



SPRING-8/SACLA Research Frontiers 2023 CONTENTS

Preface	5
Editor's Note	6
Scientific Frontiers	7
Reviews	
 Ultimate condensation of synchrotron radiation X-rays and its application to exploring cutting-edge X-ray science <i>K. Yamauchi</i>	8
meV-resolved inelastic X-ray scattering <i>A. Q. R. Baron</i>	12
Life Science	
 Time-resolved Protein Crystallography: Structural evidence for intermediates during O ₂ formation in Photosystem II <i>A. Bhowmick, J. Kern, V. K. Yachandra and J. Yano</i>	16
 Time-resolved Protein Crystallography: The process of vision: Structure of ultrafast mammalian rhodopsin determined by time-resolved femtosecond crystallography <i>M. J. Rodrigues and V. Pannells</i>	18
 Time-resolved Protein Crystallography: Mapping protein dynamics at high spatial resolution with temperature-jump X-ray crystallography <i>E. Nango and M. C. Thompson</i>	20
Protein Crystallography: High resolution structure analysis of bacteriorhodopsin K intermediate <i>S. Taguchi, S. Niwa and K. Takeda</i>	22
Protein Crystallography: Identifying antibiotics based on structural differences in the conserved allostery from mitochondrial heme-copper oxidases <i>Y. Shintani and Y. Nishida</i>	24
Protein Crystallography: <i>De novo</i> discovery and structural analysis of thiopeptide pseudo-natural products acting as TNIK kinase inhibitors <i>A. A. Vinogradov, Y. Goto and T. Sengoku</i>	26
Protein Crystallography: Structural analysis of divalent cation block generated in the prokaryotic sodium channel <i>K. Irie</i>	28
Protein Crystallography: Structure of bifidobacterial sulfoglycosidase revealed the architecture for specific sugar recognition and breakdown of intestinal mucin glycan <i>S. Fushinobu, T. Katoh and T. Kashima</i>	30
Protein Crystallography: Structural basis of the type IVb pilus-dependent transport for the colonization factor of <i>Vibrio cholerae</i> <i>H. Oki, K. Kawahara and S. Nakamura</i>	32
Protein Crystallography: Structural basis for the recognition of citrate synthase by the SCF ^{Ucc1} ubiquitin ligase complex <i>K. Nishio, T. Mizushima and K. Nakatsukasa</i>	34


Protein Crystallography: Sweet/umami taste receptor-mediated chloride-sensation revealed by X-ray crystallographic analysis <i>A. Yamashita</i>	36
Bone-vascular Structures: Exploring the impact of whole-body vibration on bone metastasis and vascularization in a murine model of breast cancer <i>T. Matsumoto</i>	38
Long-term Morphological Trends: Synchrotron stories: Illuminating the past through foraminiferal imaging <i>H. L. Filipsson and C. Choquel</i>	40
Dinosaur Bone: Virtual osteohistology of paravian dinosaurs: from 2D to 3D perspective <i>M. Kundrát, K. Uesugi and M. Hoshino</i>	42
Dinosaur Bone: Investigating the micro-scale structures of macro-scale dinosaur bones using synchrotron radiation-based X-ray micro-tomography <i>T. Imai</i>	44

Physical Science

Heavy-Fermion: Impact of the U 5f states in the electronic structure of heavy-fermion superconductor UPd ₂ Al ₃ : Electronic structure study of ThPd ₂ Al ₃ <i>S. Fujimori</i>	46
Orbital Direct Imaging: Direct imaging of orbitals using hard X-ray photoelectron spectroscopy (HAXPES) <i>D. Takegami and L. H. Tjeng</i>	48
Antiferromagnetic Domain Imaging: Micromagnetic understanding of evolutions of antiferromagnetic domains in NiO <i>T. Moriyama</i>	50
 Ultrafast Magnetization: Ultrafast subpicosecond magnetization of a two-dimensional ferromagnet <i>L. D. Anh, M. Kobayashi and M. Tanaka</i>	52
 Laser-driven Shock Compression: Dislocations faster than transverse speed of sound <i>K. Katagiri, L. E. Dresselhaus-Marais and N. Ozaki</i>	54
Electron Density Analysis: Real-space observation of ligand holes in SrFeO ₃ <i>S. Kitou and T. Arima</i>	56
Machine Learning: Bayesian framework for analyzing adsorption processes observed via time-resolved X-ray diffraction <i>Y. Yokoyama, S. Kawaguchi and M. Mizumaki</i>	58
Oxygen Storage Material: Visualization of fast oxygen deintercalation reaction using time-resolved X-ray diffraction <i>T. Yamamoto</i>	60
Two-beam Topography: Transcription of atomic scale screw dislocation of silicon carbide crystal to X-ray vortex wave field <i>Y. Kohmura and K. Ohwada</i>	62
Thermoelectric Materials: Revealing microscopic origin of ultralow lattice thermal conductivity in thermoelectric InTe using inelastic X-ray scattering technique <i>J. Zhang and B. B. Iversen</i>	64
Negative Thermal Expansion: Design and domain structure observation of phase-transition-type negative thermal expansion material <i>T. Nishikubo</i>	66

Hydrogen Embrittlement: <i>In situ</i> three-dimensional investigation of hydrogen embrittlement in high strength aluminum alloys with modified precipitates <i>Y. Wang and H. Toda</i>	68
Interface Defect: Three-dimensional atomic imaging of interface defects between hydrogen-terminated diamond and amorphous Al ₂ O ₃ insulating film <i>T. Matsushita, Y. Hashimoto, M. N. Fujii and J. Mizuno</i>	70
XRD and XAFS: Hybrid structure analysis: Accurate and precise determination of the structure parameters of mono- and bimetallic spinels via iterative and alternating refinements of powder X-ray diffraction and X-ray absorption fine structure spectroscopy <i>K. Adachi and D. Hashizume</i>	72
Nuclear Physics: First measurement of $f_0(980)$ meson photoproduction in the $\pi^0\pi^0$ decay mode <i>Q. He and N. Muramatsu</i>	74

Chemical Science

 XFEL and Electron Crystallography: Comparative structural evaluation of serial X-ray free electron laser and electron crystallography <i>K. Takaba</i>	76
Methanol Synthesis Catalysts: <i>Operando</i> characterization of copper-zinc-alumina catalyst for methanol synthesis by ambient-pressure hard X-ray photoelectron spectroscopy <i>T. Koitaya and T. Yokoyama</i>	78
Nitrogen-doped Carbon: Synchrotron-radiation-based Mössbauer spectroscopy for investigating the structure of atomically dispersed NiN _x sites in (Ni, N)-doped carbon electrocatalysts <i>R. Masuda</i>	80
Bimetallic Catalyst: Discovery of <i>in situ</i> generated Pd–Au–C _x from Pd–Au during the acetoxylation of ethylene <i>Y. Nakaya and S. Furukawa</i>	82
Oxygen Reduction Reaction: Observation of hydrogen superoxide adsorption during ORR on Pt/C catalyst in acidic solution via <i>in situ</i> high-energy resolution fluorescence detection X-ray absorption spectroscopy (HERFD-XAS) <i>H. Tanaka and K. Ishi</i>	84
Tailor-made Molecular Frameworks: Self-assembly and interconversion of large polyhedral cages with highly entangled motifs <i>Y. Domoto and M. Fujita</i>	86
Li-ion Battery: Near-dimensionally invariable high-capacity positive electrode material <i>N. Yabuuchi, S. Hiroi and K. Ohara</i>	88
Catalytic Nanoclusters: Catalytic properties of surface-exposed silver nanoclusters within a ring-shaped metal oxide <i>K. Yonesato and K. Suzuki</i>	90
Fatigue Testing: Mechanical properties and structures under the deformation of thiophene copolymers with cyclic siloxane units <i>T. Matsumoto and T. Nishino</i>	92
Hydration: Direct observation of hydration and dehydration behaviors of poly(<i>N</i> -isopropylacrylamide) on silica beads through infrared spectroscopy <i>K. Nagase</i>	94

Earth & Planetary Science

Mantle Dynamics: Curved post-garnet phase boundary and its implications for mantle dynamics <i>T. Ishii and T. Katsura</i>	96
Conductivity of Core: Measuring the electrical resistivity of liquid iron to 1.4 Mbar <i>K. Ohta</i>	98
Oxidization of Magma: Fe ³⁺ -rich oxidizing magma formed by Fe ²⁺ redox disproportionation under high pressure <i>H. Kuwahara and R. Nakada</i>	100
Core Density: Density deficit of the Earth's inner core revealed by a multi-megabar rhenium primary pressure scale <i>D. Ikuta, E. Ohtani and A. Q. R. Baron</i>	102

Industrial Applications

Fuel Cells: Multiscale water visualization inside polymer electrolyte fuel cells <i>W. Yoshimune</i>	104
Perovskite Solar Cell: Confirmation of permeation of iodide and iodine into hole-transport layer in lead halide perovskite solar cell using hard X-ray photoelectron spectroscopy <i>T. Sekimoto</i>	106
X-ray Topography: Imaging of dislocations in β -Ga ₂ O ₃ via X-ray topography based on anomalous transmission <i>Y. Yao</i>	108

Accelerators & Beamlines Frontiers 110

SPring-8

Beam Performance - Insertion device	111
--	-----

SACLA

Beam Performance - Recent update on accelerator	112
--	-----

Facility Status 114

SPring-8

Introduction	115
Machine Operation	116
Beamlines	117
User Program and Statistics	120
Research Outcome	123
Research Complex	123
SPring-8 Users Community (SPRUC)	126
Outreach Activities	127

SACLA

Machine Operation, Beamlines, and User Program and Statistics	128
---	-----

SPring-8/SACLA

Budget and Personnel	129
----------------------	-----

Note: The principal publication(s) concerning each article is indicated with all author's names in italics in the list of references.