu-dortmund.de

DELTA is a 1.5-GeV synchrotron radiation source operated by the TU Dortmund University in Germany. As a university-based facility with emphasis on research and education, it offers a high degree of flexibility for user experiments and a relatively large amount of beamtime for accelerator studies. The beamlines with short-wavelength radiation from a superconducting 7-T wiggler are regularly overbooked. The talk will give an overview of the light source and then concentrate on accelerator physics activities. Since 2011, the interaction of femtosecond laser pulses with the electron beam is being investigated in view of generating ultrashort radiation pulses in the vacuum-ultraviolet regime as well as the coherent emission of terahertz pulses [1]. Recently, an electromagnetic undulator was reconfigured to demonstrate the echo-enabled harmonic generation (EEHG) scheme, where a twofold laser-electron interaction is employed to reach shorter wavelengths [2]. This worldwide first EEHG implementation at a storage ring is not intended to be a user facility but will explore the feasibility and limitations of this novel scheme with a compact setup [3]. Yet another recent activity is the study of synchrotron photons from a single electron in the storage ring.

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Compact synchrotron light source HiSOR
- Present status and future prospects -

Masahiro Katoh[a]

[a]*Hiroshima Synchrotron Radiation Center, Hiroshima University, 2-313 Kagami-yama, Higashi-hiroshima 739-0046, Japan*

Keywords: Synchrotron, Accelerator, Electron.

The light source accelerator system at the Hiroshima Synchrotron Radiation Center (HSRC) consists of a 150 MeV injector microtron, a beam transport line, and a racetrack type storage ring. This system is called HiSOR (Hiroshima Synchrotron Orbital Radiation). The circumference of this ring is 22 m, and the bending radius is 0.87 m in the normal conducting bending magnet with high magnetic field of 2.7 T. Stored electron beam energy is 700 MeV, and synchrotron radiation having the critical energy of 873 eV from two 180-degree bending magnets can be extracted through 14 photon beam ports. There are two straight sections in the ring and two undulators are installed there. One is a linear undulator (2.4 m long, 57 mm period. Another is the variable polarization undulator (1.8 m long, 78 mm period). They provide high brightness VUV radiation to the photoelectron spectroscopy beam-lines.

HiSOR has been successfully operated since 1996. Operation hours exceed 2,000 hours in each year, and users' operation hours are about 1,600 hours. The machine is running 11 hours a day (with 2 injections) and 4 days a week. Monday is reserved for machine tunings, machine studies and maintenances. The machine startup in the morning takes 30 minutes. It is almost possible to make a turn-key operation for normal use. The beam is about 300mA just after the energy ramping and about almost a half just before the re-injection. Although the 24-hour operation has been requested from users, it is difficult to realize it due to the lack of manpower.

In the early 2010s, we had a significant issue regarding the leakage of cooling water from the synchrotron radiation absorbers into the ultra-high vacuum chamber in the dipole magnets. Unfortunately, this issue has recurred this year, approximately 10 years later. The absorber was temporally repaired to recover the accelerator as soon as possible. It should be replaced with new one, whose mechanical design would be reconsidered, in the nearest future.

We evaluated the necessity and urgency of the aging-related issues of the accelerator components, and have been replacing those one by one. We are currently promoting the replacement of the pulsed electromagnet power supply for beam injection, which would utilize semiconductor devises instead of a thyratron for the switching element. The replacement would be in the summer of 2025.

The control systems of the undulators are being upgraded. In FY2023, it was improved within the existing accelerator control system framework, so that they can be controlled from the beam-line control system. However, the response speed is not sufficiently high as requested from the users. In addition, the accuracy of the closed orbit correction is not sufficiently high and the experiments in the other beam-lines are perturbed by the undulator gap changes. To address these, we are going to install a totally new control system which is equivalent to that used in UVSOR.

Since the upgrade of the present HiSOR storage ring is not realistic because it is designed so compact and has no redundancy to introduce new ideas or apparatus. Therefore, for the future plan, a new storage ring HiSOR-2 has been designed. We are preparing several plans to flexibly adapt to the situations of the synchrotron radiation science in our country and also of Hiroshima university. The beam energy of HiSOR-2 would be 500 MeV, which is appropriate to produce high brightness VUV radiation with a compact ring. We have designed a ring with a circumference of approximately 50m but also are designing a more compact one with a circumference below 40m. Although construction of a full energy injector is included in the plan, we are also considering usage of the current HiSOR storage ring as a full-energy injector for HiSOR-2.

To prepare for future plans, we are conducting researches on new accelerator technologies, such as new injection scheme using pulse multipole magnets, accelerator control by machine learning and permanentelectric hybrid magnets. These development researches are being conducted in the collaboration with KEK-PF, UVSOR, and Nagoya University. This year, the accelerator groups of KEK-PF, UVSOR, Nagoya University and HiSOR have initiated regular monthly information exchange meetings. The collaboration aims not only to advance joint developments of new technologies but also standardization of accelerator components and maintenance parts, all of which would be effective in the reductions of the cost and the manpower for operating and maintaining the present machine and for developing the future accelerators. HiSOR-2 would be almost diffraction-limited VUV source. We continue researches on developing new light source technologies in collaboration with UVSOR. The graduate and undergraduate students join these researches. Some of them are conducted under the support of KEK's Accelerator Science International Education Program (IINAS-NX).

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The order of flash poster session

Thursday, 14 March, 2024 13:30 – 14:30

The flash talk is about 1～2 min/person.

P02S	Experimental Study on Single Electron Storage Presenter: Y. Asai (Hiroshima University)
P04S	Unexpected two-fold symmetry of the electronic structure in heavily overdoped Bi2201 observed by angle-resolved photoemission spectroscopy Presenter: Y. Miyai (Hiroshima University)
P05S	Comprehensive Studies of the Electronic Structure for the Double-layer high-T_c Superconductor $Bi_2Sr_2CaCuO_{8+\delta}$ – Revisit of the Phase Diagram by ARPES Presenter: Y. Tsubota (Hiroshima University)
P06S	Probing the Electronic Band Structure of Altermagnetic MnTe: An ARPES Study Presenter: Kazi Golam Martuz (Hiroshima University)
P07S	Effects of Quantum Charge Fluctuations on the Electron Self-energy of High-T_c Cuprate Superconductors Using Angle-Resolved Photoemission and Inverse Photoemission Spectroscopies Presenter: Y. Onishi (Hiroshima University)
P08S	Observation of Topological Surface States and Non-symmorphic Band Degeneracy in Superconducting PdSeTe Single-crystal Presenter: Y. Kumar (Hiroshima University)
P09S	Strain-Induced Relocation of Topological Surface States in Bi_2Se_3 Single Crystal Presenter: Y. Kumar (Hiroshima University)
P10S	Research of Charge Fluctuations in the Electron-doped High-T_c Cuprate NCCO Revealed by ARPES and IPES Presenter: H. Yamaguchi (Hiroshima University)
P15S	Fermi surface of chiral magnet $Yb(Ni_{1-x}Cu_x)_3Al_9$ observed by ARPES Presenter: Y. Tanimotoa (Hiroshima University)
P17S	Preparation of Pt Thin Film on MgO (001) and Observation of Its Electronic Structure Presenter: T. Asano (Hiroshima University)

P18S	Attempt to Control the Anisotropy of Topological Surface States Presenter:　R. Yamamoto (Hiroshima University)
P19S	Spin-polarized electronic states of FeCo thin film on Rh(001) substrate Presenter:　K. Kunitomo (Hiroshima University)
P21S	Demonstration of phase-resolved spin-ARPES on topological surface states in Bi_2Te_3 Presenter: T. Kousa (Hiroshima University)
P22S	Performance of laser-based SARPES with micrometer spatial and vector spin resolution at HiSOR Presenter: T. Iwata (Hiroshima University)
P26S	Monitoring the Self-Assembly of Alginate Hydrogel Using Synchrotron Radiation Circular Dichroism Presenter: T. Haga (Hiroshima University)
P27S	VUVCD Measurements of dried proteins and its application to protein-membrane interaction study Presenter: K. Hayashi (Hiroshima University)
P29S	Molecular orientation in polymer/fullerene blend films studied by NEXAFS Presenter: Y. Hanaki (Hiroshima University)
P30S	Charge Transfer in Gold Substrates and Nanoparticles Coated with Methyl Ester Substituted Aromatic Thiol Molecules Presenter: S. Tendo (Hiroshima University)

Poster Session

-Poster Session-

The poster number with "S" is eligible for the Best Student Poster Award nomination.

P01 Research and Development of Magnet for HiSOR-II

Y. Lu[a], M. Shimada[c,a] , H. Miyauchi[c,a], M. Katoh[a,b]

a Hiroshima Synchrotron Radiation Center, Hiroshima University, HSRC, Japan
b Institute for Molecular Science, Okazaki, IMS, Japan
c High Energy Accelerator Research Organization, KEK, Japan

P02S Experimental Study on Single Electron Storage

Y. Asai[a], H. Miyauchi[b, c], M. Shimada[b, c], M. Katoh[b, d]

a Graduate School of Advanced Science and Engineering Hiroshima University, Japan
b Hiroshima Synchrotron Radiation Center (HSRC), Hiroshima University, Japan
c High Energy Accelerator Research Organization (KEK), Japan
d UVSOR Synchrotron Facility, Japan

P03 Diffraction of Optical Vortex from Undulator

Y. Nishihara[a], M. Shimada[c,b], H. Miyauchi[c,b], K. Matsuo[b,a], M. Katoh[b,a,d]

a School of Science, Hiroshima University,, Japan
b Hiroshima Synchrotron Radiation Center (HSRC), Hiroshima University, Japan
c High Energy Accelerator Research Organization (KEK), Japan
d UVSOR Synchrotron Facility, Japan

P04S Unexpected two-fold symmetry of the electronic structure in heavily overdoped Bi2201 observed by angle-resolved photoemission spectroscopy

Y. Miyai[a], S. Ideta[b], T. Kurosawa[c], M. Oda[d], K. Tanaka[e], M. Arita[b]
K. Shimada[b]

a Graduate School of Advanced Science and Engineering, Hiroshima University, Japan
b Hiroshima Synchrotron Radiation Center, Hiroshima University, Japan
c Faculty of Science and Engineering, Muroran Institute of Technology, Japan
d Department of Physics, Hokkaido University, Japan
e UVSOR-III Synchrotron, Institute for Molecular Science,Japan

P05S Comprehensive Studies of the Electronic Structure for the Double-layer high-T_c Superconductor $Bi_2Sr_2CaCu_2O_{8+\delta}$
- Revisit of the Phase Diagram by ARPES

Y. Tsubota[a], Y. Miyai[b], S. Kumar[b,c] , K. Tanaka[d], S. Ishida[e], H. Eisaki[e],
S. Nakagawa[f], T. Kashiwagi[f], M. Arita[b], K. Shimada [a,b], S. Ideta[a,b]

a Graduate School of Advanced Science and Engineering, Hiroshima Univ., Japan
b Hiroshima Synchrotron Radiation Center (HiSOR), Hiroshima Univ., Japan
c Institute of Microelectronics (IME), Agency for Science, Technology and Research (A STAR), Singapore*
d UVSOR-Ⅲ Synchrotron, Institute for Molecular Science, Japan
e National Institute of Advanced Industrial Science and Technology (AIST), Japan
f Division of Materials Science, Tsukuba University, Japan

-Poster Session-

The poster number with "S" is eligible for the Best Student Poster Award nomination.

P06S Probing the Electronic Band Structure of Altermagnetic MnTe: An ARPES Study

K. G. Martuza[a], Y. Kumar[a], S. Kumar[b,c], S. Ideta[a,b] K. Shimada[a,b]
a Graduate School of Advanced Science and Engineering, Hiroshima University, Japan
b Hiroshima Synchrotron Radiation Centre (HiSOR), Hiroshima University, Japan
*c Institute of Microelectronics, Agency for Science, Technology and Research (A*STAR), Singapore*

P07S Effects of Quantum Charge Fluctuations on the Electron Self-energy of High–T_c Cuprate Superconductors Using Angle-Resolved Photoemission and Inverse Photoemission Spectroscopies

Y. Onishi[a], Y. Miyai[a], Y. Tsubota[a], K. Tanaka[c], S. Ishida[d], H. Eisaki[d], H. Sato[b], M. Arita[b], K. Shimada[a,b], S. Ideta[a,b]
a Graduate School of Advanced Science and Engineering, Hiroshima Univ., Japan
b Hiroshima Synchrotron Radiation Center (HiSOR), Hiroshima Univ., Japan
c UVSOR-Ⅲ Synchrotron, Institute for Molecular Science, Japan
d National Institute of Advanced Industrial Science and Technology (AIST), Japan

P08S Observation of Topological Surface States and Non-symmorphic Band Degeneracy in Superconducting PdSeTe Single-crystal

Y. Kumar[a], S. Kumar[b], Y. Venkateswara[d], R. Oishi[a], J. Nayak[c], T. Onimaru[a], S. Ideta[a,b], K. Shimada[a,b]
a Graduate School of Advanced Science and Engineering, Hiroshima University, Japan
b Hiroshima Synchrotron Radiation Centre (HiSOR), Hiroshima University, Japan
c Department of Physics, Indian Institute of Technology, India
d Department of Physics, SUNY Buffalo State University, USA

P09S Strain-Induced Relocation of Topological Surface States in Bi_2Se_3 Single Crystal

Y. Kumar[a], S. Kumar[b], S. Ideta[a,b], T. Okuda[a,b], K. Shimada[a,b]
a Graduate School of Advanced Science and Engineering, Hiroshima University, Japan
b Hiroshima Synchrotron Radiation Centre (HiSOR), Hiroshima University, Japan

P10S Research of Charge Fluctuations in the Electron-doped High-T_c Cuprate NCCO Revealed by ARPES and IPES

H. Yamaguchi[a], Y. Onishi[b], Y. Miyai[b], Y. Tsubota[b], M. Atira[c], K. Tanaka[d], H. Sato[c], D. Song[e], K. Shimada[b,c], S. Ideta[b,c]
a School of Science, Hiroshima Univ., Japan
b Graduate School of Advanced Science and Engineering, Hiroshima Univ., Japan
c Hiroshima Synchrotron Radiation Center (HiSOR), Hiroshima Univ., Japan
d UVSOR-Ⅲ Synchrotron, Institute for Molecular Science, Japan
e Stewart Blusson Quantum Matter Institute, University of British Columbia, Canada

-Poster Session-

The poster number with "S" is eligible for the Best Student Poster Award nomination.

P11 XPS study on the boron-doped amorphous carbon films

Y. Muraoka[a], K. Matuso[b], T. Wakita[a], T. Yokoya[a]
a AResearch Institute for Interdisciplinary Science, Okayama University, Japan
b Graduate School of Natural Science and Technology, Okayama University, Japan

P12 Synchrotron ARPES studies of nodal line semimetal $LaTe_{1+x}Bi_{1-x}$

R. Saito[a], Y. Okishi[a], T. Higashikawa[a], T. Wakita[a,b], Y. Kumar[c], Y. Miyai[c], H. Kageyama[a], R. Kondo[a], Y. Nogami[a], S. Ideta[c], K. Shimada[c], Y. Muraoka[a,b], T. Yokoya[a,b]
a Graduate School of Natural Science and Technology, Okayama University,, Japan
b Research Institute for Interdisciplinary Science, Okayama University, Japan
c Hiroshima Synchrotron Radiation Center, Hiroshima University, Japan

P13 Current Activities of Research and Education on BL-5 (FY2023)

T. Yokoya[a,b], T. Wakita[a], Y. Muraoka[a,b]
a Research Institute for Interdisciplinary Science, Okayama University, Japan
b Research Laboratory for Surface Science, Okayama University, Japan

P14 Visualization of boron distributions in cancer cells dosed with a boron delivery drug

T Wakita[a], K. Igawa[b], M. Kaneda[c], N. Ikeda[c], H. Terato[d], Y. Muraoka[a,c], T. Yokoya[a,c]
a Research Institute for Interdisciplinary Science, Okayama University, Japan
b INeutron Therapy Research Center, Okayama University, Japan
c Graduate School of Natural Science and Technology, Okayama University, Japan
d Advanced Science Research Center, Okayama University, Japan

P15S Fermi surface of chiral magnet $Yb(Ni_{1-x}Cu_x)_3Al_9$ observed by ARPES

Y. Tanimoto[a], M. Sugimoto[a], R. Kamimori[a], Y. Nakashima[b], H. Sato[c], K. Yamagami[d], M. Arita[c], S. Kumar[c], K. Shimada[c], S. Nakamura[e], S. Ohara[e]
a Graduate School of Advanced Science and Engineering, Hiroshima University, Japan
b Faculty of Science, Hiroshima University, Japan
c Hiroshima Synchrotron Radiation Center, Hiroshima University, Japan
d Japan Synchrotron Radiation Research Institute, Japan
e Graduate School of Engineering, Nagoya Institute of Technology, Japan

P16 ARPES study of $TiFe_xS_2$ (x = 0, 0.33)

Y. Nakashima[a], Y. Tanimoto[b], M. Sugimoto[b], H. Sato[c], Y. Miyai[b], S. Ideta[c], K. Shimada[c], M. Miyata[d], M. Koyano[d]
a Faculty of Science, Hiroshima University, Japan
b Graduate School of Advanced Science and Engineering, Hiroshima University, Japan
c Hiroshima Synchrotron Radiation Center, Hiroshima University, Japan
d School of Materials Science, Japan Advanced Institute of Science and Technology, Japan

P17S Preparation of Pt Thin Film on MgO (001) and Observation of Its Electronic Structure

T. Asano[a], K. Sumida[b], K. Kunitomo[a], T. Okuda[b], K. Miyamoto[b]
a Graduate School of Advanced Science and Engineering, Hiroshima University, Japan
b Hiroshima Synchrotron radiation Center (HSRC), Hiroshima University, Japan

-Poster Session-

The poster number with "S" is eligible for the Best Student Poster Award nomination.

P18S Attempt to Control the Anisotropy of Topological Surface States

R. Yamamoto[a], K. Sumida[b], K. Miyamoto[b], T. Okuda[b]
a Graduate School of Advanced Science and Engineering Hiroshima University, Japan
b Hiroshima Synchrotron Radiation Center (HSRC), Hiroshima University, Japan

P19S Spin-polarized electronic states of FeCo thin film on Rh(001) substrate

K. Kunitomo[a], K. Sumida[b], K. Miyamoto[b], C. Zhang[a], Y. Sakuraba[c], T. Okuda[b]
a Graduate School of Advanced Science and Engineering Hiroshima University, Japan
b Hiroshima Synchrotron Radiation Center (HSRC), Hiroshima University, Japan
c National Institute for Materials Science (NIMS), Japan

P20 Ultrafast Spin-Dependent Dynamics in a Carrier-Tuned Topological Insulator

K. Sumida[a], K. Kunitomo[b], M. Kakoki[b], K. A. Kokh[c], O. E. Tereshchenko[c], J. Reimann[d], J. Güdde[d], U. Höfer[d], K. Miyamoto[a], T. Okuda[a,e], A. Kimura[b,e]
a Hiroshima Synchrotron Radiation Center, Hiroshima University, Japan
b Graduate School of Advanced Science and Engineering, Hiroshima University, Japan
c Physics Department, Novosibirsk State University, Russia
d Department of Physics and Materials Sciences Center, Philipps-University, Germany
e International Institute for Sustainability with Knotted Chiral Meta Matter (SKCM2), Japan

P21S Demonstration of phase-resolved spin-ARPES on topological surface states in Bi_2Te_3

T. Kousa[a], T. Iwata[a,b], S. Kumar[c], A. Kimura[a,b], K. Miyamoto[c], T. Okuda[b,c] K. Kuroda[a,b]
a Graduate School of Advanced Science and Engineering, Hiroshima University, Japan
b International Institute for Sustainability with Knotted Chiral Meta Matter(WPI-SKCM2), Hiroshima University, Japan
c Hiroshima Synchrotoron Radiation Center, Hiroshima University, Japan

P22S Performance of laser-based SARPES with micrometer spatial and vector spin resolution at HiSOR

T. Iwata[a,b], T. Kousa[a], A Y. Nishioka[a], K. Ohwada[a], K. Sumida[c], E. Annese[d], M. Kakoki[a], K. Kuroda[a,b], H. Iwasawa[e], M. Arita[c], S. Kumar[c], A. Kimura[a,b], K. Miyamoto[c], T. Okuda[b,c]
a Grad. Sch. Adv. Sci. Eng., Hiroshima Univ., Japan
b WPI-SKCM¬2., Hiroshima Univ., Japan
c HiSOR, Hiroshima Univ., Japan
d Brazilian Center for Research in Physics, Brazil
e Institute for Advanced Synchrotron Light Source, National Institutes for Quantum Science and Technology, Japan

P23 Direct Observation of Spin-split Electronic Structures in Antiferromagnet NdBi by Laser-based SARPES

R. Yamamoto[a], T. Motoyama[b], T. Iwata[a,b], T. Kosa[b], Y. Nishioka[b], K. Ideura[b], M. Arita[c], S. Ideta[c], K. Shimada[a,c], K. Miyamoto[c], T. Okuda[a,c], A. Kimura[a,b], T. Onimaru[b], K. Kuroda[a,b]
a International Institute for Sustainability with Knotted Chiral Meta Matter (WPI-SKCM2), Hiroshima University, Japan
b Graduate School of Advanced Science and Engineering, Hiroshima University, Japan
c Hiroshima Synchrotron Radiation Center, Hiroshima University, Japan

-Poster Session-

The poster number with "S" is eligible for the Best Student Poster Award nomination.

P24 Secondary Structural Changes of FUS-LC induced with Phase-Separation observed by VUV-CD

K. Fujii[a], N. Maita[a], K. Matsuo[b], M. Kato[a]
a Institute for Quantum Life Science, National Institutes for Quantum Science and Technology, Japan
b Hiroshima Synchrotron Radiation Center, Hiroshima-university, Japan

P25 Insights into Physical Interactions and Structuration in Self-Assembled Azapeptide Hydrogels Through Spectroscopy Techniques

M. Ibrahim[a,b], J. Bodiguel[b], M. Averlant-Petit[b], K. Matsuo[a]
a Hiroshima Synchrotron Radiation Center (HiSOR), Hiroshima University, Japan
b Université de Lorraine, CNRS, LCPM, France

P26S Monitoring the Self-Assembly of Alginate Hydrogel Using Synchrotron Radiation Circular Dichroism

T. Haga[a], M. Yoshida[a], T. Haino[a], K. Matsuo[b], M. I.A. Ibrahim[b]
a Graduate School of Advanced Science and Engineering, Hiroshima University, Japan
b Hiroshima Synchrotron Radiation Center (HiSOR), Hiroshima University, Japan

P27S VUVCD Measurements of dried proteins and its application to protein-membrane interaction study

K. Hayashi[a], R. Imaura[a], K. Matsuo[a,b]
a Graduate School of Advanced Science and Engineering, Hiroshima University, Japan
b Hiroshima Synchrotron Radiation Center, Hiroshima University, Japan

P28 Optical Activity Measurement of Circularly Polarized Lyman-α Light Irradiated and Magnetic Field Applied Amino-acid Films

J. Takahashi[a], M. Kobayashi[b], G. Fujimori[c], H. Ota[d], K. Matsuo[e], Y. Taira[d], M. Katoh[d,e], K. Kobayashi[c,f], Y. Kebukawa[f], H. Nakamura[b]
a Doshisha University, Japan
b National Institute for Fusion Science, Japan
c Yokohama National University, Japan
d UVSOR Synchrotron Facility, Japan
e Hiroshima Synchrotron Radiation Center, Japan
f Tokyo Institute of Technology, Japan

P29S Molecular orientation in polymer/fullerene blend films studied by NEXAFS

Y. Hanaki[a], H. Yoshida[b,c], T. Sekitani[b,c]
a Faculty of Science, Hiroshima University, Japan
b Graduate School of Advanced Science and Engineering, Hiroshima University, Japan
c Hiroshima Synchrotron Radiation Center, Hiroshima University, Japan

-Poster Session-

The poster number with "S" is eligible for the Best Student Poster Award nomination.

P30S Charge Transfer in Gold Substrates and Nanoparticles Coated with Methyl Ester Substituted Aromatic Thiol Molecules

S. Tendo[a], A. Niozu[a], K. Yoshioka[a], J. Adachi[b], H. Tanaka[b], S. Wada[a,b]
a Graduate School of Science and Engineering, Hiroshima University, Japan
b Photon Factory, Institute of Materials Structure Science, KEK, Japan
c Hiroshima Synchrotron Radiation Center, Hiroshima University, Japan

P31 Ultrafast charge transfer through biphenyl and fluorene monolayers studied by core-hole clock spectroscopy

A. Niozu[a], K. Yoshioka[a], S. Tendo[a], S. Asakura[b], Y. Hanaki[b], J. Koizumi[b], Y. Ohura[b], J. Yamada[b], S. Wada[a, c]
a Graduate School of Science and Engineering, Hiroshima University, Japan
b Faculty of Science, Hiroshima University, Japan
c Hiroshima Synchrotron Radiation Center, Hiroshima University, Japan

P32 Soft X-ray Absorption Spectroscopy of Phospholipid Films Supported on Au Substrates by Different Casting Techniques

Y. Ohura[a], K. Yoshioka[b], S. Tendo[b], A. Niozu[a,b], S. Wada[a,b,c]
a Faculty of Science, Hiroshima University, Japan
b Graduate School of Science and Engineering, Hiroshima University, Japan
c Hiroshima Synchrotron Radiation Center, Hiroshima University, Japan